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LARGE-SCALE REARING OF COD FRY (GADUS MORHUA) IN AN INLET

by

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ABSTRACT

For two years cod larvae have been transferred to a large dammed pond (60 000 m^3) after rotenon treatment of the system. Hydrography and standing crop of zooplankton and fish larvae have been monitored frequently.

Both year the cod larvae have had a very high feeding incidence and the whole population of larvae has started to grow fast with no fraction of emaciated larvae identified.

Large stocks of hydromedusae have probably preyed upon the cod larvae until metamorphosis 35-40 days post- hatching.

In 1981, when no dam leakage interrupted the experiment, many thousand cod fry reached a size of 10 cm in late July, partly on a diet from an automatic feeder.

In late autumn 1981 most of the produced cod fry will be released in coastal waters and a tagging and recapture program will be initiated to give informations on their subsequent biology.

INTRODUCTION

Large-scale experiments with marine fish larvae in large basins have long traditions in Norway (Rognerud 1887, Rollefsen 1946). This type of experiments with fish larvae was resumed in 1975. The experiments have included a number of commersial species and have been carried out in the large out-door basins at Statens Biologiske Stasjon Flødevigen, Southern Norway (Ellertsen et al. 1981, Moksness and Øiestad 1979, Øiestad et al. 1976, Øiestad and Moksness 1981).

A rather high survival to the 0-group stage of most species was observed when they were released in an enclosure system without predators. We wanted to examine to what extent this high survival rate could be obtained in natural sea ponds. This type of locations is very numerous along the Norwegian coast. If reasonable high survival could be obtained with minor modifications of the system, these ponds could be used to rear large number of marin fish fry.

MATERIAL AND METHODS

In 1980 a natural 60 000 m^3 large pond with two narrow inlets was dammed, Fig.1. After rotenon treatment when potensial fish predators were exterminated, about 0.6 mill cod larvae at end of yolk sac stage were transferred from the laboratory to the pond 7 April. In 1981 the experiment was repeated with 0.5 mill cod larvae released 31 March.

Both year the cod larvae were sampled by a two-chamber net hauled horizontally in distinct depths by means of a float. Total filtration opening was 0.3 m^2, mesh size 350 um, haul distance 70 m and speed 2 knop.

Zooplankton was also sampled in these net hauls and besides pumping in one meter steps was carried out weekly. Pumping

time was 30 sec with a 80 l/min pump and the water was filtered across a 40 um mesh-sized net.

Hydrography, nutrient salts and phytoplankton was monitored weekly.

In 1980 one of the dams was opened in early June. In 1981 the same dam was opened 27 June and a fine-meshed metal screen was mounted across the opening to prevent escape of cod fry and intrution of unwanted fish.

In 1980 and 1981 starvation groups were established in the laboratory and in 1981 also a transport group (larvae being exposed to transport to and from the inlet).

In May 1981 an automatic feeder was mounted at a raft in the pond.

RESULTS

In 1980 we had increasing problems with dam leakage and the experiment was terminated two months after release of the cod larvae. In 1981 the leakage problem was minor and results to the end of July are included.

Hydrography

Salinity was both year about 32 o/oo except in the more brackish surface water. The oxygen saturation was above 90 % except for the very bottom water where it from time to time was 50-90 % saturation.
The temperature is indicated in Fig.2 for 4 meter depth. It increased from about 5°C at release of larvae to 10-12°C at metamorphosis and to a maximum of 16°C before opening of the dam. For the rest of the period it was about 16 °C.

Phytoplankton

The spring bloom was dominated by Sceletonema costratum and for the rest of the period the phytoplankton biomass was dominated by unidentified flagellates.

Zooplankton

Both year the hydromedusae were very numerous, with highest values in 1981 and with Rathkea octopunctata and Sarsia sp. as the dominant species, Fig 3 and 4.
Rotifera were very numerous in early April both year with a decline in late April, Fig.5 and 6. Nauplii of calanoid copepods were at a steady level during April while an increase in calanoid copepods was observed from mid-April, Figs. 5 and 6. Dominating species were Calanus finmarchicus, Centropages hamatus and Pseudocalanus elongatus.

The mean density of potensial prey organisms (rotifera and nauplii) in the depth below 3 meter where most fish larvae were distributed was during first feeding 107 per litre in 1980 and 24 per litre in 1981, Figs. 5 and 6.

Cod larvae

The starvation groups had a 100 % survival for 15 days both year, Fig.7, and the same was observed for the transport group.

The catches of cod larvae declined both year, but to a lower level in 1980, Fig.8. At metamorphosis the population estimates were at about 5 000 in 1980 and 30 000 in 1981.

The length increment was about the same both year and metamorphosis was reached at day 35-40 post-hatching, Fig.9, giving a daily length increment of 0.24 mm and 0.23 mm for 1980 and 1981 respectively. From metamorphosis to the end of June 1981 the daily length increment was 1.11mm while it was only 0.83mm from then to the end of July.

The body height distribution used as an indicator of starvation, did not decrease, Fig.10, and the specific rate of increase to metamorphosis was 6.2 % and 5.3 % in 1980 and 1981 respectively.

