This paper not to be cited with prior reference to the authors.

International Council for
the Exploration of the Sea

C.M. 1985/F:25
Mariculture Committee.

THE TRANSFER OF ATLANTIC SALMON (SALMO SALAR) WITH CONSTRICTED YOLK SACS TO AN ARTIFICIAL HATCHING SUBSTRATE.

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Abstract

Atlantic salmon larvae were transferred from a flat screened hatching tray to an artificial hatching substrate when all larvae had developed yolk sac constrictions. The transfer increased the growth rate and the yolk absorbtion rate of the larvae. When the larvae was transferred at an early stage the yolk constrictions was absorbed normally showing that yolk sac constrictions are not an irreversible injure but rather a condition which is maintained through high larval activity.

I. INTRODUCTION

In earlier reports from the project 'Hatching - Fry quality', (Hansen & Torrissen, 1984; Hansen & M ller, 1985; Hansen, 1985; Hansen & Torrissen, 1985), the effect of artificial hatching substrates on growth and mortality of Atlantic salmon (Salmo salar) and sea trout (Salmo trutta) has been investigated.

Hansen & M ller (1985) also described the dry weight changes in time of yolk sac constrictions of Atlantic salmon larvae incubated on astro-turf and flat screenes. However, Hansen & M ller (1985) weighed yolk sac constrictions en mass for each sample groups and could consequently not investigate to what extent the yolk size affected the size of the yolk sac constrictions. They also concluded that astro-turf prevented the formation of yolk sac constriction as other substrates as gravel (Emadi, 1973) and plastic saddles (Leon, 1975) has been shown to do. However, it has never been investigated what effect a substrate would have on already constricted yolk sacs and this was the purpose of this experiment.

II. MATERIALS AND METHODS

EXPERIMENTAL CONDITIONS

This experiment was carried out with totally 4.8 L eyed Atlantic salmon eggs pooled from three females. The eggs were divided into twelve equal groups of 0.4 L for further incubation.

Five Ewos 2003 hatching trays was used. All five were partitioned into four longitudinal compartments with PVC plates. The bottom screen of eight of these compartments were covered with astro-turf as described by Hansen & M ller (1985). The twelve egg groups were incubated and hatched in the twelve compartments without astro-turf.

The experimental design is given in table 1. Every three days following 50% hatching 20 alevins from each of 3 randomly chosen compartments were sampled, anaesthetized and killed with benzocain and examined for yolk sac constrictions. 14 days posthatching all the alevins had developed yolk sac constrictions and four groups were randomly chosen and transferred from the flat screened to the astro-turf covered compartments. Four groups were also transferred on day 20.

The water input was 10 L/min per tray giving 2.5 L/min per compartment, assuming even dispersal of the water. The temperature varied between 7.6 and 8.8 C with a mean of 8.0. pH varied between 6.4 and 6.8 with a mean of 6.6.

SAMPLING AND MEASUREMENTS

The sampling design is given in table 1. 20 larvae from each group were collected with a dip net, anaesthetized and killed in benzocain and preserved in 5% formalin. The larvae were later dissected into yolk constriction, remaining yolk, and body on separate preweighed weighing boats. The tissues were dried for 2 days at 60 C and weighed using an electronic microbalance (d = +/- 0.1 mg). The total yolk weight was later calculated (yolk constriction weight + weight of remaining yolk).

STATISTICAL ANALYSES

The experimental data were statistically analysed by RS/1 statistical software (Bolt Beranek and Newman, Inc., Cambridge, Massachusetts). A confidence level of 5% was adopted in all tests. The dry weights were compared using F-test for equality of variances and later a Student t-test for separate or pooled variances.

III. RESULTS

DRY WEIGHT DEVELOPMENT OF BODY AND YOLK

The development of the body dry weight is presented in Fig. 1. The body dry weight was statistically significantly higher in the first transferred (FT) alevins than in the alevins which where held back in the flat screened compartments (NT, no transfer) from day 20 and throughout the experiment (Table II). The groups which were transferred on day 20 (ST, second transfer) had also a higher dry weight than NT on days 31 and 40. The difference was, however, not significant on day 40. The ST groups had significantly lower body weight than the FT groups through the whole experimental period.

