International Council for
the Exploration of the Sea

C.M. 1984 (F:16)
Mariculture Committee
Ref. Demersal Fish Cttee

# MASS-PRODUCTION OF COD FRY (Gadus morhua L.) IN A LARGE BASIN IN WESTERN NORWAY - A NEW APPROACH

by

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## ABSTRACT

In February 1984, the fresh water in a small lake was replaced by seawater pumped from 40 m depth. Four-day old cod larvae were transferred on 11 and 26 April into this seawater basin, which was 5 m above sea level with a volume of 23 000 $m^3$.

The growth and survival of the two cod larva populations were monitored until late June, when the basin was drained and all surviving cod fry collected and transferred alive to the Aquaculture Station Austevoll. The diet of the cod larvae and fry was monitored, as were densities of zooplankton, water temperature, and oxygen saturation.

## INTRODUCTION

Basin experiments have been carried out in Norway since 1975 (reviewed by Øiestad 1982) and pond experiments since 1980 (Kvenseth and Øiestad 1984). The pond experiments in 1983 resulted in the production of about 75 000 cod fry, and in a repeated experiment this year about 60 000 cod fry were produced.

The problem in the pond experiments has been large populations of hydromedusae, which dictated a special strategy (Øiestad et al. 1983). As hydromedusae were a minor problem in the initial basin experiments (Øiestad 1982), we wanted to make parallel basin experiments parallel to those in the pond.

## MATERIALS AND METHODS

We selected a small lake close to the sea in Austevoll, south of Bergen. In early 1984, the fresh water was replaced by sea water from 40 m depth. The lake, henceforward called a basin, had a volume of 23 000 $m^3$ and a maximum depth of 5 m.

On 11 April, 1.8 million cod larvae were transferred from the hatchery at the Aquaculture Station Austevoll to the basin. The cod larvae were at the end of the yolk sac stage. A second release of 200 000 cod larvae was made 26 April.

Zooplankton were sampled by pumping in six different depths (120 µm mesh size*) and by net hauls in four depths (0, 1, 2 and 2½ m; 350 µm mesh size). Cod larvae were sampled by net hauls until early June, mainly at midnight. There was no water exchange in the basin during April and May. In June it was 1-3%/day.

Daily temperature and weekly oxygen saturation measurements were carried out for every meter down to the bottom.

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*By a mistake, the samples were washed with 120 µm mesh size, so all rotifers and a fraction of the nauplii were lost.

From mid-May, a filtration system for zooplankton was established in the bay and the filtrate pumped up into the basin (filtration capacity 2 $m^3$/min, pumping capacity 0.2 $m^3$/min). Dry pellets were offered the cod fry from automatic feeders from mid-May.

The cod larvae were captured beginning mid-June by attracting them above a net by dry pellets. The net was drawn up and the cod fry pumped by a fish pump from the basin to a net cage in the sea before transfer to the station. The basin was completely drained in late June to ensure complete recapture of surviving fry.

RESULTS

Hydrography

The temperature increased slowly in April from 5°C to 11°C below 2 m depth. Above 2 m depth, the temperature was higher in late April (13°C). In May and June, the temperature fluctuated at about 11°C below 2 m depth. The salinity was about 32°/oo except in the surface layer, where rainfall reduced it to below 30°/oo from time to time. Oxygen saturation was above 100%.

Zooplankton

There was a very low standing stock of zooplankton in early April. The density of nauplii was below 1/litre in both April and May.

Hydromedusae were almost non-existent. The density of calanoid copepods was at a maximum in mid-April (0.1/litre). Pelagic stages of Balanus sp. were numerous in April (3/litre in mid-April).

## Cod larvae: growth survival and diet

The cod larvae grew very slowly until late April (Fig. 1). Improved feeding conditions gave a high growth rate in May and June (Fig. 1), and the specific growth rate to metamorphosis was 11% for the first group, which metamorphosed about 15 May at an age of almost 40 days.

The population declined from the initial 1.8 million to 75 000 at metamorphosis. The second group declined from 200 000 to 25 000 at metamorphosis in late May. However, only 30 000 cod fry survived post-metamorphosis and were collected when the basin was drained about 20 June. Their mean size then was 4.1 cm and wet weight 0.7 g. It was not possible to separate the groups (Fig. 2).