The feeding incidence increased rapidly to 100 %, Fig.11. The initial diet was dominated by rotifera with an eventual

changing to stages of calanoid copepods,in 1980. For 1981 no gut examination has been carried out so far.

DISCUSSION

From a maricultural point of view the high feeding incidence and high and homogenous growth rate was very promissing, Figs. 11 and 10. Seemingly no fraction of the population was at any time emaciated giving a potensial 100 % survival.
In 1980 the leaking would give a high loose of larvae with out-flowing sea water as would predation from intruding fish.
Neglecting 1980 results, the reduction in 1981 might have been caused by hydromedusae which is known to be predators on fish larvae (Fraser 1969, Lebour 1923).

The high daily length increment after metamorphosis might partly be due to the food supply from the automatic feeder. In previous basin experiments the production of 0-group cod have been regularly 0.9-1.0 per m^3 to a mean length of 7 cm. The final production of cod fry in the inlet this year will be clarified in late autumn.

PERSPECTIVES

These very promissing initial results will be followed up in future experiments where the hydromedusae will be tried exterminated.

The produced fry will primarily be tagget and released in the region south of Bergen and the survival, migration, growth, pattern of fishing mortality and recruitment to local spawning stocks will be investigated. Initial tagging experiments have been carried out with cod fry produced in the basin experiment in 1976 and 1977, and a 10 % return has been reported (Moksness and Øiestad 1980).

A fraction of the fry will be reared to commersial size to look at the pay back of an intensive culture of this species.

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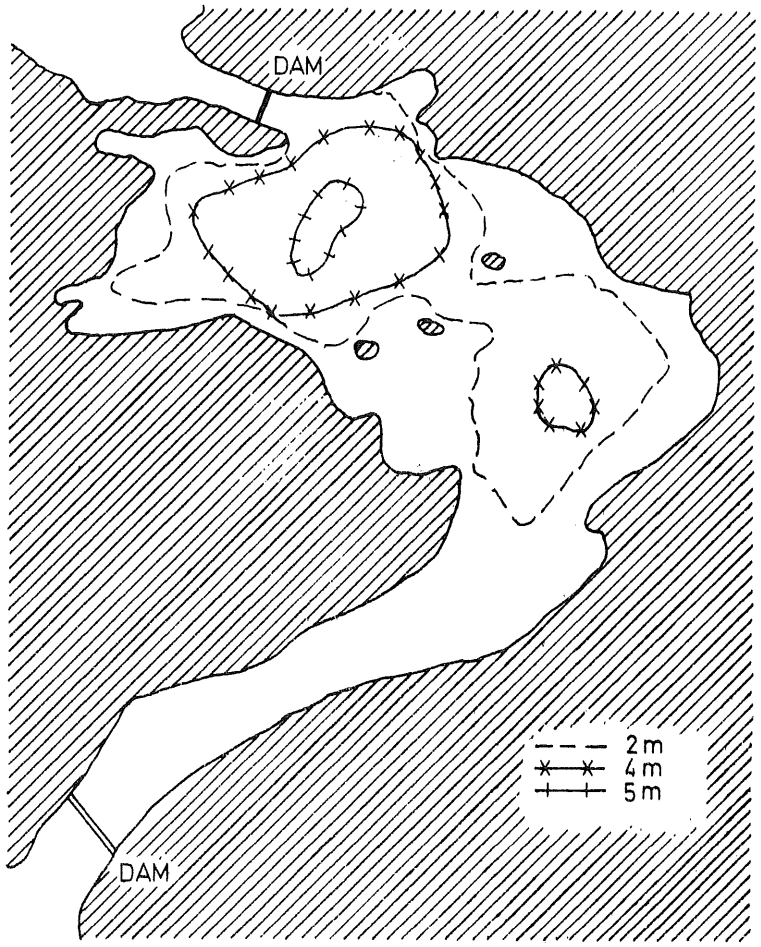

Fig.1. The inlet is situated close to the mari-culture station in Austevoll about 20 n.mils south of Bergen, at $60^{o}.04'$ N and $5^{o}.15'$ E. Depth contour lines and the two dams are indicated.

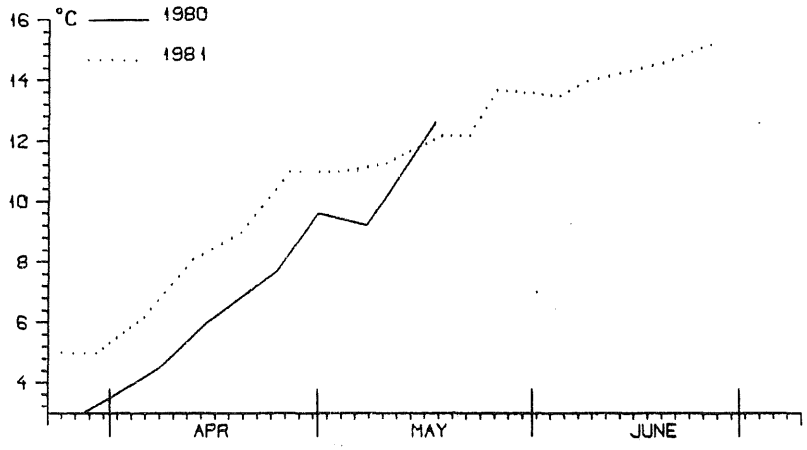

Fig.2. Temperature at 4 m depth for 1980 and 1981.