At the end of the experiment the yolk weights ranged in the order NT, ST, FT with NT with the highest yolk weight (Fig. 2.). The differences between FT and the two other transfers were significant. The difference between NT and ST was, however, not significant.

YOLK SAC CONSTRICTIONS

On day 14 when all the larvae had developed yolk sac constrictions the mean constriction weight per larvae was 6.9 mg. The correlation between yolk constriction weight and total yolk weight (Fig. 3.) was also positive. Moreover, the correlation was also positive when the yolk constriction weight was calculated in per cent of the total yolk weight (Fig. 4.).

Both the frequency of constricted yolk sacs and the size of the yolk constrictions were reduced by transferring the larvae to astro-turf (Fig. 5. and 6.). All constrictions had disappeared in the FT alevins at day 31 while still 35% of the NT alevins had constrictions. Also the ST increased the absorbtion of the constrictions relative to the NT alevins. At the termination of the experiment on day 40 the FT groups were the only without constrictions, however, the frequency in the ST groups were also low (1.25 %). In the NT groups 6.25% of the alevins still had yolk sac constrictions. The yolk in these constrictions was coagulated and could not be absorbed.

IV DISCUSSION

DRY WEIGHT DEVELOPMENT OF BODY AND YOLK

The increase in growth rate when the larvae were transferred from the flat screened trays to astro-turf was as expected and in accordance with earlier investigations on Atlantic salmon. Eriksson & Westlund (1983) and Hansen & M ller (1985) among others has found a higher growth rate in larvae incubated in astro-turf relative to flat screen incubated ones. Moreover, Hansen & Torrissen (1985) found that a transfer from astro-turf to a flat bottomed feeding tank lowered the growth rate despite the fact that more yolk was available due to a higher yolk absorbtion rate at the somewhat higher temperature. The transfer in the present experiment is then the contrary to the transfer in Hansen & Torrissen (1985), and gave consequently a increase in growth rate.

The difference in growth rate is due to the non-supportiveness of the flat bottom which fail to satisfy the alevins preference for vertical stability (Marr, 1963; Bams, 1969). This is compensated for by high swimming activity which increase the respiration rate of the larvae (Nortvedt et al., 1985) and reduce the protein synthesis and lower the protein conversion efficiency (Taranger et al., 1985).

Hansen (1985) summon up the different stressors which is known to reduce the yolk absorbtion in fish larvae. Recently Skogheim & Rosseland (1984) has found the same reduction in absorbtion rate for acid aluminium-rich water. The ranging of yolk weights on day 40 is in accordance with the observations of Leon (1975) and Hansen & M ller (1985). The reduced yolk absorbtion in the flat screen incubated larvae is probably caused by the high activity stress on the flat screens (Hansen & M ller, 1985). This activity stress has recently been confirmed by Nortvedt et al, (1985) who at the early stages of yolk absorbtion found more than a 35% difference in respiration rate between astro-turf and flat screen reared alevins.

YOLK CONSTRICTIONS

The highest yolk constriction weight in this experiment amounted to 6.9 mg per alevin and this is more than twice the amount (3.1 mg) found by Hansen & M ller (1985). This is, however easily explained if comparing the yolk weights in these two experiments. In Hansen & M ller (1985) the yolk on day 14 amounted to 25.0 mg compared to the 31.0 mg found in the present experiment. And according to Fig. 3. the size of the yolk constrictions are very much dependent on yolk weight.

What is even more interesting is the observation that larvae with large yolk sacs develop relatively bigger yolk sac constrictions than larvae with little yolk. We can assume that the larvae with biggest yolk sacs at day 14 also had the biggest yolk sacs at hatching. This should be a sound assumption despite the fact that the absorbtion rate is highest in larvae with high yolk weight at hatching (Hansen & Torrissen, 1984). The higher absorbtion rate of larvae with high yolk weight at hatching will tend to lower the variance in yolk weight in an experimental group as the yolk is absorbed. However, it will probably not influence the individual ranking of the yolk weights to any significant extent. We also know that there exist a very good correlation between egg size and yolk weight at hatching and that big eggs give bigger fry than small eggs (Dahl, 1918; 1919). When evaluating the growth potential and the potential of survival (as done by Bagenal, 1969 and Wallace & Aasjord, 1984) it is therefore obvious that big eggs have a higher quality than small ones. To utilize such a quality advantage, however, it is important to use a hatching substrate because larvae from big eggs will tend to develop relatively bigger yolk sac constrictions than larvae from small eggs.

