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HATCHING OF ATLANTIC SALMON (Salmo salar) IN AN ARTIFICIAL SUBSTRATE

by

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ABSTRACT
Atlantic salmon (Salmo salar) eggs were hatched in a Californian hatching system with and without Astro-turf. Growth, yolk absorbtion rate, yolk conversion efficiency, start feeding success and mortality are discussed.

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INTRODUCTION

This paper is a preliminar report on a study for a university thesis at the Department of Fisheries Biology, University of Bergen. The study is carried out in cooperation with the Division of Aquaculture, Institute of Marine Research.

The experiments were carried out at Matre Aquaculture Station and with financial support from the station.

Controlled hatching of salmonids in gravel is well known (see f.ex. Babcock (1911), Bailey and Taylor (1974), Bams (1970, 1972 and 1974) and especially Bams and Simpson (1977)).

Use of artificial substrates have also been reported by several authors (see f.ex. Leon (1975), Porter and Meerburg (1977), Eriksson (1980) and Hansen, Holm, Møller and Thorsen (1982)).

The Norwegian fish farming industry has severe mortality problems both in the hatchery and during the start feeding period.

In Norway standard hatching systems are being used, and the main purpose of this experiment was to investigate to what extent the environment in the hatching system effects the growth rate, survival rate and yolk conversion efficiency of the fry.

MATERIAL AND METHODS

Eyed eggs from a number of Atlantic salmon were pooled and six groups each containing 6 700 eggs (1.2 litre) were placed in separate hatching trays.

An EWOS traditional Californian hatching system was used, but three trays were modified as outlined in figure 1. The rest of the trays were used in the traditional way without modifications.

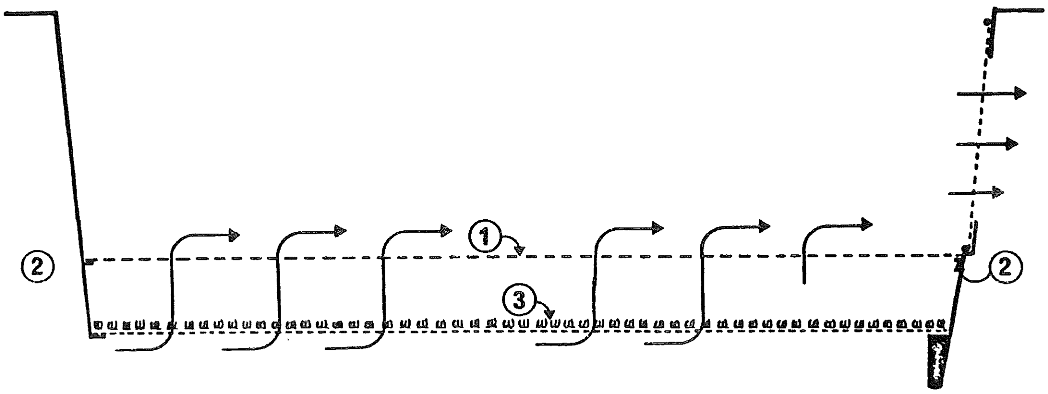

Figure 1. Outline of a modified hatching tray. The modifications are: 1. 3x20 mm perforated plastic screen. 2. Plastic strips. 3. Astro-turf. The big arrows indicate the water flow.

The Astro-turf (Monsauto) was sewn to the perforated aluminum bottom and the 3x20 mm perforated plastic screen was laid loose on plastic strips mounted just underneath the water outlet.

In the modified trays the eggs were placed on the perforated plastic screens. After hatching the alevins swam through the holes in the plastic screen and into the Astro-turf. The dead eggs are therefore prevented from fouling the Astro-turf. After hatching the perforated plastic screens were removed from the trays.

The water input was 10 litres per minute.

41 days after hatching 5 000 fry from each group were transferred to separate feeding units ($1m^2$) and fed dry feed pellets (Ewos no 1). After 19 days of feeding about 1 800 fish in one of the groups died because of an accidental stoppage in the water supply. Consequently all the groups were reduced to 3 200 fry and kept at this density throughout the start feeding period.