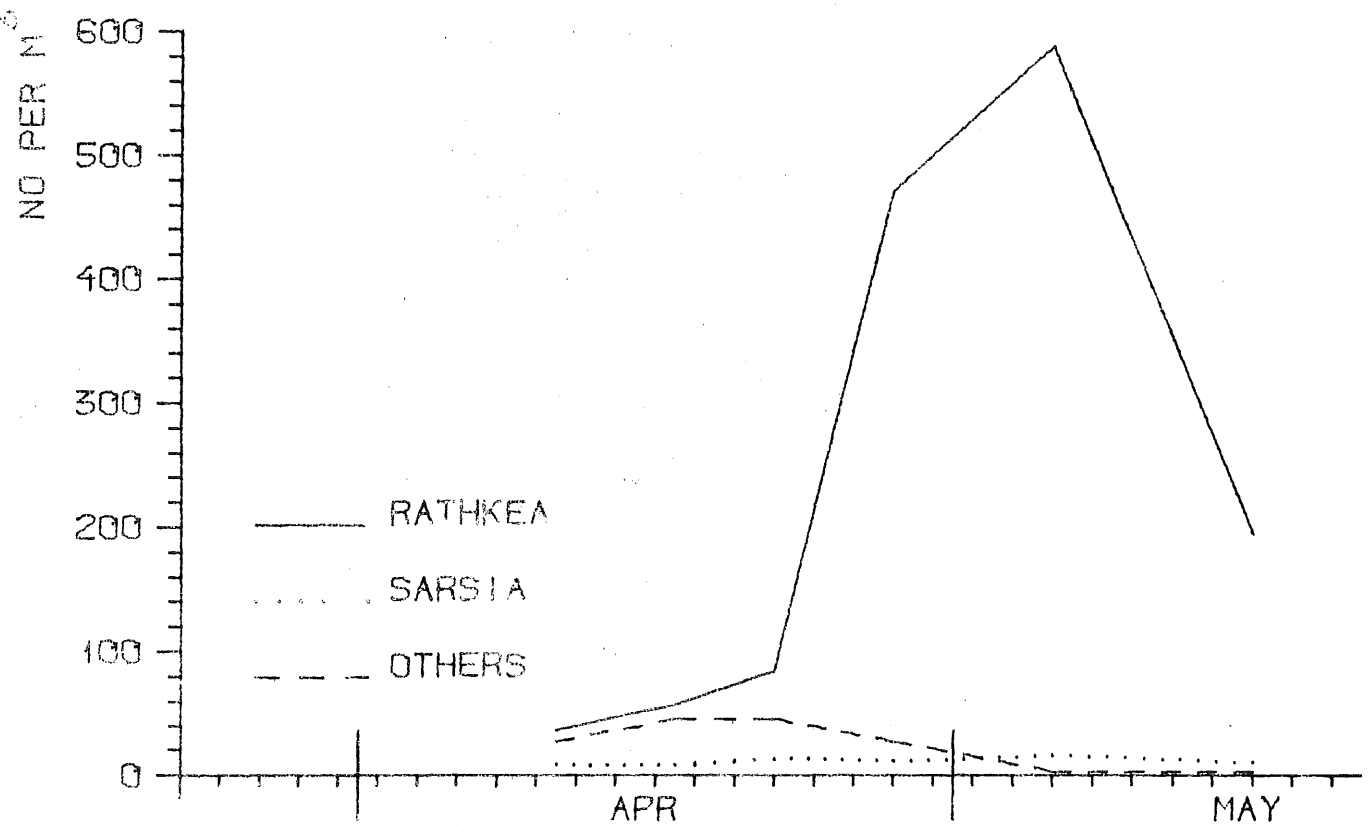

Fig.3. Mean number of hydromedusae per m^3 in 1980 at 4 m depth.

