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APPETITE FEEDING EXPERIMENTS WITH COD - PRELIMINARY RESULTS

BY

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ABSTRACT

Various size groups of cod were kept in periods of 3 to 4 weeks in ad lib. feeding experiments at deprivation times from 4 to 48 hours. Ration size varied from 0.4 to 6.2 % (wet weight) per meal in the series. Average daily food consumption were 1.9 % at 4 - 5°C and 2.5 % at 6.2 - 6.5°C. The cod seemed to regulate the daily intake of food to the same amount in per cent of wet weight regardless of intervals between feedings. Appetite seemed to be best in the evening.

INTRODUCTION

The daily rate at which food can be consumed is a prime growth factor (Brett,1971). It is related to a number of factors which include the amount of food eaten in a meal, the number of meals per day, the rate at which a meal is evacuated from the stomach, fish size, activity of the fish, the type and availability of food and temperature.

Most studies deals with salmonids,Brett(1971), Elliott(1975), Grove, Loizides and Nott(1978),but some information is also available on cod as rewieved by Daan(1973).

The present paper is a part of a joint work on the nutrition,digestion growth and metabolism on cod and gives some information on the appetite, ration size, daily consumption and feeding rythm.

By feeding cod ad libitum meals at various time intervals under controlled conditions, is it possible to attain important information of feeding rate estimates to be used in fish production studies in the wild or for aquaculture purpose. The results should be regarded as preliminary.

MATERIALS AND METHODS.

The fish used in this study were 93 cod, Gadus morhua L. of various size (table 1), obtained from local fishermen in the Austevoll area. The cod were divided in size groups at arrival and kept in oval fibre glas tanks (175 l) in three weeks before start of the studies. The same fish were used in all the four experimental series, although the groups were changed according to size and time interval between feedings. Three new groups (24, 36, 24 h) were introduced in exp. nr 4.

The holding technique as described by Braaten (1976) were used, although there were no temperature regulation of the sea water. Unfiltered sea water from 50 m depth were used in continuous flow system. Salinity ranged between 31.1 and 34.4 °/oo with an average value of 32.5 °/oo. Temperature remained fairly constant during each experiment, but due to a cold winter and a sudden cooling of the deep sea water, the experiments had to be separated in two distinct temperature groups (table 1), I, IV and II, III.

All groups were fed newly thawned capelin which was chopped in suitable pieces. Heads were not used. Uneaten food were remowed by a small dip net after all groups had been fed, and weighed.

Feeding were only performed during the 16 hr. light period and between 08.00 a.m. and 21.00 p.m. at following intervals: 4, 6, 12, 24, 36 and 48 hr. All groups were fed to satiation at every meal. The cod were not fed for 72 hr. before the start of an experiment. A deprivation period of three days made the fish hungry and was followed by a large intake of food. The two first days in each feeding period has therefore been omitted in the calculation of average ration size.

The size of each meal and the cumulative intake of food was recorded so that satiation time and total amount could be calculated. The return of appetite was measured by repeating the feeding procedures for a period of three to four weeks.

For each size group total ration, growth rate and growth efficiency was calculated in addition to average daily food intake.

RESULTS AND DISCUSSION.

Ration size.

The intake of food per meal varied considerable in the groups (table 2) and increased in average from 0.4% wet weight as the lowest in the 4-hr series to 6.2% as the highest in the 48-hr series.

The maximum ration in one meal found in 4, 6, 12, 24, 36, 48-hr series were 2.9, 2.5, 5.0, 7.9, 7.2 and 7.7% respectively.

At feeding intervals between 4 and 12 hours, large oscillations in the food intake were found throughout the whole experimental period (fig 1 and 2). A large meal was followed by a small meal and vice-versa similar to Bretts (1971) studies on sockeye salmon. Feeding at intervals of 24 hours or more were less variable for small and medium sized fish (150 - 230 g), while larger fish (430 - 564 g) showed great variations in food intake between meals (fig 2). A small meal that follows a large indicate that stomach has not yet been depleted sufficient to receive a new large meal.