The mean, maximum and minimum water temperature and pH are presented in table 1.

Table 1. Mean, maximum and minimum temperature and pH for the periods from hatching to start feeding and during start feeding.

		HATCHING TO START FEEDING	START FEEDING
TEMP. °C	MEAN	6.3	12.4
	MAX-MIN	7.0 - 5.6	17.0 - 6.1
pH	MEAN	6.3	6.4
	MAX-MIN	6.7 - 5.8	6.5 - 6.3

Fish samples were preserved in 5% formaldehyde solution and later dried to constant weight (at least 24 hours) at 60°C. After drying, the whole alevins (total weight) and the yolk sacs were weighed separately. Individual body weight was then calculated (total weight minus yolk sac). Yolk sac constrictions were cut off and weighed in bulk for each sample. Yolk conversion efficiency was calculated from the data on body weight and yolk weight. The groups were sampled every 5 to 10 days.

RESULTS AND DISCUSSION

The dry weight development of the alevins in the two different systems are presented in figure 2.

The alevins reared in Astro-turf were significantly heavier (bodyweight) than the alevins reared on a flat screen nine days

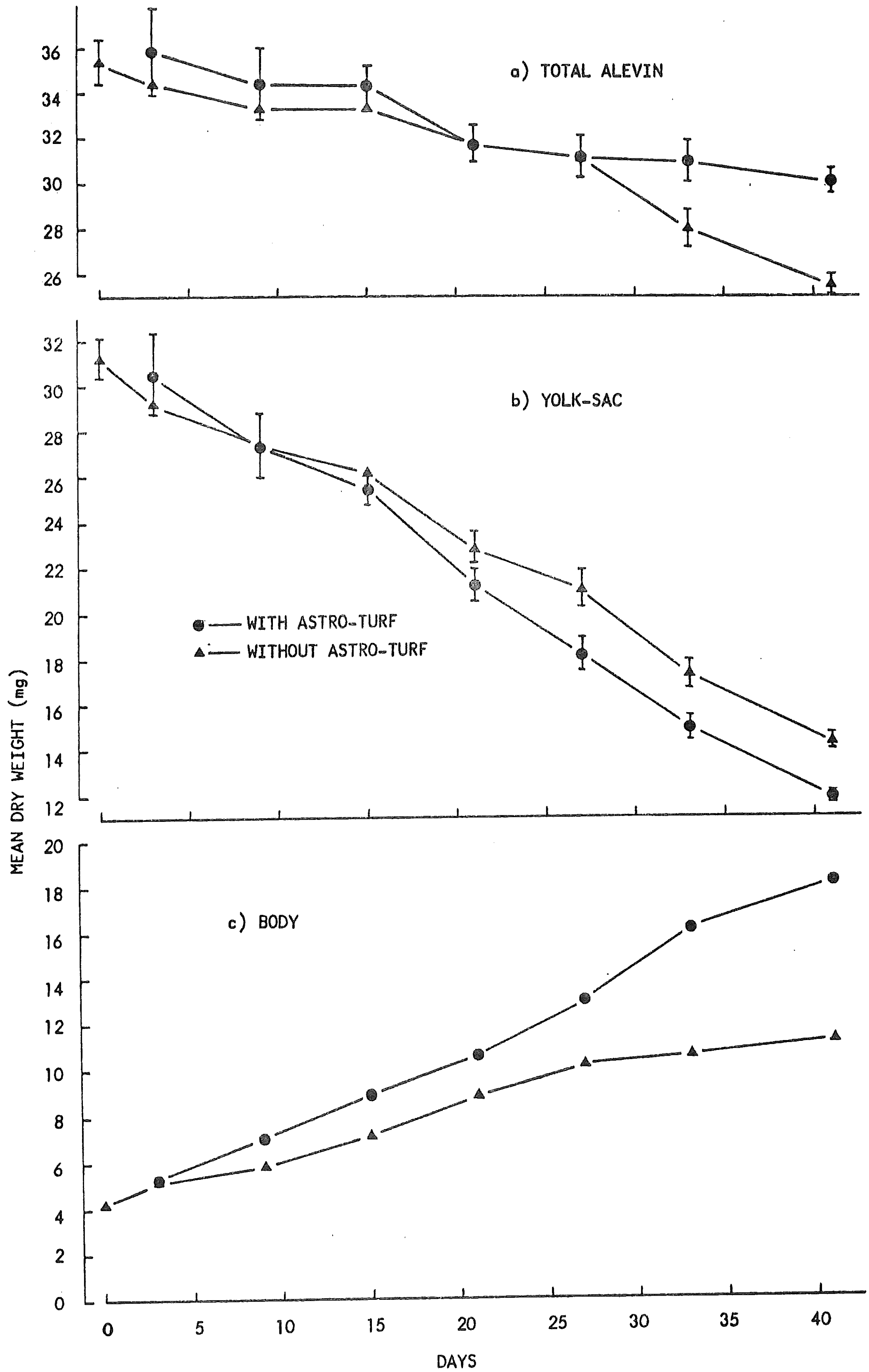

Figure 2. Development of mean dry weights of a) total alevin, b) yolk sac and c) body for Atlantic salmon hatched in systems with and without Astro-turf. Vertical lines indicate 95% confidence limits.

after hatching (fig. 2c). The difference in total weight was not significant until 33 days after hatching (fig. 2a). The results are in accordance with the results of Erikson (1980) and Hansen et al. (1982) who reported larger unfed Atlantic salmon fry when incubating the alevins in Astro-turf. Leon (1975) got improved growth rate of unfed Atlantic salmon fry when using plastic saddles as incubation media compared with traditional tramp.

Porter and Meerburg (1977) hatched Atlantic salmon in gravel as well as in Astro-turf. Statistically the fry from the gravel incubator were significantly larger than the fry from the Astro-turf incubator. The size difference was not considered to indicate a biologically significant difference in fry quality.

The alevins reared in Astro-turf absorbed their yolk sac more rapidly than the alevins reared on flat screen (fig. 2b). Plastic saddles has been found to have the same effect (Leon 1975).

The body growth rate of the alevins reared on a flat screen decreased markedly at the end of the yolk sac period. This is probably the result of a drop in the yolk conversion efficiency (fig. 3).