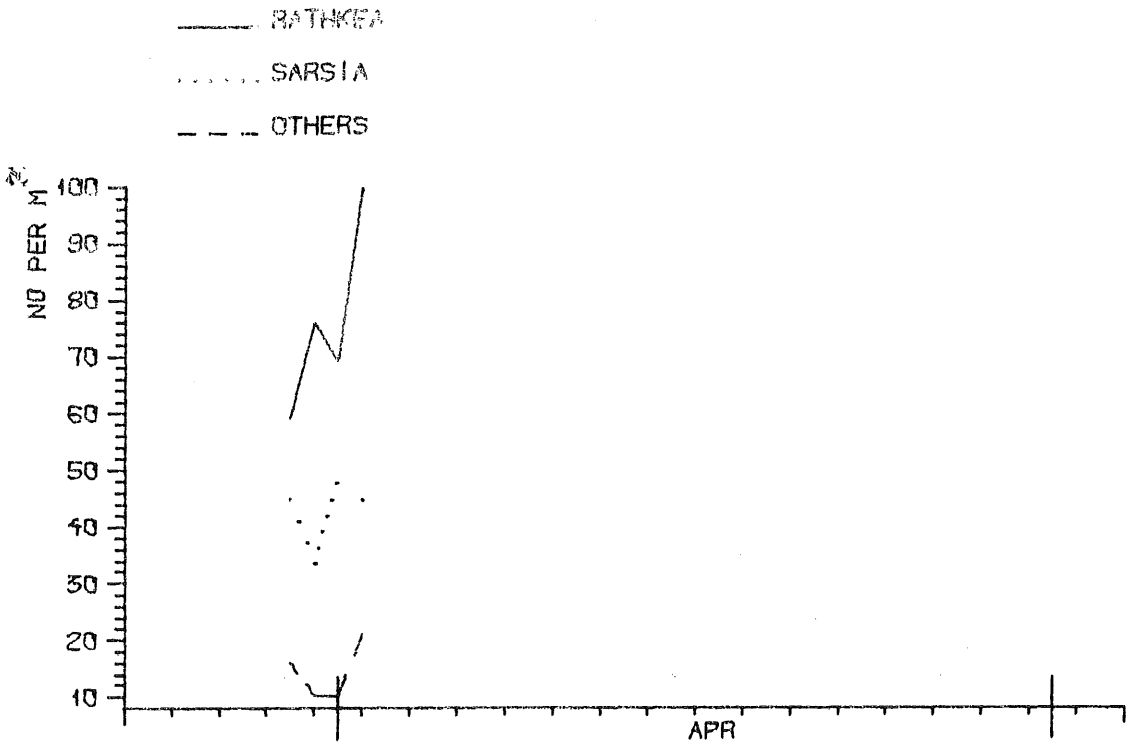

Fig.4. Mean number of hydromedusae per m^3 in 1981 at 4 m depth.

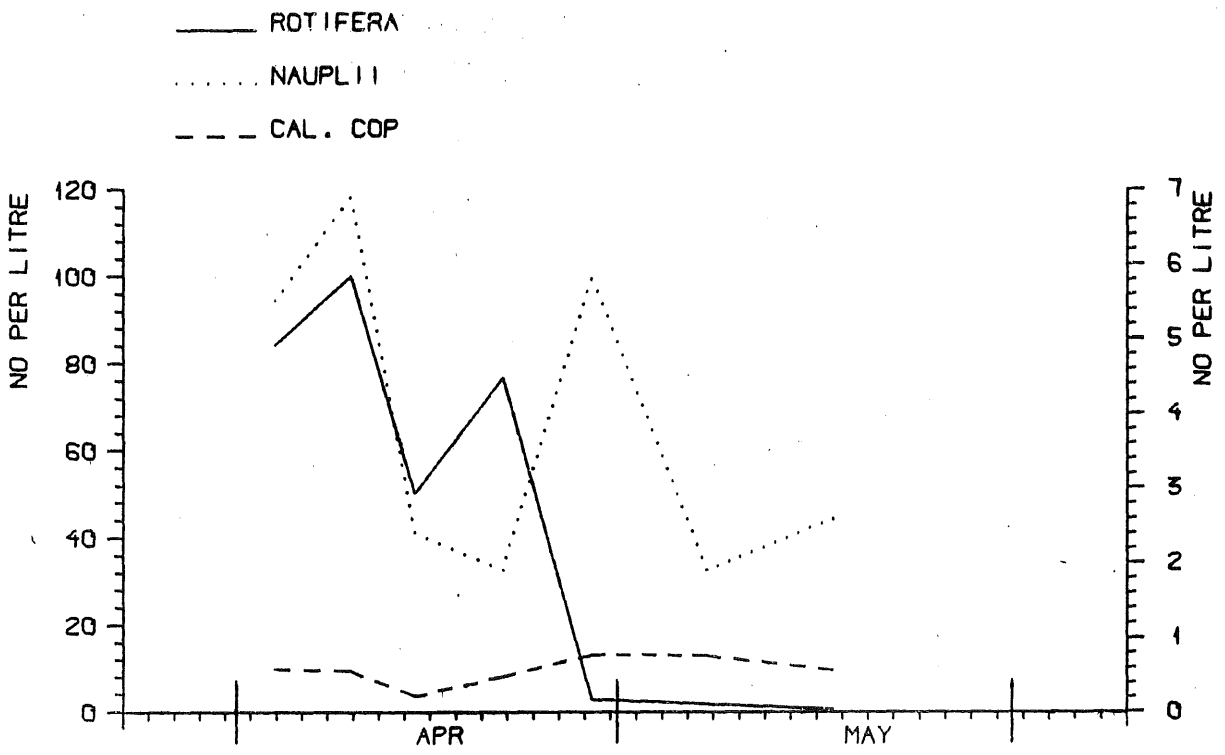

Fig.5. Mean number of rotifera (left coordinate), nauplii and calanoid copepods (right coordinate) per litre in 1980. Samples from 3m, 4m, 5m and bottom have been averaged.