As shown in Figures 5. and 6. the yolk sac constrictions was absorbed normally when the larvae was transferred to astro-turf at an early stage. The yolk sac constrictions are therefore clearly not irreversible but rather a condition which is maintained and aggravated by a high larval activity. When the larvae are transferred to a substrate the activity is lowered and the yolk sac constrictions are absorbed. However, at a later stage of yolk sac constrictions the blood circulation through the yolk sac veines is impeded and the yolk coagulate and can not be absorbed.

The project 'Hatching - Fry quality' has received financial support from Norges Fiskeriforskningsr å (NFFR), (Norwegian Fisheries Research Council).

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Table 1. Experimental design

DAY NR	REMARKS	TRANSFER	SAMPLE
0	50 % hatching		
14	100 % yolk sac constrictions	first	first
20		second	second
31			third
40			fourth

Table 2. Results from the statistical testing of the weight data.

Ps = probability value from t-test with separate variances.
Pp = probability value from t-test with pooled variances.
FT = first transfer (day 14)
ST = second transfer (day 20)
NT = no transfer

	BODY	YOLK	YOLK CONSTRICTION
Day 20			
NT - FT	Ps < 0.001	Ps = 0.006	Ps < 0.001
Day 31			
NT - FT	Ps < 0.001	Ps = 0.502	
FT - ST	Pp = 0.001	Pp = 0.117	
NT - ST	Pp = 0.006	Pp = 0.325	Ps = 0.001
Day 40			
NT - FT	Ps < 0.001	Ps = 0.022	
FT - ST	Pp < 0.001	Pp = 0.001	
NT - ST	Ps = 0.404	Ps = 0.502	Ps = 0.161

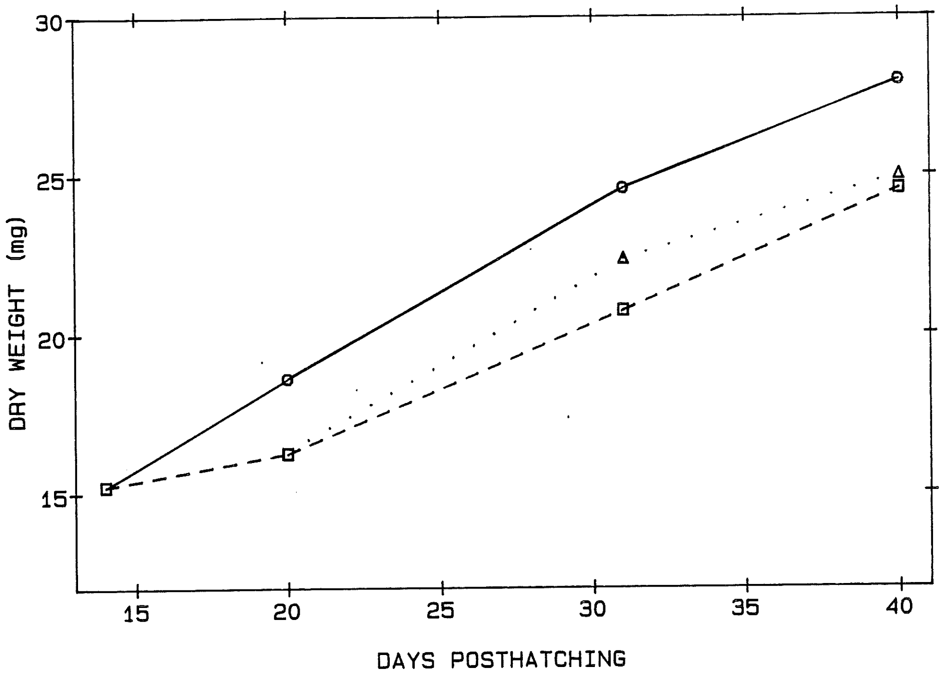

FIG. 1. Dry weight development of body of Atlantic salmon (Salmo salar) alevins transferred from flat screened hatching trays at two different stages in development. ○, First transfer (FT); △, Second transfer (ST); □, No transfer (NT).

