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PROTEASE ACTIVITIES IN THE DIGESTIVE TRACT OF ATLANTIC SALMON FRY FROM FIVE DIFFERENT RIVER STRAINS

by

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ABSTRACT

Atlantic salmon (Salmo salar) fry from five different river populations in Norway were used for studying protease activities.

The proteases of the fry from Alta and Lærdal rivers showed significantly high activities during the experimental period. At the later period, the enzyme activities fluctuated perhaps because of variation in rearing temperature. The growth rate of Alta and Lærdal river strains were significantly high when compared to Figgjo, Imsa and Ekso river strains.

Significant effect of rearing temperature on the protease activities in the digestive tract of fingerlings from these populations were also observed.

INTRODUCTION

During the last 10 years, a lot of work has been done on genetic variation and selective breeding of Atlantic salmon (Salmo salar). Significant differences in growth rate and age of sexual maturation were observed among the fish from different river origins (Nævdal et al, 1978). However, digestion and utilization of the feed of different salmon populations under different environmental conditions, especially difference in rearing temperature, have not been studied. It is tentatively that genetic variation in growth rate may be related to differences in digestibility and feed utilization. Such differences may also be related to environmental factors, such as adaptation to water temperature of particular rivers. Different Atlantic salmon strains may have different optimum temperature for optimum growth.

This preliminary experiment was done on the first year-class Atlantic salmon (Salmo salar) in 1981. The observation was conducted in order to see the effect of genetic variation on protease activities of the digestive tract and on growth rate among five different river populations. The effect of rearing temperature on protease activities among these populations was also studied.

MATERIALS AND METHODS

Five groups of Atlantic salmon (Salmo salar) eggs were collected from different river origins in Norway, Figgjo and Imsa rivers (south western coast), Ekso and Lærdal rivers (western coast) and Alta river (northern coast).

Eyed eggs, but newly fertilized eggs from Ekso river, were delivered to and hatched at Matre Aquaculture Station. The average hatching temperature was 6.2 ± 1.5°C. About 1-1.5 month after hatching when 2/3 of the yolk sac was absorbed, the alevins were transfered into fish tank (1.5 x 1.5 x 0.4 m^3) supplied with 10 l/min of freshwater (90% recirculated). The fish were fed a commercial dry pelleted feed (EWOS ST40, No.1). The average temperature of the recirculated water was 12.7 ± 1.5°C.

Each group was sampled periodically after hatching until 171 days. Ten to fifteen fish were used for the assay of protease activities. At the early experimental period, the whole fish was used for the determination. From 85 days after hatching, two sections of the digestive tract, stomach and pyloric caeca including the intestine were used for the proteolytic activities determination. Both body weight and length were measured before sacrifice.

Another experiment was carried out in order to see the effect of rearing temperature on protease activities. Fingerlings (2 ± 0.5 g) from the five river populations were cultured at six different average temperatures, 4.5°, 4.8°, 9.0°, 10.2°, 12.6° and 14.2°C. To minimize the environmental effect, they were cultured together and labelled by fin cutting technique. Wet feed was used in this experiment and the feed composition is shown in Table 1. After 10 days of feeding, ten fish from each group were killed and the digestive tracts were divided into 3 sections, stomach, pyloric caeca and intestine.

The methods for the determination of proteases and the assay for proteolytic activities were used acccording to Rungruangsak and Utne (1981). The peptic-like activity of the stomach extract was assayed at 37.5°C, the tryptic-like activities of pyloric caeca and intestinal extracts at 52.5°C (Torrissen,1981).

The extract from the whole fish was assayed at both temperatures. The assay was done in tripication. The total protease activity was resulted from the sum of the activities of stomach, pyloric caeca and intestine.

Analysis of variance was used for statistically calculation (Steel and Torrie, 1960).

RESULTS AND DISCUSSIONS

The fish from Alta and Lærdal rivers showed significant higher growth rate ($P < 0.01$) than those from Ekso, Figgjo and Imsa rivers (Fig.1).

Tryptic-like enzymes were observed to have more pronounced activities than peptic-like enzyme, but it seemed to be developed later since the peptic-like activity was able to be detected before (within 1 week) at the early experimental period. The total protease activities are shown in Fig.2. At the early period, the total protease activities of Alta and Lærdal river strains were significantly higher than the others ($P < 0.005$), both the peptic-like and the tryptic-like enzymes. At the later experimental period, the total protease activities of Alta and Lærdal strains also showed significantly higher ($P < 0.005$) than Figgjo and Imsa strains but not Ekso strain.