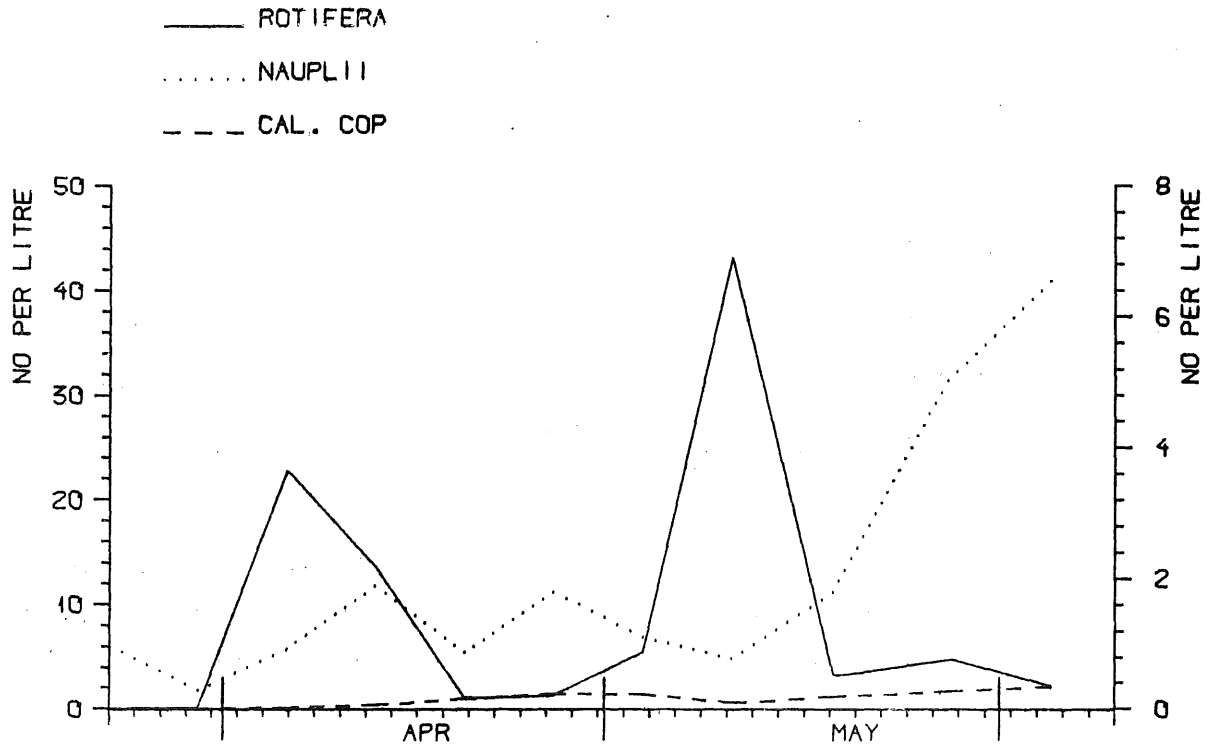

Fig.6. Mean number of rotifera (left coordinate), nauplii and calanoid copepods (right coordinate) per litre in 1981. Samples from 3m, 4m, 5m and bottom have been averaged.

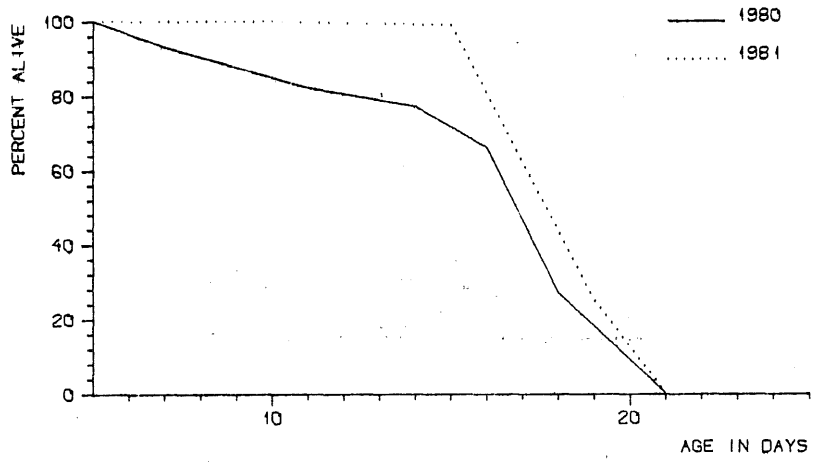

Fig.7. Mortality of starvation groups in 1980 and 1981.

