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On the Problem of Feeding, Diurnal, Annual Food Ration and Balance for Silver Hake Population in the Scotian Shelf Area

by

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ABSTRACT

Diurnal rations of hake females and males were calculated by size-groups based on joint Soviet-Canadian cruises in 1988, 1990. Annual food uptake was calculated by food items. Comparative characteristics were obtained on food composition and biomass. At hake stock assessment food supply of young, adult and old fishes should be considered separately.

INTRODUCTION

The greatest permissible population biomass of species is determined by food supply, i. e. by availability of particular food quantity and quality to be utilized by specimens for body forming and stock reproduction. (Nikolsky, 1974). At hake stock assessment food supply of young and adult fishes should be considered separetely, as food amount,required for normal vital activity of variuos groups during particular period, became one of the major factors of species growth and production rate. (Rikhter and Vinogradov, 1992). Rational fishery management requires the quantitative estimate of food relations between size-age groups of a species and members of association as well as the estimate of forage base parts, quantitative relations of those parts and food amount, utilized by major consumers. Food amount, utilised by fish during a sertain period of time (e. g. a diurnal period), defines a ration, the estimate of which permits to assess a relative effect of population on the forage base and vice versa.

MATERIAL AND METHODS

In the article the information obtained from two joint Soviet-Canadian cruises in 1988 and 1990 were used. Stomachs were sampled from hake of the following size-age groups: 12-20 cm and

21-25 cm (1^+, 2 juvenile); 26-35 cm (3^+, 4^+, 5^+, 6^+ mature, participating in mass spawning); 36-58 cm (7^+ - 10^+ fishes of older age groups with considerable natural mortality, mainly females). Stomachs were sampled from males and females separately.

To reveal diurnal feeding dynamics and ration of hake hauls were carried out every 2-3 hours during at least 23 hour periods. In the area of Scotian Shelf two diurnal stations were carried out with DT/TV 30/36 and "Hake-4" trawls during 25-26 July 1988 and 2-3 July 1990.

Samples for feeding analysis were taken over entire 24-hour period, 40 specimens from each trawl in average. Totally 436 specimens were analyzed in 1988 and 974 specimens in 1990 (Tables 1, 2). Forage zooplankton was sampled with small (20.3) and large (60.1) Bongo-net, and subtrawl net IKS-80 directly during haul.

At subsequent treatment of materials on hake feeding total indices of fullness (in ‰), food composition by mass (in %) were calculated. Indices of fullness were calculated based on actual food items weight and reproduced weight. (Methodical guide ..., 1974).

Since a study of diurnal feeding trends revealed no clear peak in different age-size groups at particular diurnal ration, the method applied was based on food digestion rate at two and more peaks of stomach filling over 24-hour period.

Calculations of total food consumption by population and by size-age groups required such quantitative characteristics of biological processes as age, number of fish by ages (in %), weight by ages, diurnal and annual rations, food composition by groups, food energetic equivalent and etc.

RESULTS AND DISCUSSION

Regulated hake fishery with licences within Canadian economical zone promotes successful Soviet fishing fleet operations only when the stock size is known, date of its going out into the shelf is predicted, peculiarities of distribution are revealed, time of aggregation formation and stability, which depends on food items composition, amount and feeding dynamics of this species is determined.

program of joint Soviet-Canadian researches is based on several working hypothesis, such as the following:

- terms and areas of hake aggregation formation are determined by water masses dynamics, particularly at shelf slops;

- aggregation size and stability depend on stock size and composition, food item amount, feeding dynamics and rate of gonad ripening.

Research of those aspects is very important in short-term fishery prediction and recommendations on optimal quotas size.

The first joint Soviet-Canadian cruise of the series was carried out on SRTM-K-8108 "Strelnya" from May through September 1988. Preliminary results show that in June-July aggregations occurence and, density over the narrow shelf area, allotted to our fishery, depend primarily on abundant food availability and distribution, which creates significant concentrations of hake and provides high average diurnal catches. Analysis of fishery situation for the years of licence fishery (1977-1985) revealed (Vinogradov, 1988), that unfavourable temperature conditions at the shelf slops in fishing area (August 1984, 1985) coinsided with good foraging conditions (calanus, young fish) promoting increase of young fish abundance in July-August and concentration of adult hake, which in turn provides high catches.

The next cruise of the Soviet-Canadian series was carried out by R/V vessel RTMA-7111 "Evrika" from May through July 1990. Trophological researches in this cruise was aimed at qualitative study of feeding, including diurnal food composition assessment (diurnal ration) at natural conditions. Besides diurnal vertical migrations, relations between hake and other species, feeding selectivity, qualitative and quantitative food composition and distribution were researched.

Hake vertical migrations were researched based on the results of pelagic hauls. The data available evidenced that fish moved upwards from midday till 18.00-20.00 in the evening. The most active hake feeding on the major food item M. norvegica occurred from 18.00-20.00 till 6.00-8.00. Diurnal food uptake for hake of 28-33 cm in length and average weight of 163 g amounted to 1.2% of a body weight. According to Don Waldron (personal communication) diurnal ration for that period amounted up to 1.5-2% of a body

weight. As in the first cruise, we observed food selectivity of hake with preference of larger euphausiids. Thus, during the first two cruises quantitative characteristics of hake feeding, food composition and possibility of forage base and feeding conditions usefullness to compare with hake biomass and stock size estimates were obtained for the first time (Vinogradov, 1982). The possibility appeared to assess foraging conditions, promoting the young fish abundance increase in summer (Vinogradov, 1988) and adult fish food distribution over the trophical network (Vinogradov, 1986).