The diet in April was mainly rotifers until late April, when nauplii were included in the diet (Fig. 3). In early May, (age 25) the diet changed to calanoid copepods (16%) and harpacticoids (31%) with nauplii (32%) and rotifers (21%) still important contributors, at least by number. Even in mid-May, (age 42) the small prey organisms contributed with 25%. Contributions from bivalves and large dinoflagellates were observed from late May (age 47) (miscellaneous, Fig. 3). In early June large fraction of the population was observed with pellets in the gut, but zooplankton continued to be the main item in their diet.

## DISCUSSION

Cod larvae had high survival to metamorphosis in earlier basin experiments (Ellertsen et al. 1981; Øiestad 1982). The heavy reduction after metamorphosis has been assumed to be caused by cannibalism. The cod may not necessarily ingest the prey, but might injure them so they eventually die (Øiestad 1983). Cannibalism is also the most likely explanation for the reduction in numbers post-metamorphosis in this experiment. The large variation in size (Fig. 2) at this stage should increase

the attacks. The number surviving to termination gave a mean fry density of 1.3/$m^3$, which is equal to that observed in earlier basin experiments (Øiestad et al. 1984).

This experiment has indicated that it is possible to establish large artificial ecosystems and use them for production of marine fish fry. Further experiments with other species will be carried out during the summer 1984 in the refilled basin.

ACKNOWLEDGEMENT

This reduction experiment was funded by "Funding for efficiency of fisheries", managed by The Royal Fishery Department, Oslo.

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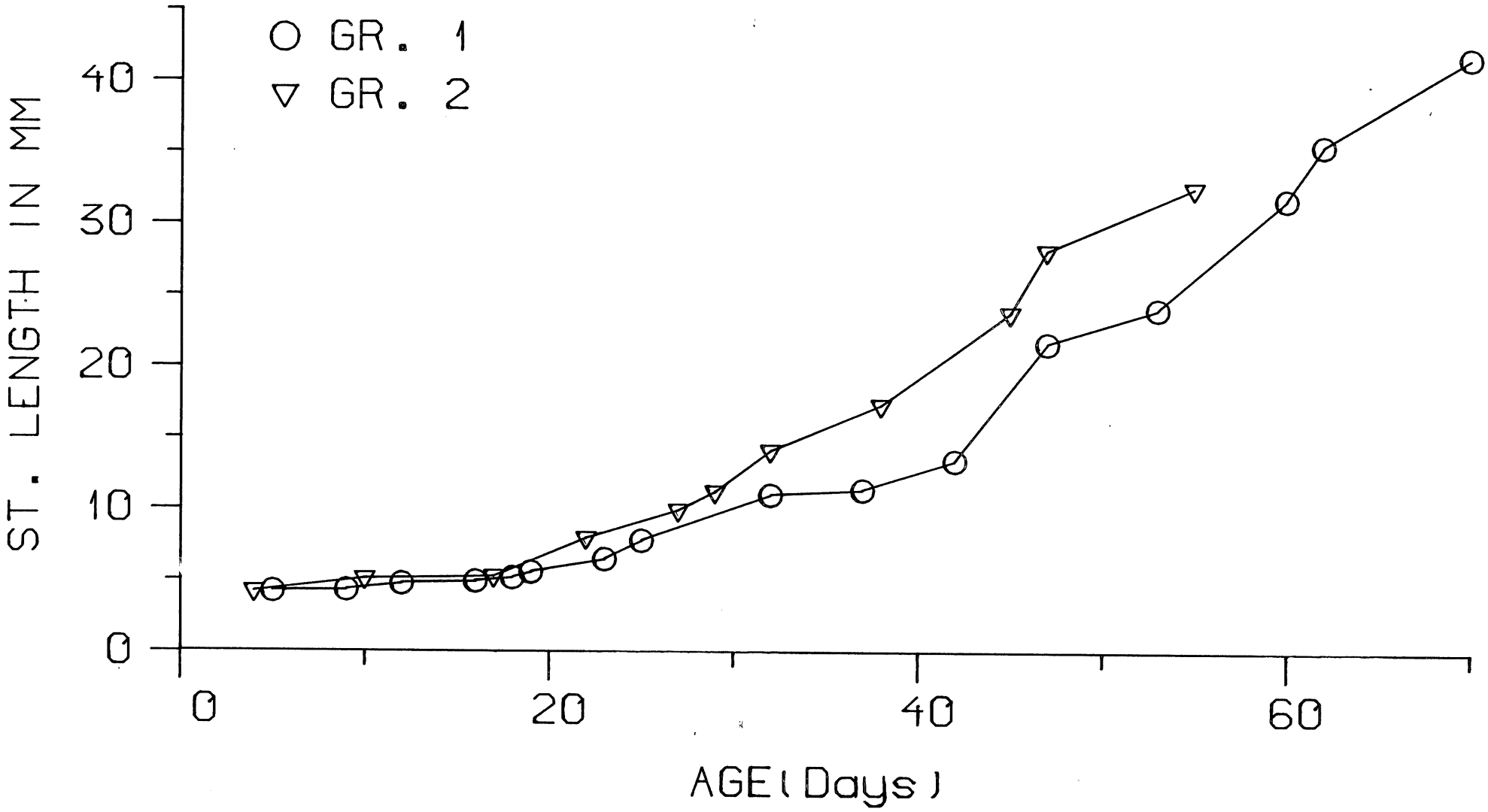