This result confirm earlier studies by Jobling et al.(1977) and Grove et al.(1978), that gastric emtying rate decreases as the size of fish increases.

Daily food consumption.

Althought ration size per meal showed large variations within each serie and between the various feeding interval series, average intake of food per day showed relativly little variation (table 1 and 3). In experiment I and II the smallest fish had the largest intake of food. This can be explained by the variation in size of fish between the various groups. It is a well known fact that ration size decreases as the fish size increase (Brett and Shelbourne 1975, Elliot, 1975).

It was expected that smaller meals at shorter intervals would give a larger daily intake of food than few but larger meals as found by Brett (1971).

The results indicate that cod during the prevailing experimental conditions seems to regulate the daily intake of food to the same amount (in per cent of weight) regardless of time intervals between feedings. The size effect on ration seemed to have little effect for cod above 260 g.

Maximum daily food intake ranged between 5.7% (4-hr intervals) to 7.9% (24-hr intervals) for cod between 496 and 638 g. Average daily food intake omitting the first two introducing days of feeding in each serie was also calculated. At 6.2 - 6.5 °C the daily ration ranged from 1.9 to 3.1 % per day with an average of 2.5%. At 4.1 - 5.0 °C ration ranged between 1.3 and 3.1% with an average value of 1.9%.

These results are in good agreement with several earlier studies quoted from Daan (1973).

Author	Fish size	Area/temp.	Ration (%)
Strzyzewska (1959)	25 cm	Baltic Sea	2.3-4
Novikova (1962)	35-45 "	" "	1.7-2.3
Lishev & Uzars (1967)		" "	1.6
Tarverdi (1962)		ad.lib.exp.	2.2-2.9
" "	25-40 cm	Barents Sea (3-4°C)	2.0
Kohler (1964)	33-46 "	ad.lib.exp. 2.3-13.6°C)	2.0-2.4
Daan (1973)	30-50 "	North Sea	1.0-1.7

Diurnal variations.

Since feeding only were performed during daytime it was only possible to compare appetite in the morning, the middle part of the day and the evening. At 4-hr intervals food intake were always highest in the morning and from 2-3 times larger than the following meal, then meal size increased gradually during the day. However, because of night, time interval between the last meal one day and the first meal the following day had to be 12 hours.

In all other experiments with several meals a day (6-hr and 12-hr series), largest appetite were always found in the evening (last meal) regardless wether if it were 6 or 12 hours between meals. These

findings indicate that appetite was best in the evening.

In the 4-hr series, average ration size ranged between 0.4 and 0.8%. As shown by Jobling et al.(1977) and others, a small ration will be evacuated at a shorter time interval than a larger meal, although at a slower rate. This might explain why the first meal usually were greatest in the 4-hr series, and 12 hours is a necessary time interval to digest and evacuate a large enough part of the meal to increase appetite. According to Brett (1971) and Elliott (1975) the greatest increase in appetite for sockeye were foun where stomach content were respectively 75% and 90% digested. According to ration size, good appetite was in the present study recorded after 24 hours.

This indicate that time to 75 - 90 % depletion of stomach in continuous feeding experiments at 6 °C could be about 24 hours. This is in agreement with Tylers (1970) results at 5 °C and Jones (1974) at 6 °C. On the other hand, Daan (1973), Bagge (1977) and Karpevich and Bokova (1937) found that complete digestion could take from 2 to 6 days depending on temperature, fish size and meal size.

CONCLUDING REMARKS

Growth and conversion efficiency was calculated in all experimental series (table 1). Fairly high values of growth and conversion values were obtained in exp.I and IV,while the results varied a great deal in the other two series. The decrease in growth rate for fish above 250 g can to a great extent be explained by maturation of some of the experimental fish.For this reason all but two groups in exp. III were excluded.

Maturation has probably also affected appetite and ration size in some groups in part of the experimental period.

The variable size of fish in the experiments was another complicating factor for interpretation of the results, howewer further experiments are planned.