Hake diurnal ration assessment

In June of 1990 the results of diurnal hake feeding trends revealed two feeding peaks at 20.00-1.30 and 6.00-10.30 (Fig. 1), correlated with euphausiid diurnal migrations (16.00-22.00 and 1.00-8.00, Fig. 2).

In July 1988 study of diurnal hake feeding trends revealed several peaks of stomach fulness, most apparent in fishes consuming euphausiids (Fig. 3). Different groups of males and females uptake euphausiids at different time periods, sometimes even counterphase consumption occurred. Thus, the general feeding pattern in July 1988 was similar to that in June 1990 (Fig, 4), particularly for consumption of M. norvegica.

The diurnal ration was calculated according to the method of G. P. Romanova (1958), modified by Volk and described by A. V. Kohan (1963). Digestion rate was assessed by feeding decrease. As the plot (Fig. 1) shows there were two sharp decreases of hake feeding activity in June: from 11:50 till 13:45 and from 15:50 till 17:50. The average amount of food degested within 2 hours was estimated by means of those decreases in males. Then the average food amount degested within 1 hour was deduced based on the two decreases. The result was 56.8% for an hour. As stomach fullness index increased, amount of food just consumed was estimated taking in account food already digested. Thus, diurnal ration of hake males 12-35 cm in length amounted to 13% of body weight in June 1990. According to the method by B. N. Elkina (1952) and Yu. G. Yurovitskiy (1962) a daily ration is doubled sum of peak stomach fullness indices, amounting to 179+160=339 in males and doubled sum equals to 678 ‰ or 6.8%. According to

the method by N. S. Novikova (1951) the daily ration consists of average food amount consumed for an hour multiplyed by 24 hours, i. e. 56.8x24=1363.2‰ or 13.6%. A daily ration for females and both sexes of all size groups were calculated similarly. The results obtained are presented in Table 3.

The above mentioned methods were also used to calculate a daily ration for males and females of various size groups in July 1988 (Table 3). The results shown in the table vary both in daily ration estimates, calculated by different methods, and by months. Evidently that daily rations, calculated according to the methods by Romanova, Kohan and Novikova are similar as they based on the common background estimate of consumption accounting food digestion rate. However the value of food consumption according to the method by Novikova is underestimated as it accounted only digested food. Methods by Elkina and Yurovitskiy take into account only peak indices of food consumption. The most accurate estimates of daily rations were obtained according to the methods by Romanova, Kohan, as they took in account both food consumed during a day and already digested. The method by Novikova is based only on food digested, however, during a day fish digests food just consumed, and increase or decrease of food consumption in June and July may result in rising or reduction of daily ration value. Thus for abundant food items (euphausiids), daily ration values according to Novikova, especially in young fish (12-25 cm) in June were somewhat lower (Table 3) than those by Romanova and Kohan, but higher than in July. In older fish, especially in females, daily ration value varies in relation to large prey consumption and period of its digestion, which considerably increases daily ration, sometimes up to 70% of a body weight.

Thus method by Romanova-Kohan appeared to be the most reliable one of the three methods, as it takes in account both food consumption and digestion at particular diurnal periods.

Calculation of annual ration for hake population in the Scotian Shelf area

The total annual food consumption for hake population was calculated based on the data on Scotian hake population amounted to 304.3 thous. t in 1988 and 352.7 thous. t in 1990 (Waldron et al., 1991), data on different age groups abundance ratio,

and relative annual ration estimates (Table 4). Various age group proportion (in percents) by weight was obtained based on the known ratio (in percents) of different age groups abundance in population and each fish age group weight. For this purpose percent value by abundance, instead of absent percent value by weight, was multiplied by weight. Then all ages were summed and percent value was obtained for each age from that sum. The total stock size (304.3 and 352.7 thous. t) was allocated by age groups according to percent by weight obtained. Weight of a given age group was multiplied by annual ration (in % of weight, given in kilojoules) to obtain annual food consumption by hake of each age in kilojoules.

Food consumption in weight units (in thous. t, Table 7, 8) was calculated by dividing the above mentioned values by average food energetical equivalent for a particular age group (Table 5, 6). Using known food composition by age groups in percents by weight we calculated forage species weight, consumed by hake of each age. Sum of the latter values provided the total number of forage species of each group, consumed by hake males and females during a year (Table 7, 8) and average hake food composition in percents by weight.

In July the total food biomass, consumed annualy amounted to 25.7 mln.t in 1988, based on a daily ration estimate in June and July. Fish constituted 66.5% of the total amount, including 55.6% (or 14.3 mln. t) of young hake.

In 1990 food biomass, consumed by hake during the year, amounted to 35.4 mln. t with fish constituting 36.4% including 27.9% or 9.8 mln. t of young hake.