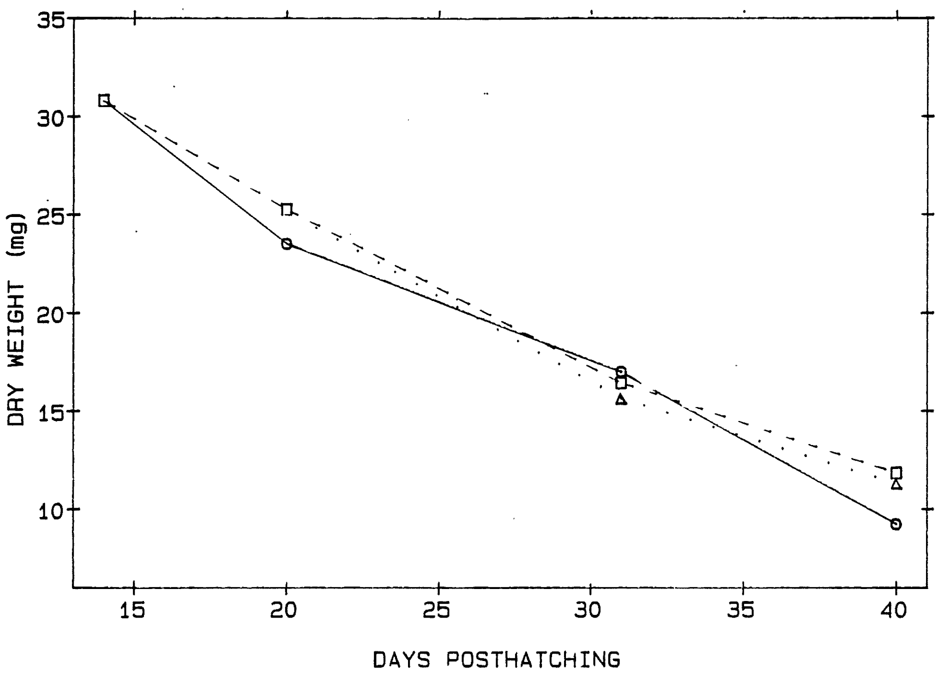

FIG. 2. Dry weight development of yolk of Atlantic salmon (Salmo salar) alevins transferred from flat screedes hatching trays at two different stages in development. ○, First transfer (FT); △, Second transfer (ST); □, No transfer (NT).

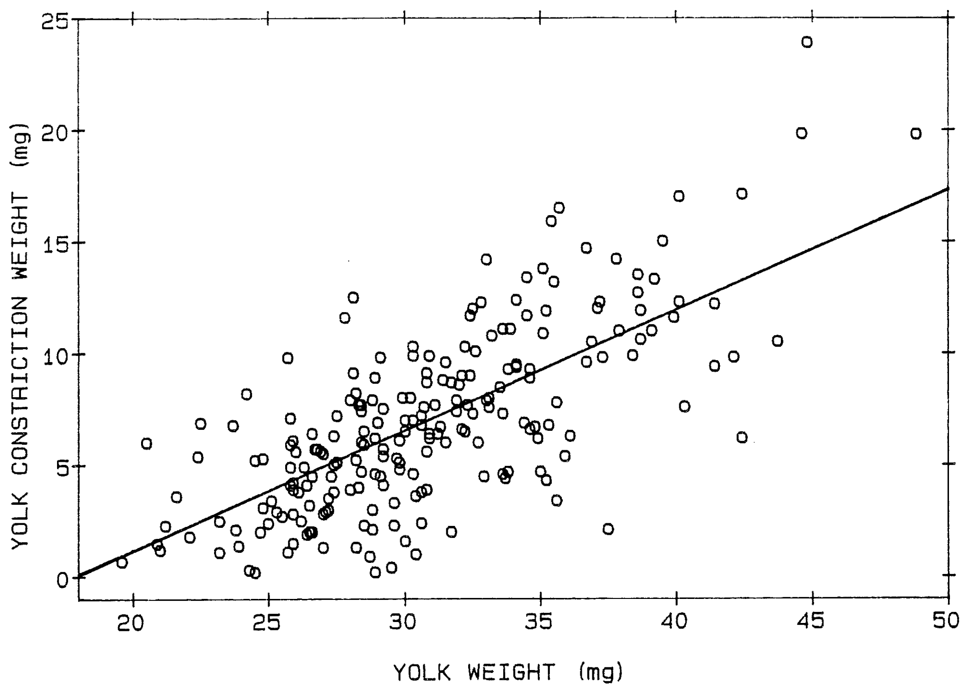

FIG. 3. The relationship between the yolk constriction weight and the total yolk weight 14 days after 50% hatching. (Regression Y = 0.54X - 9.63, n = 216)