In order to compare fish of various sizes all results will be adjusted to a common fish size as made by Jones (1974).

Table.1. Water temperature (range in °C), time intervals between feeding (hours) number of cod, initial and terminal weight (g live weight), initial and terminal length (cm), ration(tot.exp per.). growth rate and gross conversion efficieny (all values are calculated in wet weight of fish and food).

Exp.	Temp (°C)	Time(h) interv.	No fish	Weight (g)	Length (cm)	Ration % wet wt/day	Growt rate % wet wt /day	Conv.e % wet wt.
I	5.3-6.7	4	12	117.1-142.0	23.4-24.1	2.8	0.92	33.0
"	"	6	13	126.0-152.6	24.1-24.6	3.0	0.91	30.7
"	"	12	10	218.5-246.8	28.0-28.6	3.0	0.58	19.3
"	"	24	9	229.1-268.8	28.6-29.0	2.6	0.76	29.6
"	"	36	12	328.4-366.8	32.3-32.5	1.7	0.53	30.9
"	"	48	11	323.6-368.9	32.3-32.5	1.9	0.62	33.6
II	3.4-5.4	4	12	366.8-397.6	32.5-33.1	1.6	0.38	27.8
"	"	6	11	368.9-373.2	32.5-33.1	1.4	0.06	4.7
"	"	12	12	142.0-169.1	24.1-25.1	3.3	0.80	28.2
"	"	24	13	152.6-164.1	24.6-25.2	2.1	0.35	18.8
"	"	36	10	246.8-288.3	28.6-29.5	1.6	0.74	50.6
"	"	48	9	268.8-295.7	29.0-29.8	1.9	0.45	28.2
III	3.8-5.9	36	11	171.3-181.9	25.2-26.2	1.9	0.29	18.2
		48	9	183.9-191.3	26.2-26.7	1.6	0.19	14.2
IV	6.3-6.8	4	7	607.4-667.7	38.5-39.5	3.1	0.29	11.5
"	"	6	9	477.6-614.9	37.1-38.3	2.2	0.77	43.2
"	"	12	10	357.8-452.9	33.6-34.8	3.1	0.71	29.1
"	"	24	7	428.7-564.1	33.9-35.8	3.0	0.83	35.0
"	"	3[illegible]	6	307.2-425.3	31.1[illegible].7	2.9	0.99	41.3
"	"	48	12	221.5-306.8	27.3-29.3	3.0	0.99	41.6

Table 2. Average intake of food pr meal (%wet weight) in relation to intervals (hr) between feeding. Each value represent the mean of all meals during the test period with standard devation.

Time intervals (h).

Exp.	Temp °C	4		6		12		24		36		48	
		x	S.D	x	S.D	x	S.D	x	S.D	x	S.D	x	S.D
I	6.2±0.4	0.6	0.6	0.9	0.7	1.5	1.0	2.7	1.7	2.3	0.7	3.8	1.3
IV	6.5±0.2	0.8	0.9	0.7	0.7	1.4	1.1	2.7	2.1	4.0	1.4	6.2	1.6
II	4.4±0.6	0.4	0.3	0.4	0.5	1.6	1.4	2.1	0.8	2.7	1.6	3.8	1.7
III	5.0±0.8									2.8	1.1	3.2	1.9

Table 3. Average amount of food consumed pr day (g/kg/day), in relation to intervals (hr) between feeding. Each value represent the mean wet weight for the test period with standard deviation.

Time interval (h).

Exp	Temp °C	4		6		12		24		36		48	
		x	S.D	x	S.D	x	S.D	x	S.D	x	S.D	x	S.D
I	6.2±0.4	22.9	11.4	27.5	9.5	29.3	13.3	23.8	12.1	15.5	2.5	21.3	8.6
IV	6.5±0.2	31.0	12.3	19.7	8.6	28.6	12.4	27.0	21.2	26.2	4.1	31.0	7.7
II	4.4±0.6	14.6	5.0	13.2	8.8	30.8	13.5	20.8	7.8	16.4	7.4	18.8	8.1
III	5.0±0.8									18.8	6.5	15.7	9.3