Comparison of food composition and amount in July 1988 and June 1990 revealed that euphausiids (27%) and young hake (55.6%) constituted the major food in July 1988, while in June 1990 the bulk of food consisted of three groups: euphausiids (34.1%), young hake (27.9%) and short-finned squid (28.2%). Thus, the amount of the caloric food available in 1990 was almost the same (in percents) as in 1988, however, in June 1990 the bulk of food consisted of two groups of young hake and squid, and in July 1988 young hake dominated. Evidently, in July young hake abundance sharply increased as a result of mass spawning. At natural conditions, however, there may be some factors reducing the species

abundance when a cold front appeared on shelf, or increasing at forage amount growth.(euphausiids). As to the euphausiid consumption by hake, in June the absolute consumption value was 12.1 mln. t, as compared to July, when it amounted to 6.9 mln. t which seemed to be related to this species reproduction. Euphausiid abundance growth in June, and that of young hake and squid in July affected hake feeding intensity, increasing it at account of the former at first and the latter on.

CONCLUSION

Abundant plankton species, utilized as a food by hake, especially by young one, undertook vertical migrations, followed by hake. This resulted in hake catches increase, especially from 16.00 to 18.00 during major zooplankton (including euphausiids) ascent (16.00-24.00) and descent (4.00-8.00).

At euphausiid consumption by hake we observed different size groups of males and females feeding at various intensity in different time periods. For old females of 36-58 cm in length which consumed less euphausiids and showed slight feeding periodicity, one half of food consisted of fishes and another half - of squid. Daily ration estimated for males and females of 12-35 cm in length in July 1988 and June 1990 varied from 3.8 to 6.9% for males and from 6.3 to 9.0% for females in July 1988; from 12.8 to 18.0% for males and from 11.7 to 26.9% for females in June 1990. Daily ration of large females of 36-58 cm in length varied from 67.1 to 70.2 % (evidently large prey was consumed by hake in that day).

The total food biomass, consumed by hake population (304.3 thous. t) in 1988 constituted 25.7 mln. t, with fish proportion 66.5%, including 55.6% (or 14.3 mln. t) of young hake. In 1990 hake population of 352.7 thous. t consumed 35,4 mln. t of food, 36.4% of which constituted fish including 27.9% (or 9.8 mln. t) of young hake. Thus, caloric food available in 1990 amounted to value of the same order as in 1988, however, in 1990 hake food consists of two groups of young hake and squid, and in 1988 young hake dominated. At natural conditions many factor may affect the forage base formation, however the best feeding conditions seems to depend on abundance growth and biomass increment during the period of forage species reproduction rather than on a cold front

development.

When hake abundance increases as a result of forage base development, catches should be regulated by older age groups removal ($7^+ - 10^+$), as the latter provide no biomass growth and are more subjected to a natural mortality. Senior age groups ($1^+ - 4^+$) provide significant biomass growth at favourable forage conditions (euphausiids and gammarides) and short trophic chain. Location of such forage species concentration facilitates fished hake aggregations searching and provides successful hake fishery.

Hake stock assessment requires differential approach to the problem of food supply for adult and young hake at various life stages.

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Table 1 Materials on silver hake feeding collected at the diurnal station on 25-26 July, 1988, (43°47'N, 62°36'W) (Scotian Shelf)

Sex	Length, (cm)	Time and number of hauls									Total
		$9^{30}-10^{00}$	$12^{00}-12^{30}$	$14^{45}-15^{15}$	$17^{15}-17^{45}$	$20^{15}-20^{45}$	$22^{55}-23^{25}$	$2^{10}-2^{40}$	$5^{10}-5^{40}$	$8^{00}-8^{30}$	
		79	80	81	82	83	84	85	86	87	
Males	12-20	13	7	12	13	13	6	13	10	6	93
	21-25	1	-	1	2	1	1	-	4	2	12
	26-32	1	-	2	4	3	4	8	7	4	33
Total by males:		15	7	15	19	17	11	21	21	12	138
Females	12-20	9	3	9	13	9	11	7	8	4	73
	21-25	1	-	-	1	-	-	-	5	2	9
	26-35	29	6	23	18	19	23	22	20	25	185
	36-56	1	2	-	10	5	4	6	-	3	31
Total by females:		40	11	32	42	33	38	35	33	34	298
Total:		55	18	47	61	50	49	56	54	46	436

Table 2 Materials on silver hake feeding collected at the diurnal station on 2-3 July 1990 (43°43'N, 62°38'W), (Scotian Shelf)

Sex	Length (cm)	Time and number of hauls													Total
		I2.55-I3.25	I5.20-I5.50	I7.20-I7.50	I9.20-I9.50	2I.I5-2I.45	23.I5-23.45	0I.I0-0I.40	03.I0-03.40	05.I5-05.45	07.I5-07.45	09.20-09.50	II.20-II.50	I3.I5-I3.45	
		59	60	6I	62	63	64	65	66	67	68	69	70	7I	
Males	I2-20	4	I0	9	I4	II	-	I2	I3	II	8	I2	I5	-	II9
	2I-25	3	5	5	4	I	I2	I0	9	5	5	I0	9	5	83
	26-35	2I	I7	I9	2I	I5	I2	II	II	20	I7	II	2I	I8	2I4
	36	I	-	-	-	-	-	-	-	-	-	-	-	-	I
Total by males:		29	32	33	39	27	24	33	33	36	30	33	45	3I	4I7
Females	2I-20	I0	9	7	4	8	-	7	7	2I	I7	I5	I5	7	I27
	2I-25	I	3	2	5	2	I2	II	I5	8	4	I2	6	4	85
	26-35	I9	2I	I8	2I	8	I7	20	I8	I7	24	I7	20	2I	24I
	36-58	I5	7	II	9	I3	3	8	7	6	8	2	5	2	96
Total by females:		45	40	38	39	3I	32	46	47	52	53	46	46	34	549
Total		74	72	7I	78	58	56	79	80	88	83	79	9I	65	966