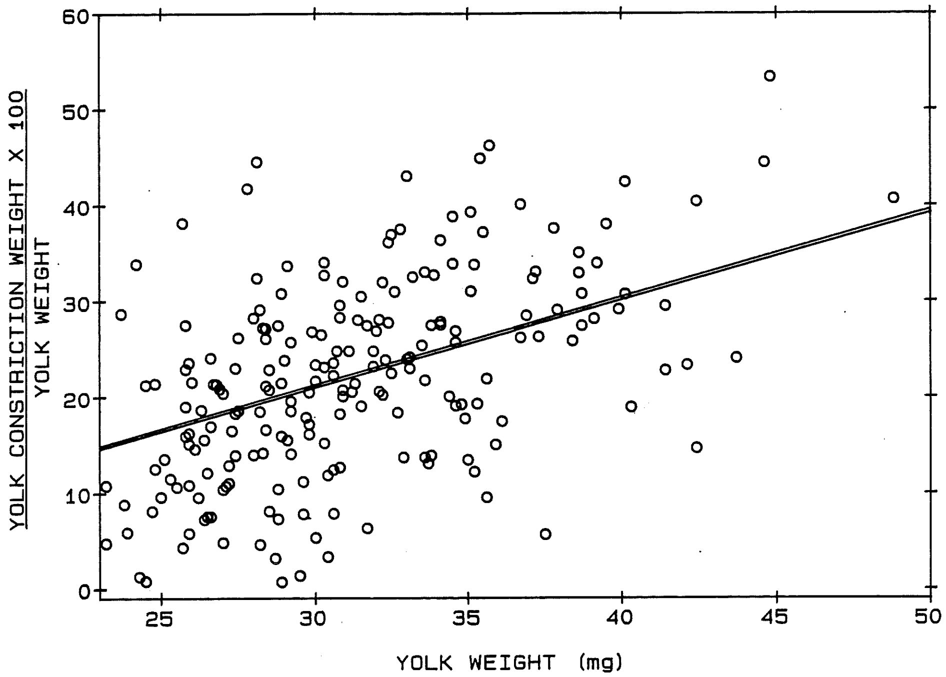

FIG. 4. The relationship between the per cent constricted yolk per yolk weight and the total yolk weight 14 days after 50% hatching. (Regression Y = 0.92X - 6.38, n = 216)