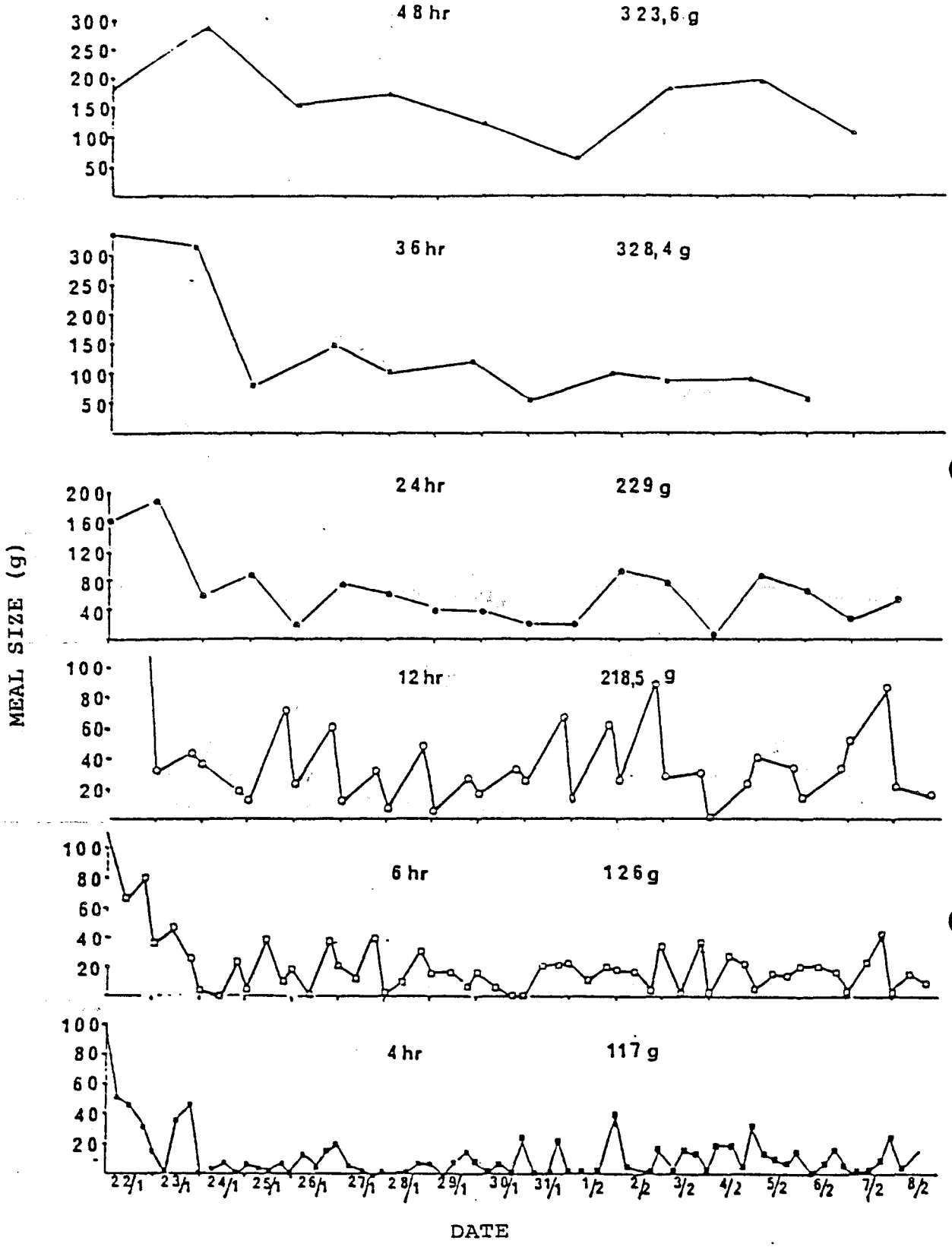

Fig. 1. Continuous feeding experiment with cod of various size groups, at time intervals from 4 to 48 hours. (experiment nr.1).