Table 3 Daily rations (in percent by weight) of different hake size-groups in the Scotian Shelf area in July 1988 and June 1990

Length (cm)	Sex	Daily rations in July 1988					Daily rations in July 1990				
		According to Romanova Kohan	According to Novikova	Accord. to Elkina, Yurovitskiy	Depth (m)	Temperature °C	According to Romanova Kohan	According to Novikova	According to Elkina Yurovitskiy	Depth	Temperature °C
I2-20	Males	6,9	5,0	5,I	I50-I65	8,4-8,9	I8,0	II,6	9,9	200-2I7	9,7-I0,2
	Females	7,6	8,I	5,0	-"-	-"-	II,7	I0,8	9,3	-"-	-"-
	Males Females	5,4	6,2	4,7	-"-	-"-	II,5	I0,3	9,6	-"-	-"-
2I-25	Males	3,8	4,I	3,8	I50-I60	-"-	I5.9	I2,9	4,8	-"-	-"-
	Females	6,3	6,6	3,9	-"-	-"-	I5,9	I7,6	6,3	-"-	-"-
	Males Females	4,0	3,0	3,4	-"-	-"-	II,8	II,4	7,5	-"-	-"-
26-35	Males	4,2	4,4	3,9	I50-I65	-"-	I2,8	I0,2	6,7	-"-	-"-
	Females	9,0	6,2	6,0	-"-	-"-	26,9	24,6	I8,I	-"-	-"-
	Males Females	8,8	6,I	5,4	-"-	-"-	I5,4	I5,4	I4,4	-"-	-"-
36-58	Females	67,I	60,0	4I,9	I50-I60	8,4-8,8	70,2	62,5	45,9	-"-	-"-
I2-58	Males	7,5	3,7	4,2	I50-I65	8,4-8,9	I3,0	I3,6	6,8	-"-	-"-
	Females	I7,6	I3,4	I4,8	-"-	-"-	2I,2	I8,0	2I,3	-"-	-"-
	Males Females	I5,6	I2,0	I3,2	-"-	-"-	20,7	I4,4	I7,9	-"-	-"-

Table 4 Food amount consumed by hake population in the Scotian Shelf area in 1988, 1990

Size	Age (years)	Fish number by age-groups, % in July 1988		Fish weight by age-groups, July 1988		1988					
						Stock weight by age-groups, males			Stock weight by age-groups, females		
						%	thous.t	kjoule 10^9	%	thous. t	kjoule 10^9
Small	1^+	4,8	5,8	51,3	45,8	4	3,34	13,98	2	4,42	18,48
	2^+	48,8	38,8	123,7	134,6	35	29,43	123,22	14	31,52	131,56
Middle	3^+	25,0	23,3	185,0	201,7	26	21,51	90,06	11	24,28	101,68
	4^+	13,0	12,6	240,5	268,5	23	19,20	80,39	10	22,08	92,5
	5^+	8,4	15,5	332,9	375,9	9	7,50	31,44	19	41,36	173,50
	6^+	-	2,0	-	455,0	3	2,51	10,51	5	11,04	46,28
Large	7^+	-	2,0	-	655,0	-	-	-	20	44,15	184,87
	8^+	-	-	-	-	-	-	-	9	19,87	83,13
	9^+	-	-	-	-	-	-	-	10	22,08	92,5
Total		100	100	-	-	100	83,5	349,6	100	220,8	924,5

Table 4 (continued) Food amount consumed by hake population in the Scotian Shelf area in 1988, 1990

1990						Annual ration, %				Annual food consumption, Kjoule 10^9	
Stock weight by age groups, males			Stock weight by age groups, females			July 1988		June 1990		July 1988	
%	thous. t	Kjoule 10^9	%	thous.t	Kjoule 10^9	Males	Females	Males	Females	Males	Females
I	0,88	3,68	I	2,64	II,05	2070	2280	5400	35I0	290,00	42I,94
33	29,I7	I22,2I	I0	26,42	II0,62	II40	I890	4770	4770	I404,7I	2486,48
3I	27,40	II4,72	I8	47,57	I99,II	I260	2700	3840	8070	II34,I6	2745,36
28	24,75	I03,63	I9	50,23	2I0,35	I260	2700	3840	8070	I0I2,9I	2497,50
6	5,30	22,I9	22	58,I7	243,56	I260	2700	3840	8070	396,I4	4684,50
I	0,90	3,77	I7	44,92	I88,08	I260	20I30	3840	2I060	I32,43	93I6,I6
-	-	-	I2	3I,7I	I32,77	-	20I30	-	2I060	-	372I4,33
-	-	-	I	2,64	II,05	-	20I30	-	2I060	-	I6734,07
-	-	-	-	-	-	-	20I30	-	-	-	I8620,25
I00	88,4	370,2	I00	264,3	II06,6	-	-	-	-	4370,35	94720,5