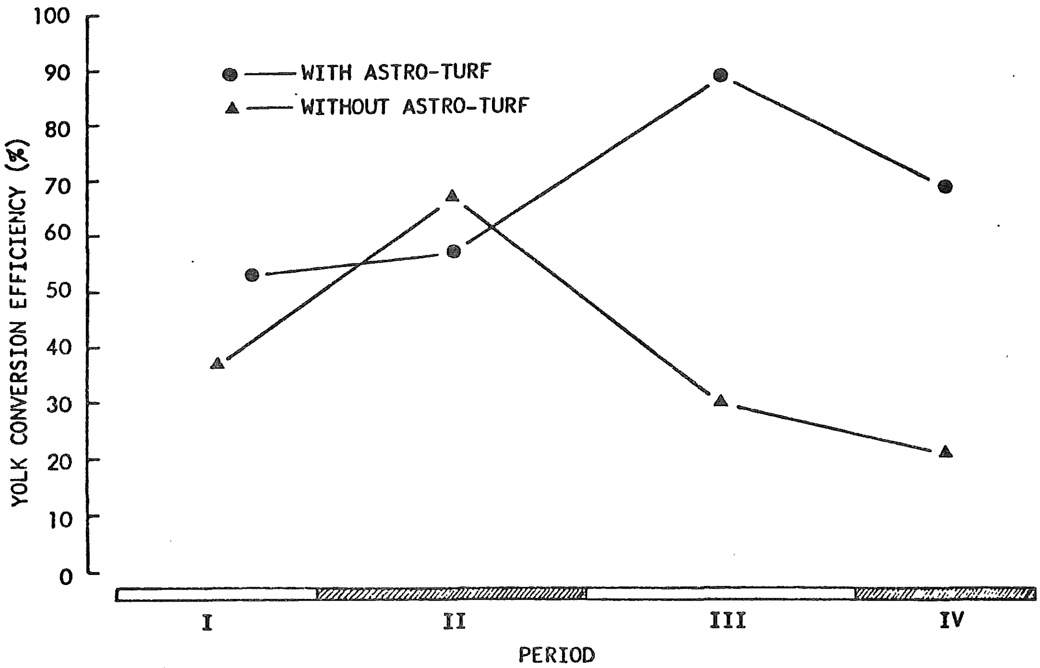

Figure 3. Yolk conversion efficiency in the four periods (days 1 (3) -9, 9-21, 21-33 and 33-41).
The first sample is taken at day 3 in the first period in the modified trays).

Flat bottomed hatching trays are known to induce malformations in the yolk sac of different Oncorhynchus species and hybrids (Emadi 1973) and on Atlantic salmon (Gunnes 1978, Hansen et al. 1982). In this experiment the alevins reared on the flat bottomed hatching trays showed constrictions in the posterior region of their yolk sacs. However, the yolk behind the constrictions was absorbed (fig. 4) and very little yolk was to be pinched off.

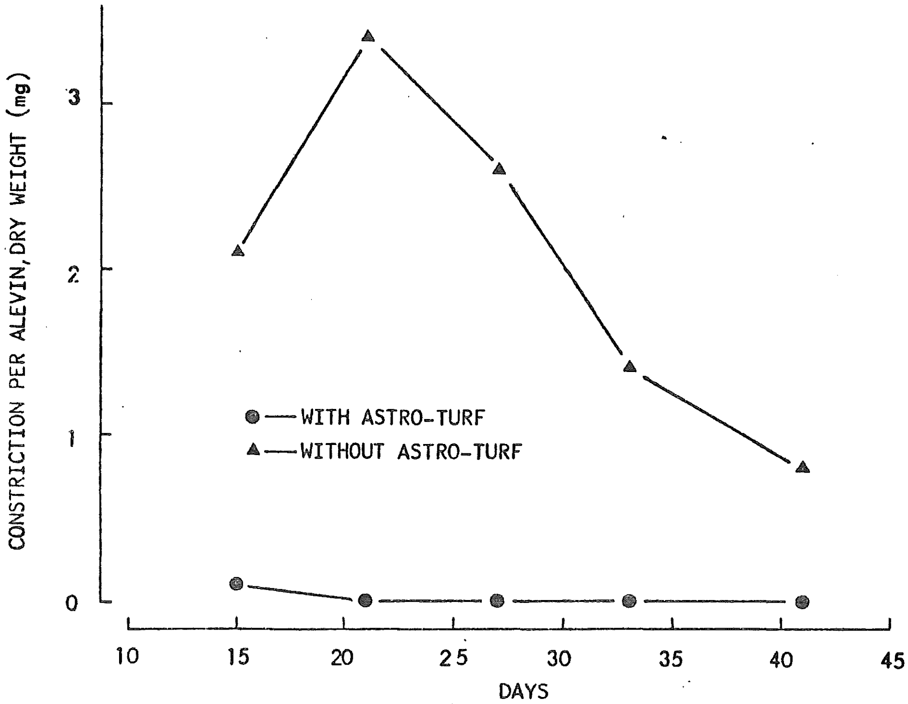

Figure 4. Mean constriction per alevin for Atlantic salmon hatched with and without Astro-turf.

The fry hatched without Astro-turf grew better than the fry hatched with Astro-turf in the first start-feeding period. However, these results were highly influenced by different mean body weight at the start of the period. This is probably due to the higher yolk conversion efficiency of the fry hatched with Astro-turf.

From start-feeding day 18 and to the end of the start feeding period fry hatched with Astro-turf grew better than fry hatched without Astro-turf.