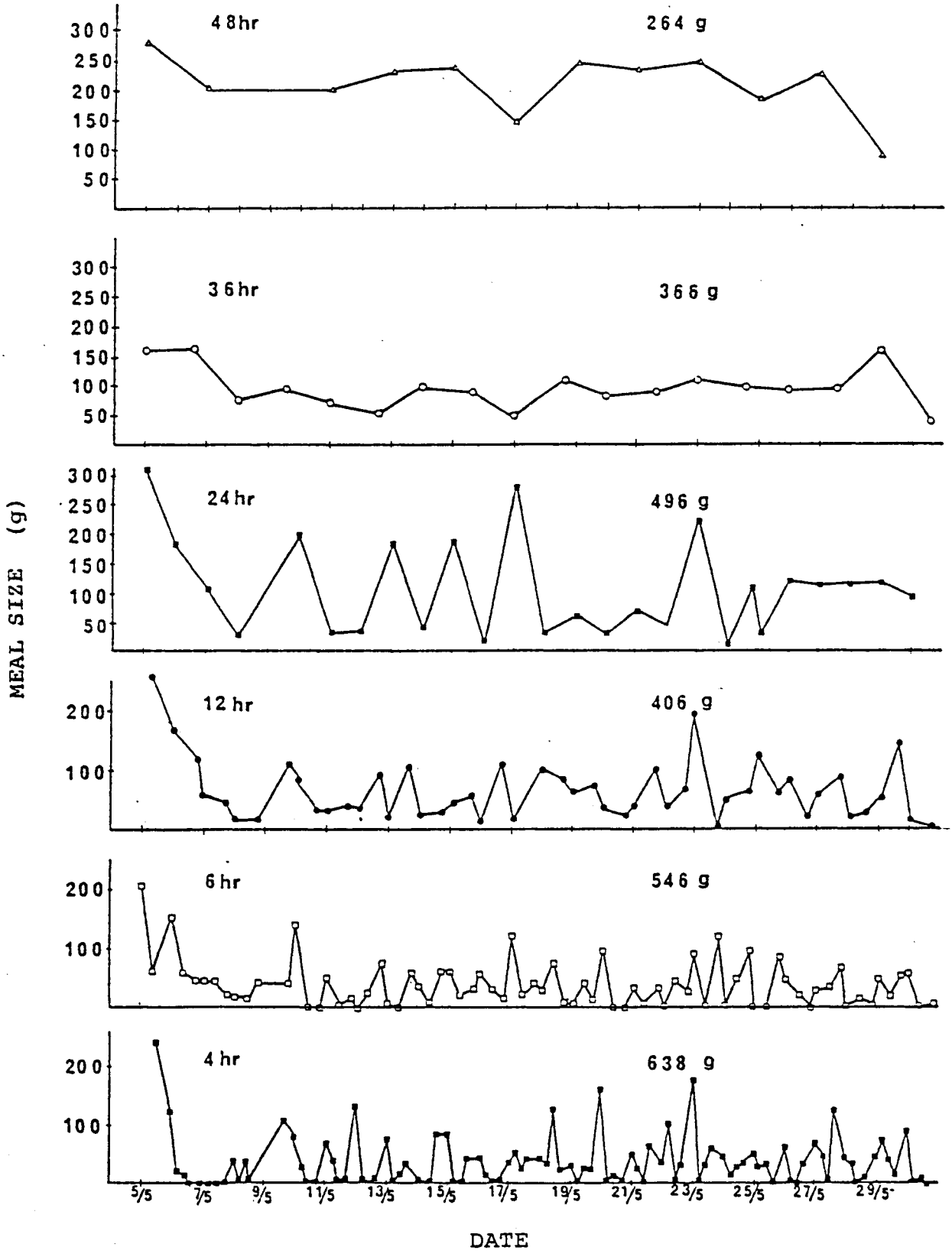

Fig. 2. Continuous feeding experiment with cod of various size groups, at time intervals from 4 to 48 hours. (experiment nr. 4).

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