Among the five river strains, newly hatched alevins from Ekso river were rather small and protease enzymes were less developed at the early period. At the later period, the total enzyme activity was significantly high ($P < 0.005$, Fig.2), in contrast to the growth rate (Fig.1).

The total protease activities of Ekso, Alta and Lærdal groups fluctuated at the late experimental period (Fig.2), perhaps because of variation in rearing temperature. As shown in Fig.3, the difference in rearing temperature had significant effect on the activities of the proteases extreacted from the digestive tracts. Total protease activity was high at 9.0°C and 12.6°C. At 9.0°C, the total protease activities of Ekso and Lærdal fingerlings were significantly high ($P < 0.005$). The

activities were pronounced because the tryptic-like enzyme of pyloric caeca extract was highly activated at 9.0°C and that of intestinal extract at 12.6°C (Fig.4). The tryptic-like enzymes from pyloric caeca and intestine were activated at different rearing temperature (Fig.4). The tryptic-like enzyme from pyloric caeca must be different from the enzyme from the intestine. This result corresponded to the observation by Torrissen (1981). The peptic-like enzyme of stomach extract was not influenced so much by rearing temperature and it tended to decrease in its activity when the temperature increased.

At day 171, during two weeks before the fry from Ekso and Alta rivers were sampled the average rearing temperature was about 10°C, and also day 140 of Lærdal group. The last sampling of Lærdal group (day 171), the temperature decreased to about 5°C. According to the results from Fig.3 and Fig.4, the decrease in rearing temperature during the time of taking sample tentatively resulted in decreasing in protease activities of Ekso, Alta and Lærdal groups at the late experimental period (Fig.2). The other samples were taken at the rearing temperature about 12-13°C.

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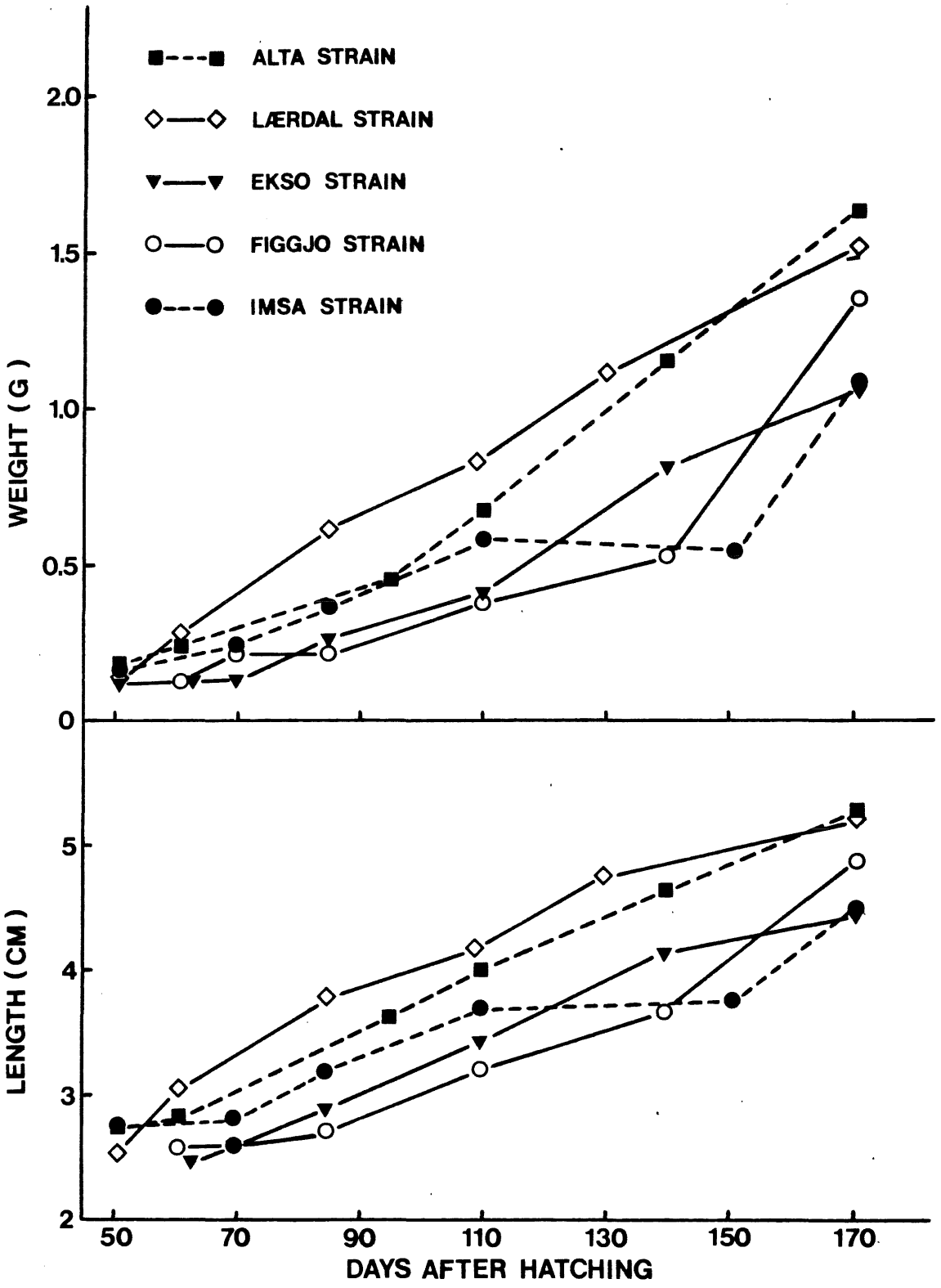