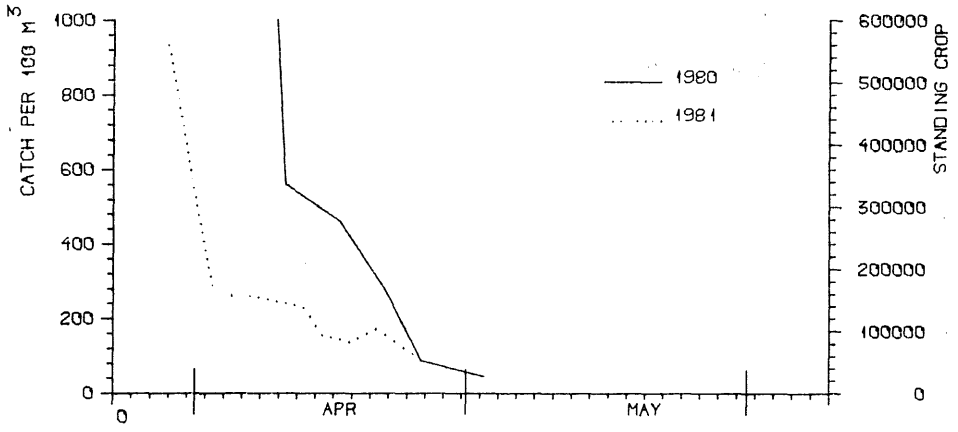

Fig.8. Catches of cod larvae per 100 m^3 in 1980 and 1981 (left coordinate) and standing crop (right coordinate) from release onward, number released being 0.6 mill in 1980 and 0.5 mill in 1981.

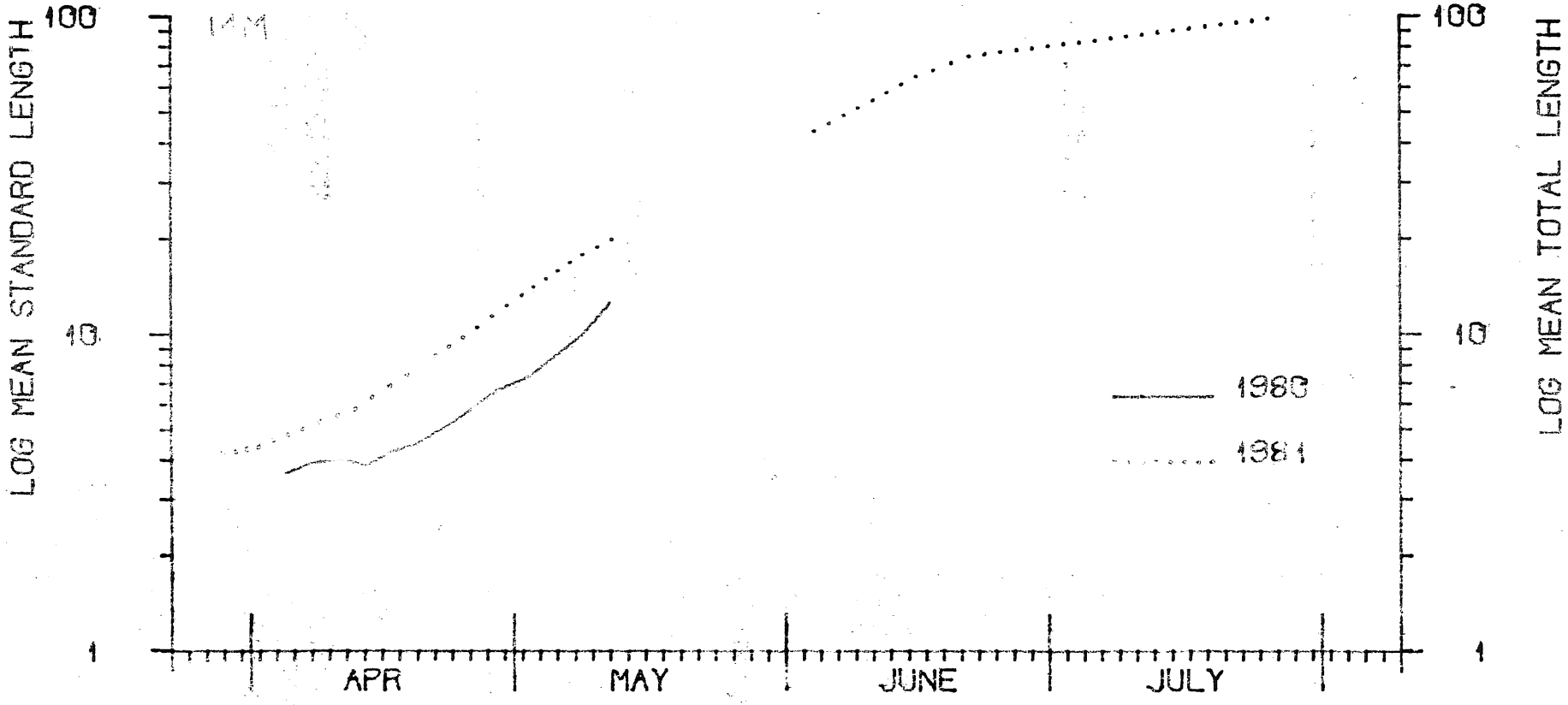

Fig.9. Mean standard length of cod larvae from release to metamorphosis (left coordinate) and mean total length in June and July (right coordinate, only for 1981).