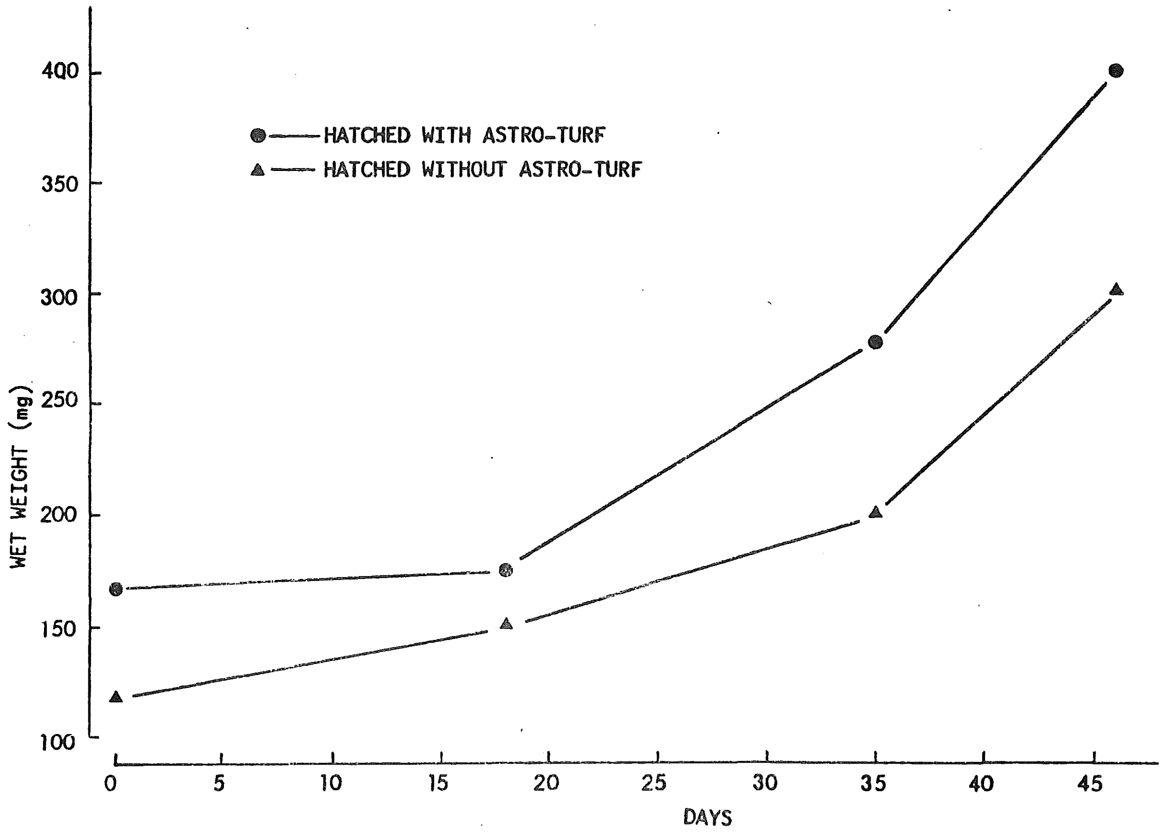

Figure 5. Start feeding results (mean wet weight) of Atlantic salmon hatched with and without Astro-turf.

The mortality in the experiment is presented in fig. 6.