Table 4 (continued) Food amount consumed by hake population in the Scotian Shelf area in 1988,1990

Annual food consuption Kjo.10^9		Average food calory value in Kjoule, July 1988		Average food calory value in Kjou, June 1990		Food consumption, thous.t/year			
June 1990						1988		1990	
Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
I98,72	387,86	3,73I	3,729	3,74I	3,730	77,73	II3,I5	53,I2	I03,98
5829,42	5276,5I					976,50	666,80	I558,25	I4I4,6I
4405,25	I6068,I8					905,00	695,98	II64,I8	397I,37
3979,39	I6976,05					277,85	692,60	I05I,63	4I95,76
852,I0	I9655,29	3,726	3,948	3,784	4,046	I06,3I	II86,55	225,78	485I,35
I44,77	39609,65					35,54	2266,I0	38,26	9494,77
-	2796I,36					-	9054,58	-	6702,74
-	2327,I3					-	4077,55	-	55I,I9
-	-	-	4,II0	-	4,I72	-	4590,47	-	-
I5409,65	728262,09					2378,93	23343,78	409I,22	3I285,77

Table 5 Hake food consumption and energetical equivalent

in the Scotian Shelf area in 1988

Hake size	S m a l l					M i d d l e					L a r g e		
Food items	Percent by weight (a)		Food energetical equivalent Kjo/g(b)	a · b		Percent by weight		Food energetical equivalent Kjo/g(b)	a · b		Percent by weight	Food energetical equival. Kjo/g (b)	a · b
	Males	Females		Males	Females	Males	Females		Males	Females	Females		Females
Copepods	2,4	3,0	3,977	9,54	II,93	-	-	-	-	-	-	-	-
Gyperiids	0,I	0,4	2,5I2	0,25	I,00	-	-	-	-	-	-	-	-
Euphausiids	97,5	96,6	3,726	363,28	359,93	I00,0	64,7	3,726	372,6	247,07	4,0	3,726	I4,90
Shrimps	-	-	-	-	-	-	0,2	3,977	-	0,79	-	-	-
Squid	-	-	-	-	-		4,0	4,I87	-	I6,75	8,0	4,I87	33,50
Hake	-	-	-	-	-		24,0	4,I87	-	I00,49	74,0	4,I87	303,90
Mackerel	-	-	-	-	-		-	-	-	-	I4,0	4,I87	58,68
White hake	-	-	-	-	-		7,0	4,I87	-	29,3I	-	-	-
Sand-ell	-	-	-	-	-		0,I	4,I87	-	0,42	-	-	-
Total	I00	I00	-	373,07	372,86	I00	I00	-	372,6	394,83	I00	-	4I0,98
Average equivalent Kjoule/g				3,73I	3,729				3,726	3,948			4,II0

Table 6 Hake food composition and energetical equivalent in the Scotian Shelf area in 1990

Hake size	Small					Middle					Large		
Food items	Percent by weight (a)		Food energetical equivalent kjoule/g(b)	a · b		Percent by weight (a)		Food energetical equival. kjoule/g (b)	a · b		Percent by weight(a)	Food energ. equiv. kjoule/g(b)	a·b
	Males	Females		Males	Females	Males	Females		Males	Females	Females		Females
Gyperiids	0,I	0,3	2,5I2	0,25	0,75	0,I5	0,05	2,5I2	0,38	0,I3	-	-	-
Euphausiids	94,4	96,4	3,726	35I,79	359,I9	85,80	29,93	3,726	3I9,69	III;52	3,0	3,726	II,I8
Shrimps	4,6	3,2	3,977	I8,29	I2,73	2,03	I,00	3,977	8,07	3,98	0,5	3,977	I,99
Sagitts	-	0,I	3,I40	-	0,3I	0,02	0,02	3,I40	0,06	0,06	-	-	
Squid	-	-	-	-	-	-	28,00	4,I87	-	II7,24	50,5	4,I87	2II,44
Hake	0,8	-	4,I87	3,35	-	I2,00	37,0	4,I87	50,24	I54,92	I7,0	4,I87	7I,I8
Mackerel	-	-	-	-	-	-	-	-	-	-	25,0	4,I87	I04,68
White hake	-	-	-	-	-	-	-	-	-	-	2,0	4,I87	8,37
Red hake	-	-	-	-	-	-	2,0	4,I87	-	8,37	2,0	4,I87	8,37
Sand-eel	0,I	-	4,I87	0,42	-	-	2,0	4,I87	-	8,37	-	-	-
Total	I00,0	I00,0		374,I	372,98	I00,0	I00,0		378,44	404,59	I00,0		4I7,2I
Average food equivalent Kjoule/g				3,74I	3,730				3,784	4,046			4,I72

Table 7 Annual food consumption of food items by Scotian hake population (July 1988) (in thous. t, %)