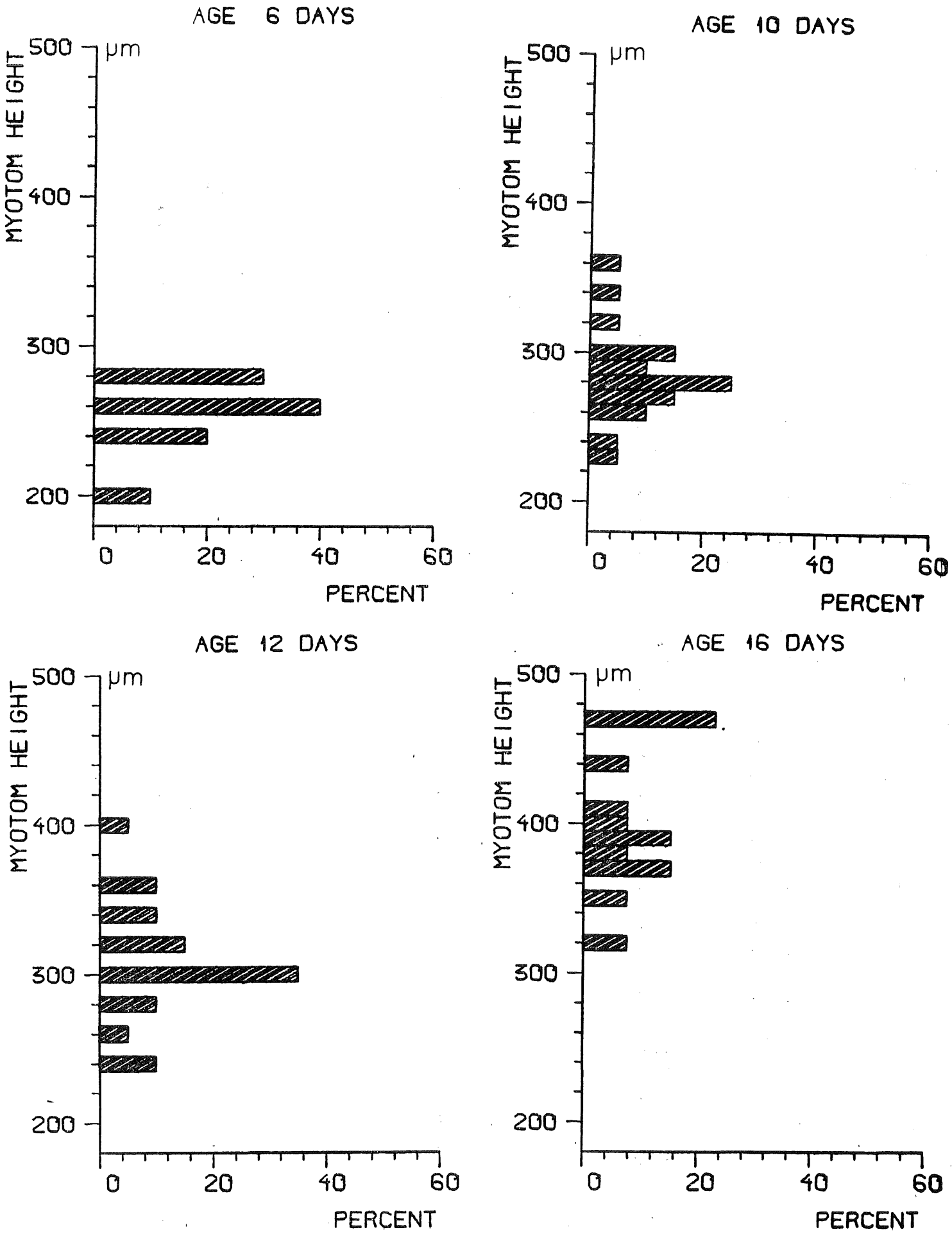

Fig.10a. Body height-frequency-distribution from release through first feeding for cod larvae in 1980.