Fig. 1. Standard length of cod larvae released in Svartatjønn 11 April (Gr. 1) and 26 April (Gr. 2) in the 1984 basin experiment.

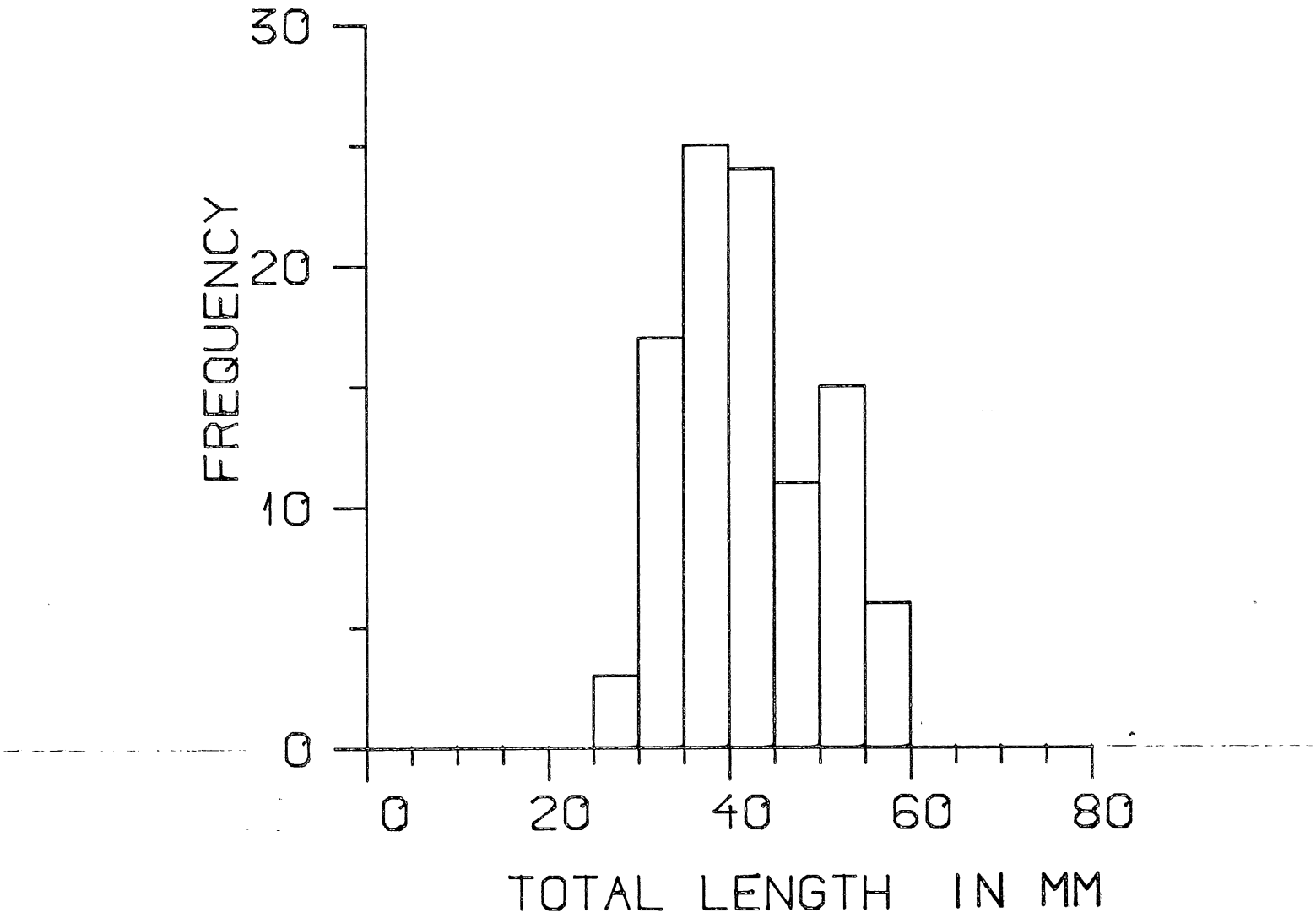


Fig. 2. Total length frequency distribution 20 June in the 1984 basin experiment in Svartatjønn. Age of the first group of cod was than 74 days.