Figure 1 : The growth rate of Atlantic salmon fry among five different river populations at early development.

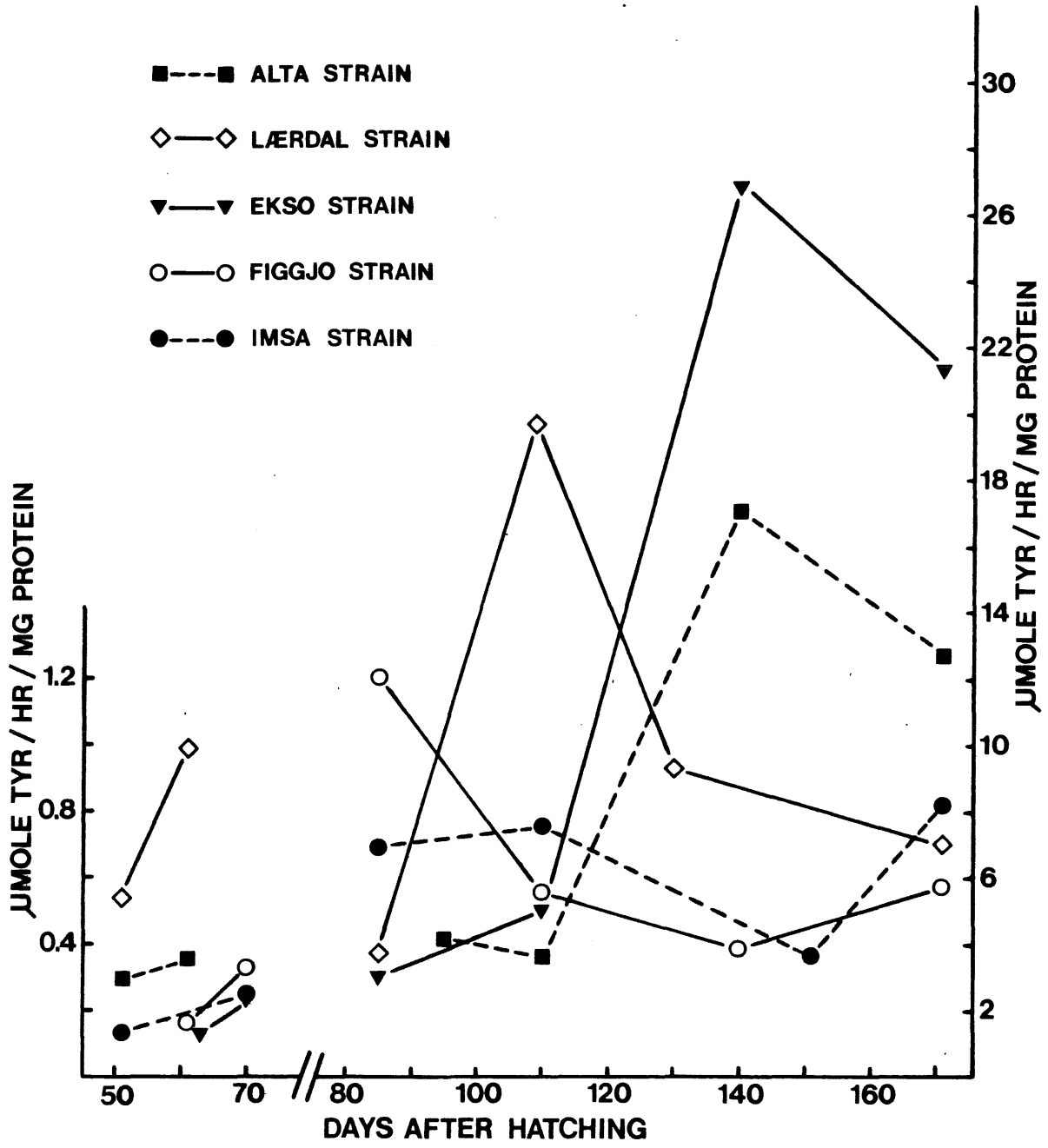

Figure 2 : The total protease activities of Atlantic salmon fry among five different