Options	Hake size groups					All size groups					
Food item groups	Small		Middle		Large	Males		Females		Males + Females	
	Males	Females	Males	Females		thous.t	%	thous.t	%	thous. t	%
Copepods	25,30	23,40	-	-	-	25,30	I,0	23,40	0,I	48,70	0,2
Gyperiids	I,05	3,I2	-	-	-	I,05	0,I	3,I2	+	4,I7	+
Euphausiids	I027,88	753,43	I324,7	3I32,27	708,9I	2352,58	98,9	4594,6I	I9,8	6947,I9	27,0
Shrimps	-	-	-	9,68	-	-	-	9,68	+	9,68	+
Squid	-	-	-	I93,65	I4I7,8I	-	-	I6II,46	6,9	I6II,46	6,3
Silver hake	-	-	-	II6I,89	I3II4,72	-	-	I4276,6I	6I,2	I4276,6I	55,6
Mackerel	-	-	-	-	248I,I6	-	-	248I,I6	I0,6	248I,I6	9,6
White hake	-	-	-	338,89	-	-	-	338,89	I,4	338,89	I,3
Sand-eel	-	-	-	4,85	-	-	-	4,85	+	4,85	+
Total for fishes	-	-	-	I505,63	I5595,88	-	-	I7I0I,5I	73,2	I7I0I,5I	66,5
Total	I054,23	779,95	I324,7	484I,23	I7722,6	2378,93	I00,0	23343,78	I00,0	25722,7I	I00,0

Table 8 Annual food consumption of ffod items by Scotian hake population (June 1990) (in thous. t)

Options	Hake size groups					All size groups					
Food item groups	Small		Middle		Large	Males		Females		Males + Females	
	Males	Females	Males	Females	Females	thous.t	%	Thous. t	%	Thous.t	%
Copepods	25.30	23.40	-	-	-	25.30	1.0	23.40	0.1	48.70	0.2
Gyperiids	1.05	3.12	-	-	-	1.05	0.1	3.12	+	4.17	+
Euphausiids	1027.88	753.43	1324.7	3132.27	708.91	2352.58	98.9	4594.61	19.8	6947.19	27.0
Shrimps	-	-	-	9.68	-	-	-	9.68	+	9.68	+
Squid	-	-	-	193.65	1417.81	-	-	1611.46	6.9	1611.46	6.3
Silver hake	-	-	-	1161.89	13114.72	-	-	14276.61	61.2	14276.61	55.6
Mackerel	-	-	-	-	2481.16	-	-	2481.16	10.6	2481.16	9.6
White hake	-	-	-	338.89	-	-	-	338.89	1.4	338.89	1.3
Sand-eel	-	-	-	4.85	-	-	-	4.85	+	4.85	+
Total for fishes	-	-	-	1505.63	15595.88	-	-	17101.51	73.2	17101.51	66.5
Total	1054.23	779.95	1324.7	4841.23	17722.6	2378.93	100.0	23343.78	100.0	25722.71	100.0

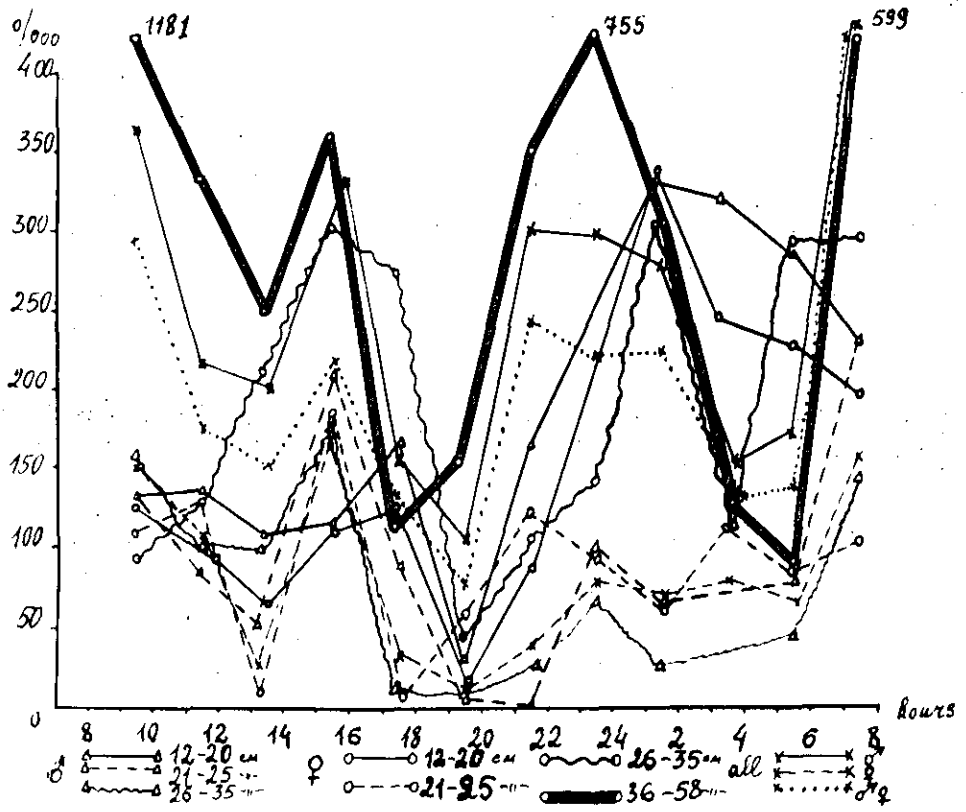

Fig. 1. Total indices of stomach fullness for hake males and females of various size groups at diurnal station in June 1990.