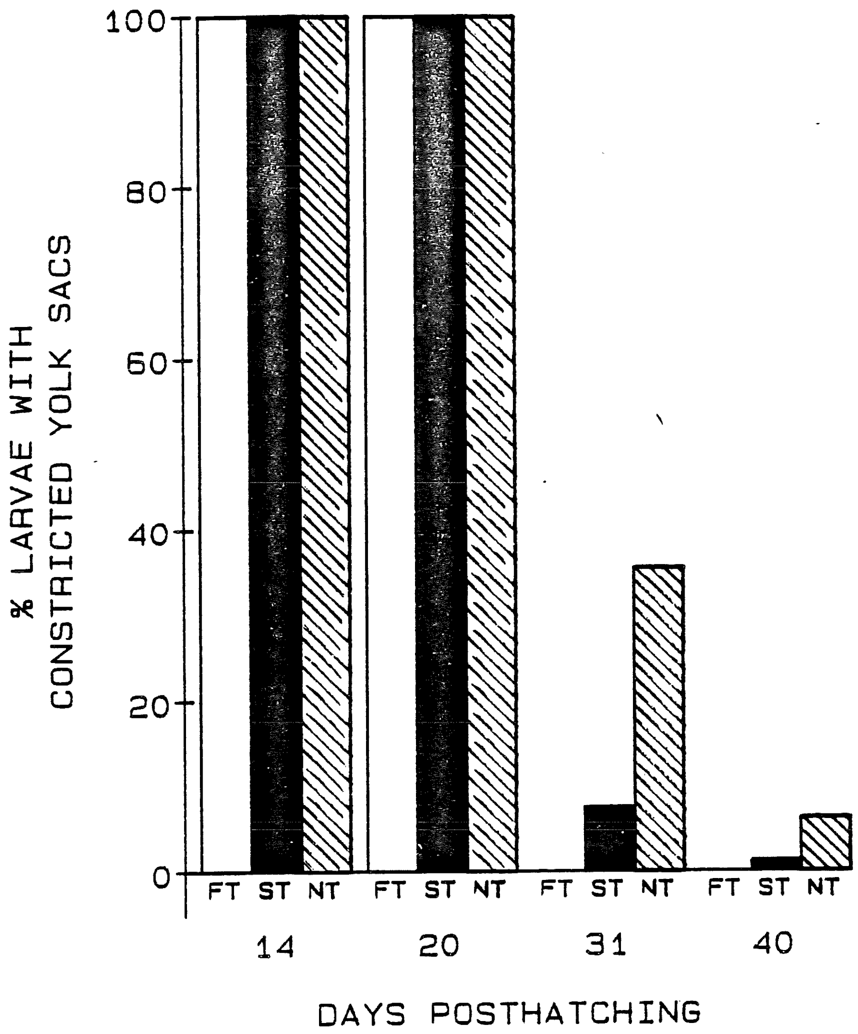

FIG. 5. Per cent yolk sac constrictions in Atlantic salmon (Salmo salar) alevins transferred from from flat screened hatching trays at two different stages in development. First transfer (FT); Second transfer (ST); No transfer (NT).

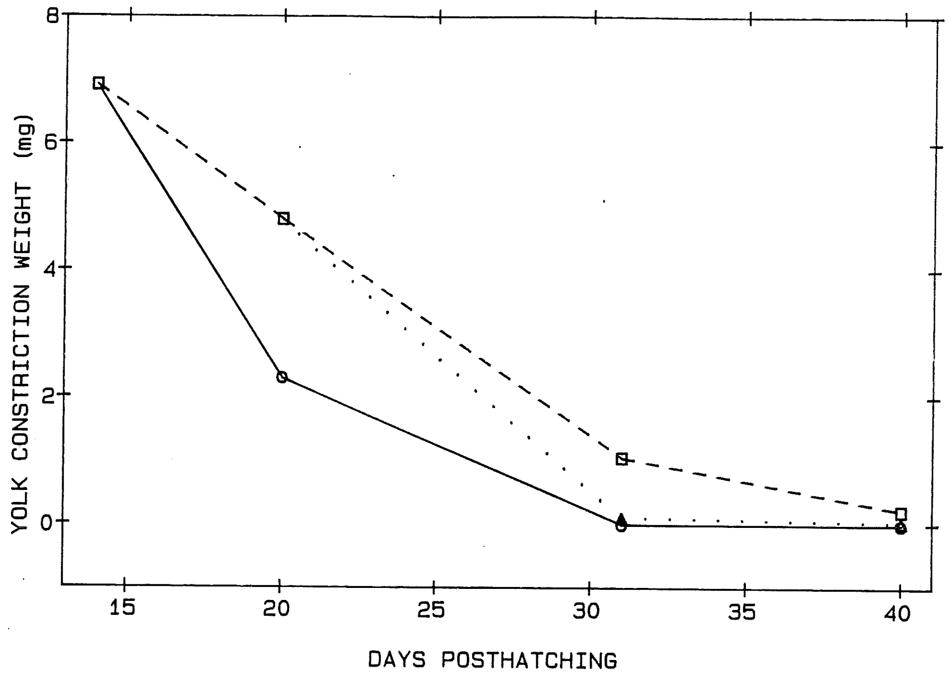

FIG. 6. Dry weight development of yolk sac constrictions in Atlantic salmon (Salmo salar) alevins transferred from from flat screened hatching trays at two different stages in development. ○, First transfer (FT); △, Second transfer (ST); □, No transfer (NT).