river populations at early development.

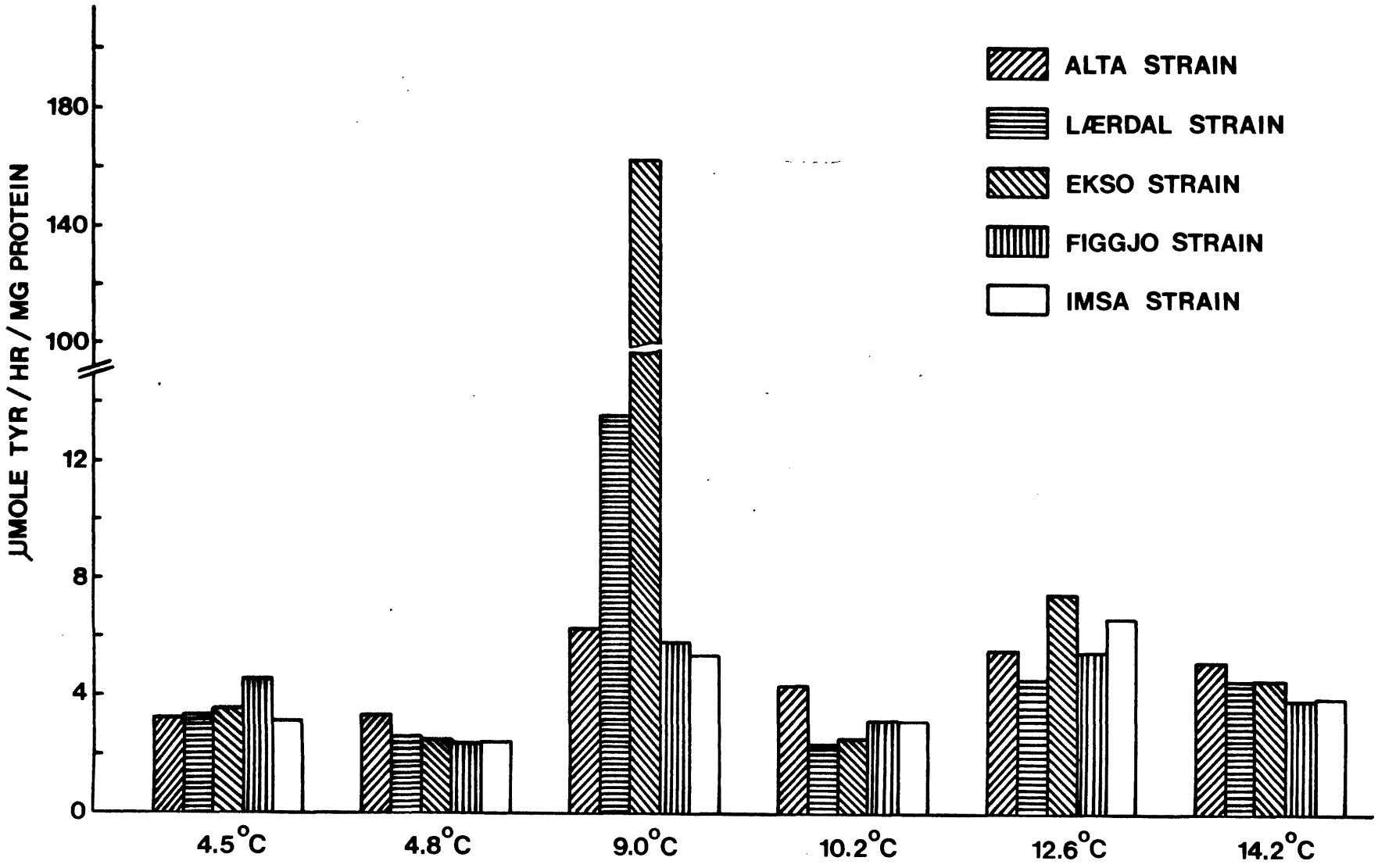

Figure 3 : The total protease activities of Atlantic salmon fingerlings among five different river populations at six different rearing temperatures.