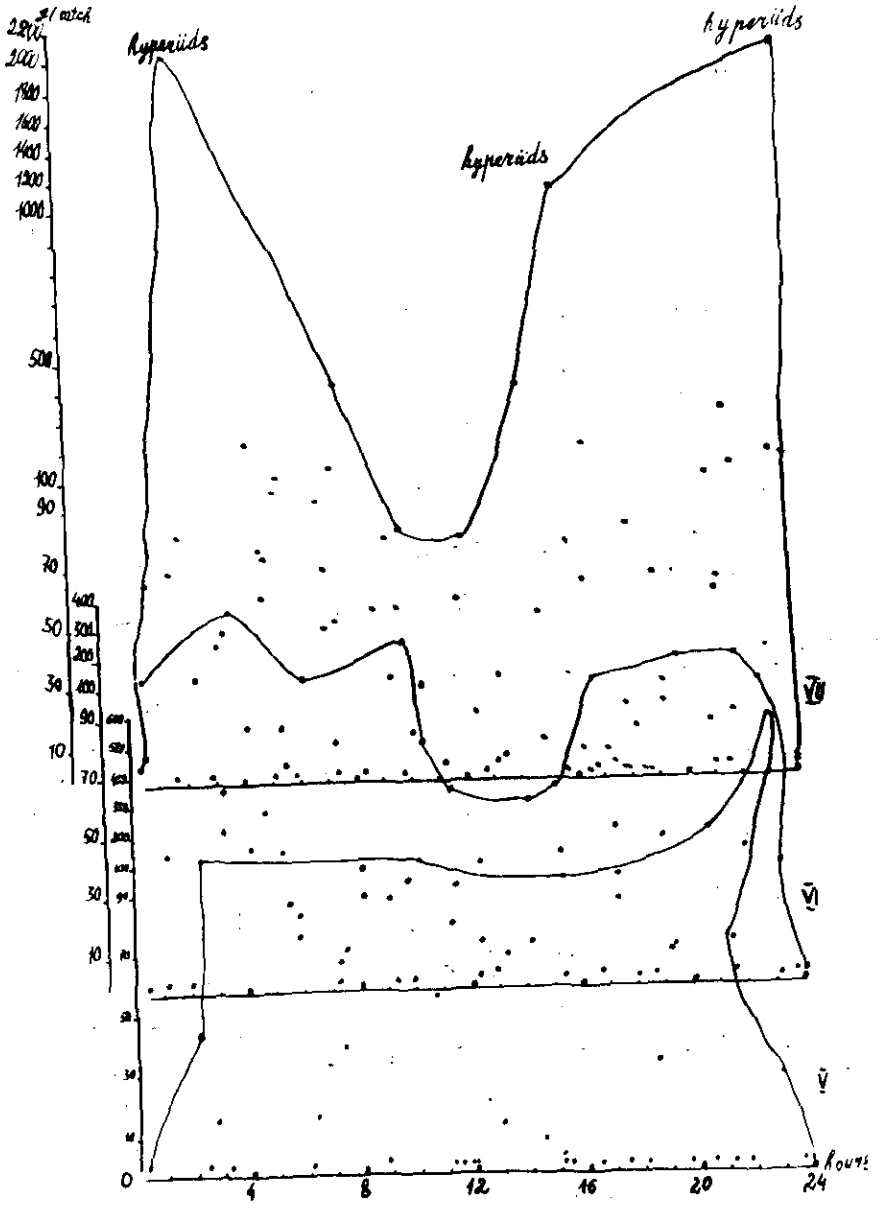

Fig. 2. Catches (in g) of euphausiids, gyperiids by 30 min periods at diurnal basis in May (large Bongo), June, July (IKS-80, subtrawl net) in 1990.