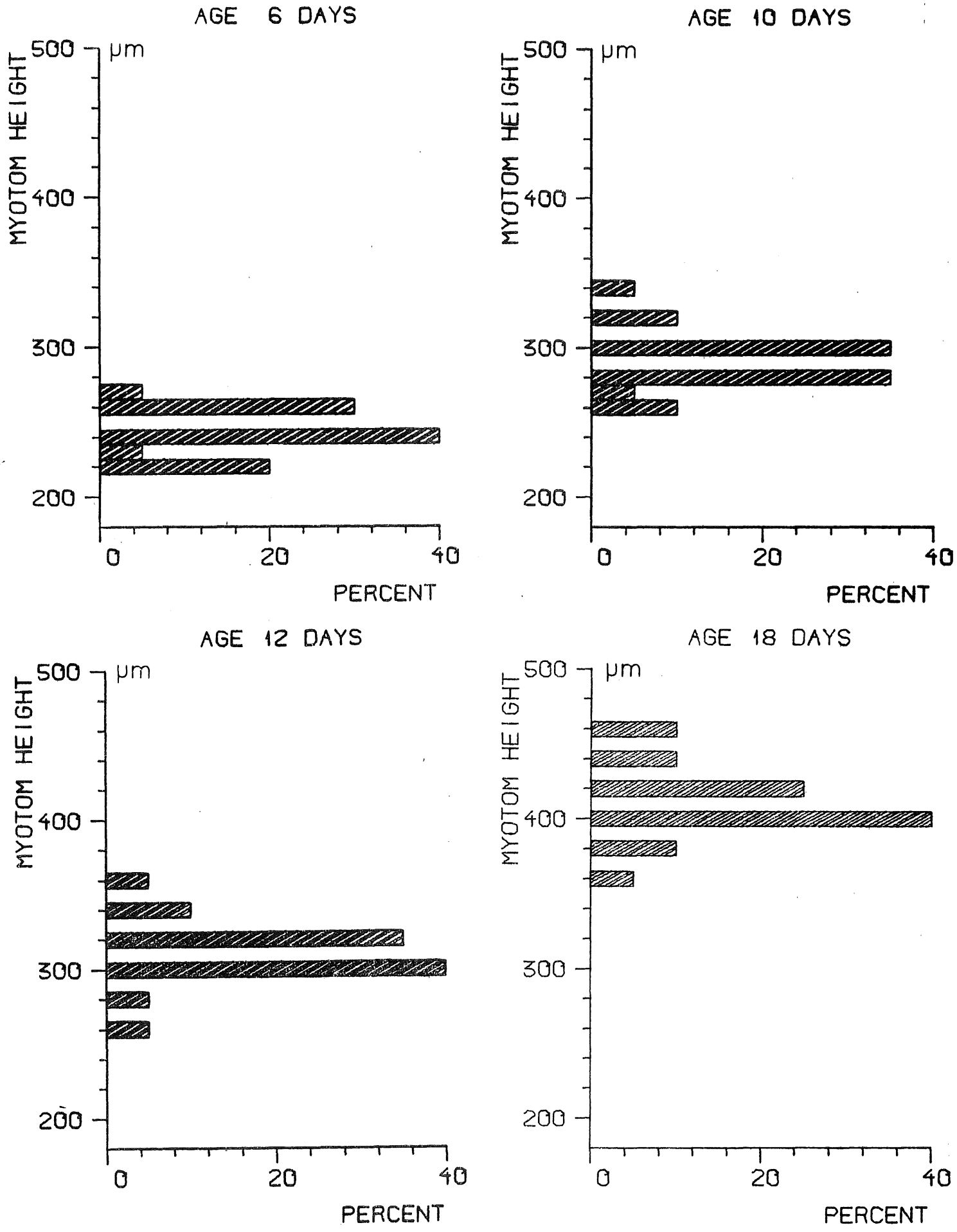

Fig.10b. Body height-frequency-distribution from release through first feeding for cod larvae in 1981.

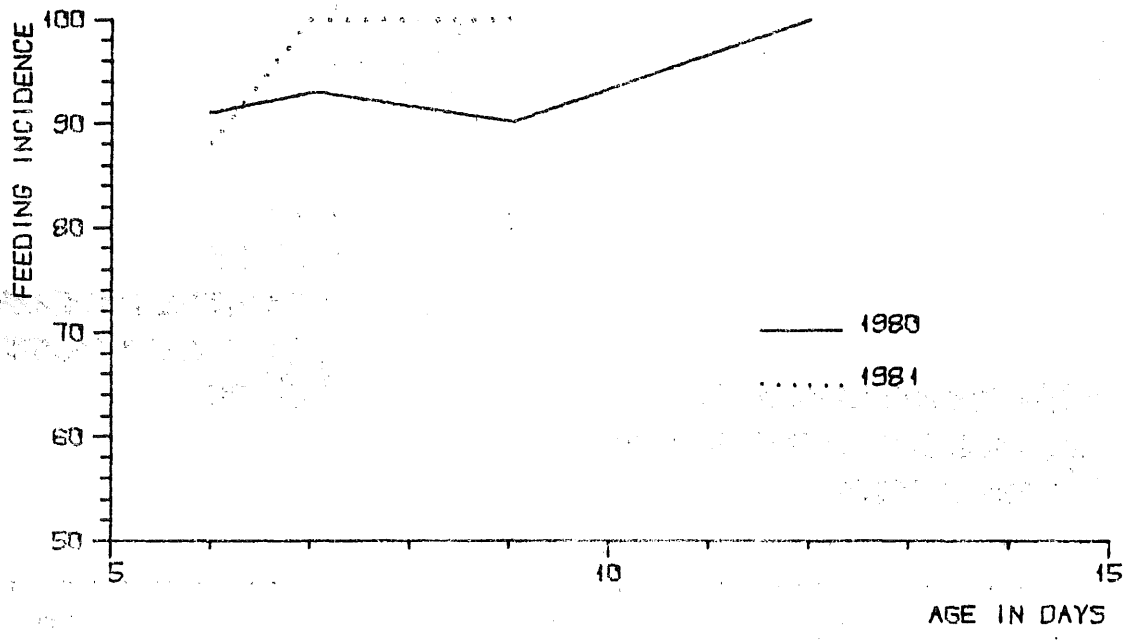

Fig.11. Feeding incidence for cod larvae in 1980 and 1981.