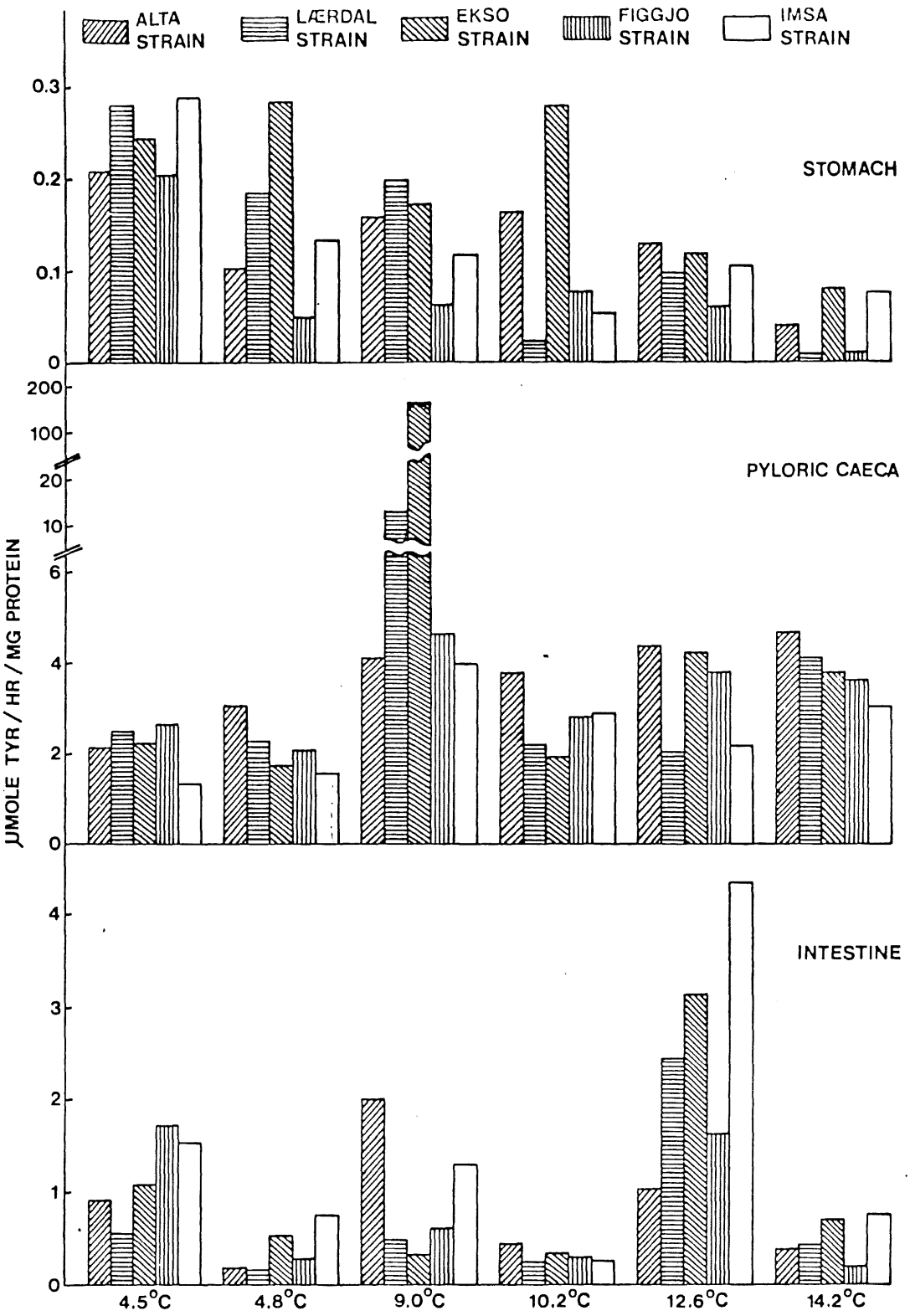

Figure 4 : The protease activities of three different sections of the digestive tract of Atlantic salmon fingerlings at six different rearing temperatures.

Table 1 : The composition of the wet feed.

Component	Weight (%)
Capelin	54.3
Fishmeal (Norsea mink)	21.1
Steamed wheat/oat meal	13.6
Soya-oil	4.0
Carboxymethylcellulose and Vitamins *	1.0

* According to Halver (1972)