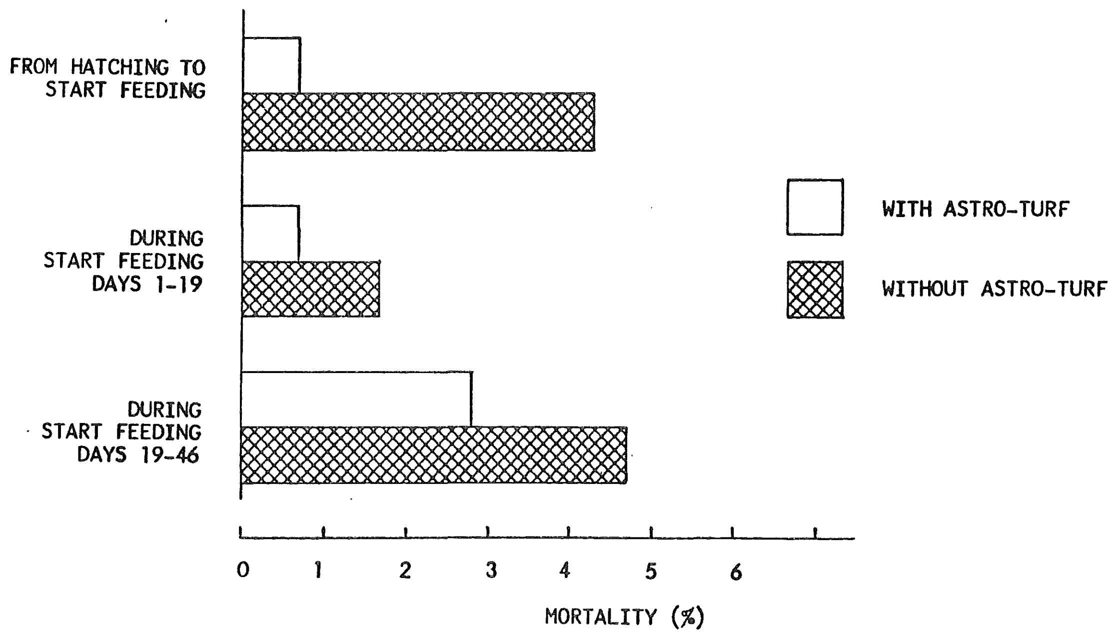

Figure 6. Mortality of Atlantic salmon alevins and fry in the periods from hatching to start feeding (percentage of 6 700), start feeding days 1-19 (percentage of 5 000), start feeding days 19-46 (percentage of 3 200).

The mortality of alevins and fry hatched with Astro-turf were lower in all three periods.

Also plastic saddles have been reported to give a reduction in the mortality that usually coincides with initial feeding of Atlantic salmon (Leon 1975).

In conclusion, use of artificial substrates in the hatching trays seems to give significantly quantitative and qualitative improvement in hatching and start feeding of salmonids. Astro-turf is one such substrate which easily may be used in traditional hatching systems.

REFERENCES

Babcock, J.P. 1911. Some experiments in the burial of salmon eggs suggesting a new method of hatching salmon and trout. Trans.Am.Fish.Soc. 40:393-395.

Bailey, J.E. and Taylor, S.G. 1974. Salmon fry production in a gravel incubator hatchery, Auke Creek, Alaska, 1971-72. NOAA Tech.Memo., NMFS ABFL-3:13 p.

Bams, R.A. 1970. Evaluation of a revised hatchery method tested on pink and chum fry. J.Fish.Res.Board Can. 27:1429-1452.

- 1972 A quantitative evaluation of survival to the adult stage and other characteristics of pink salmon (Oncorhynchus gorbuscha) produced by a revised hatchery method which simulates optimal natural conditions. J.Fish.Res.Board Can. 29:1151-1167.

- 1974 Gravel incubators: a second evaluation on pink salmon, (Oncorhynchus gorbuscha), including adult returns. J.Fish.Res.Board Can. 31:1379-1385.

Bams, R.A. and Simpson, K.S. 1977. Substrate incubators Workshop - 1976. Report on Current State-of-the-Art. Fish.Mar. Serv.Res.Dev.Tech.Rep. 689:68 pp.

Emadi, H. 1973. Yolk sac malformation in pacific salmon in relation to substrate, temperature, and water velocity. J.Fish.Res. Board Can. 30:1249-1250.

Erikson, C. 1980. Kläckningsforsøk med bottensubstrat. Report to Fiskodlingskonferensen, Mariehamn.

Gunnes, K. 1979. Survival and development of Atlantic salmon eggs and fry at three different temperatures. Aquaculture 16:211-218.

Hansen, T., Holm, J.C., Thorsen, J. and Møller, D. 1982. Settefiskoppdrett i vassdrag. Virksomheten i Kvernavatnet 1979-1981. In press.

Leon, K.A. 1975. Improved growth and survival of juvenile Atlantic salmon (Salmo salar) hatched in drums packed with a labyrinthine plastic substrate. Prog.Fish-Cult. 37:158-163.

Porter, T.R. and Meerburg, 1977. Upwelling incubation boxes for Atlantic salmon (Salmo salar). ICES, Coun.Meet. 1977 (M:22).