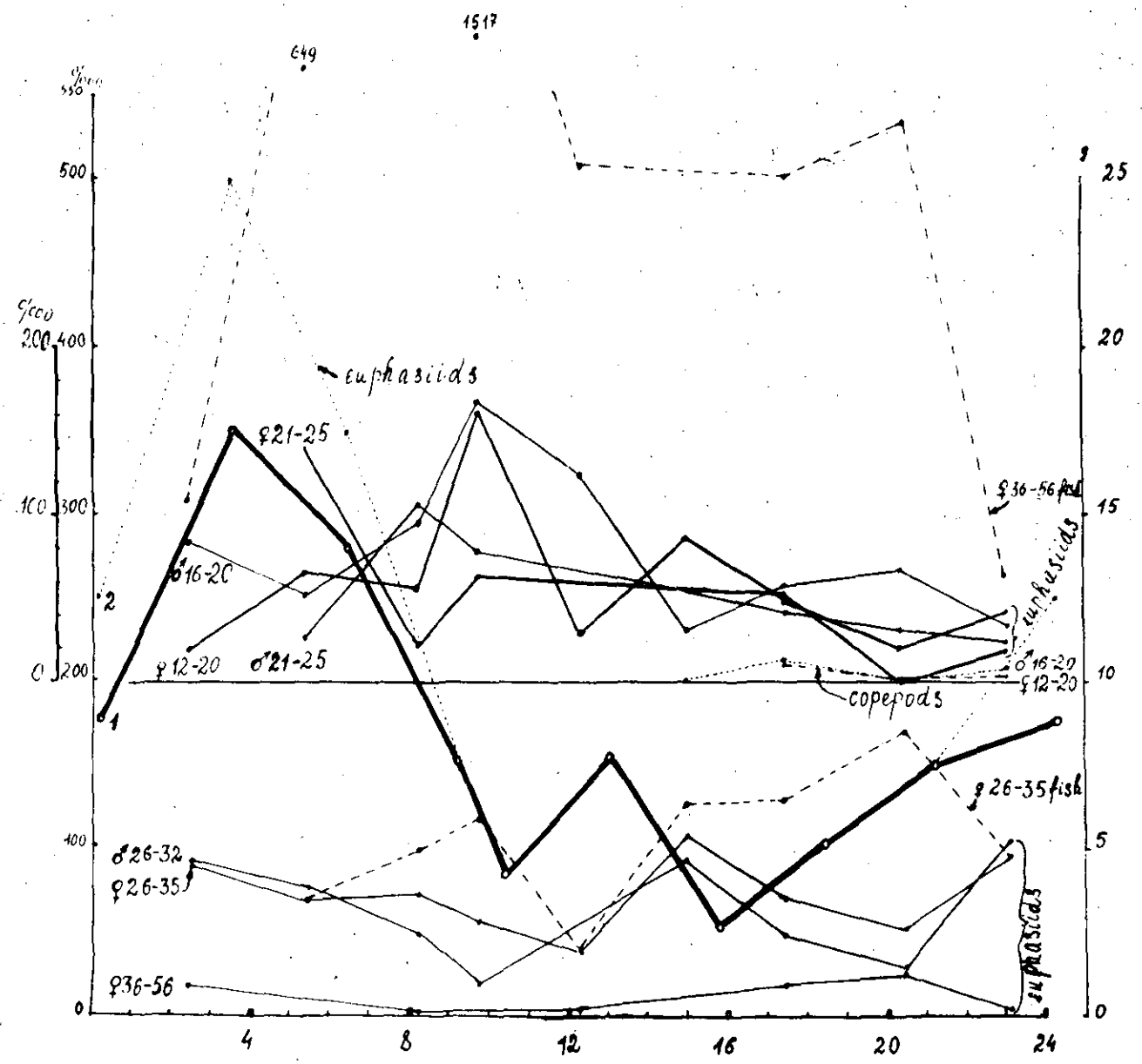

Fig. 3. Feeding intensity of hake males and females of various size groups at diurnal station in July 1988.

Notification: 1.- forage zooplankton total biomass (mainly copepods);

2 - euphausiids biomass.

Note: hake size groups (in cm) and indices of stomach fullness (in ‰) by food items are presented.

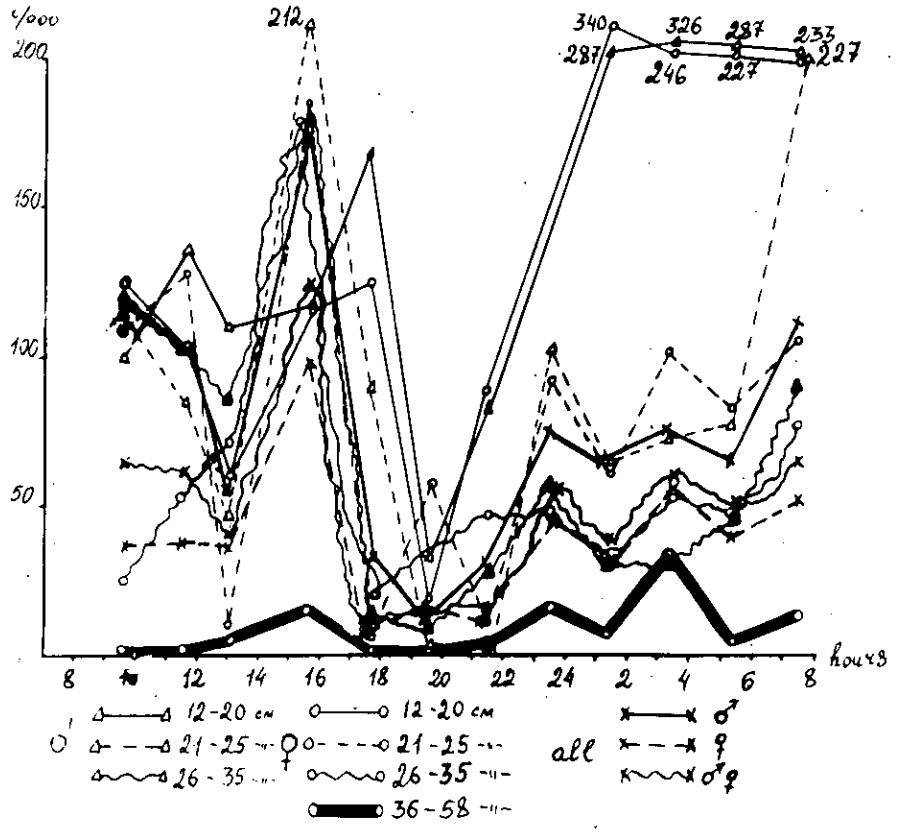

Fig. 4. Individual indices of stomach fullness (euphausiids) for hake males and females of various size groups at diurnal station in June of 1990.