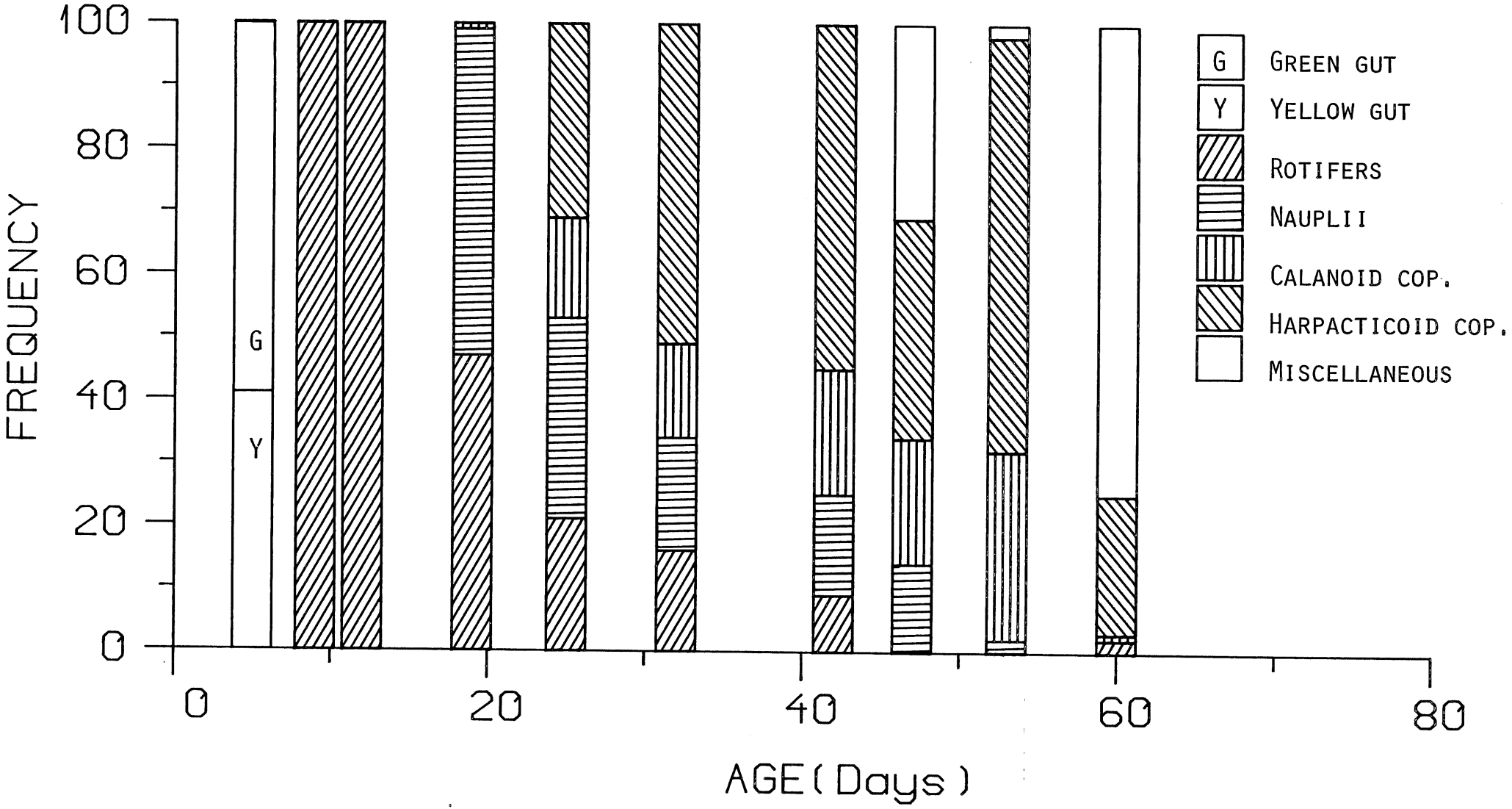


Fig. 3. The diet of cod larvae in the 1984 basin experiment in Svartatjønn. Age is given with referance to Gr. 1 (released 11 April), and all samples except the three first are taken at midnight.