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Comparative Analysis of the Biological State and CPUE of Silver Hake on the Scotian Shelf in the Area of Foreign Fisheries, 1989-1990

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ABSTRACT

The dynamics of the biological indices (mean length, mean stomack fullness, mean maturity stages, porcentage of immature fish in the catches) and catches per unit effort (CPUE) by 5-day period was analysed for the fishing seasons of 1989-1990. Significant year-to-year differences between the above mentioned parameters were revealed which to a great extent can be explained by an exceptionally early withdrawal of larger size silver hake from the fishing area in 1990. The nature of the relationships between the CPUE and the various biological indices was studied and a conclusion made about the possibility to forecast the short-term trends in the silver hake concentration densities during its feeding period (April-June) basing on the relationships obtained. An opinion was expressed that the CPUE value is to a great extent determined by the peculiar features in the silver hake behaviour and distribution and, hence, is not always a reliable indicator of this fish stock state on the Nova Scotia Shelf. In this very case the use of CPUE for 1990 seems doubtfull.

INTRODUCTION

As it is known the conditions for the silver hake fisheries on the Scotian Shelf in 1989 and 1990 differed significantly. It can be supposed that this was influenced by features of hake behaviour and distribution in those years which could not but effected the biological parameters of the species in the fishing area as well. The mean purpose of this study was to reveal the differences in the silver hake biological condition from the area south of Small

Mesh Gear Line (SMGL) as well as the to attempt to reveal the relationships between some biological parameters and CPUE for the fish in various periods of the fishing seasons in the years under investigation.

MATERIALS AND METHODS

The material used as a basis for the analysis of the silver hake biological condition was mainly collected by the USSR observers on the fishing vessels and contained the information not only on length and weight composition of the hake commercial catches for every 5-day period but on the male and female gonad stages and their feeding intensity averaged by 5-day periods as well. The maturity stages were determined using a scale proposed by Sauskan and Serebjakov (1968). When averaging, however, the intermediate stages related to the portional nature of spawning were pooled into one (spawning) stage. The immature fish (maturity stage II) were not counted when calculation the means. Stomack fullness was classified based on a 5-degree scale (0, 1, 2, 3 and 4). Catches per unit effert (CPUE) averaged by 5-day periods were calculated from daily information reported by the commercial vessels. Besides, some data on the hake biology collected by R/V Evrika north of SMGL were used as well.

The biological characteristics and the commercial indices for one year were compared to those for another one. The degree of correlation between the various biological parameters in every year concerned and the CPUE values was revealed.

RESULTS AND DISCUSSION

Dynamics of CPUE and the biological parameters of silver hake by 5-day period for two years is presented in Figs. 1-6. As it is seen from Fig. 1, the fishery trends in May 1989 and 1990 were directly opposit while in June and start of July those trends appeared to be similar. The correlation factor for the latter period was 0.79 (Table 1). However, irrespective of general trends a higher catch level in 1989 is easily traced during the whole fishing period except middle of July.

Let us consider the dynamics of the hake mean length (Fig. 2).

In some periods a rather significant similarity with the trends in CPUE is observed which fact is supported by a high degree of correlations between the parameters under consideration (Table 2). It should be noted that a similar high dependence between the changes in fish concentration densities (CPUE values) and the variations in length composition was observed in April 1966 when fishing for silver hake in the Hudson Canyon area (Rikhter, 1968). As it can be seen from the Fig. the mean length of hake in 1989 was noticably greater than that in 1990 during the whole fishing season. Basing on the data presented it can be supposed that the mean length of fish in some periods (particularly in the first half of the fishing season) can serve as an indicator of the future or current changes in the CPUE level. The variations of the hake lengths in the catches, in its turn, seem to be resulted by the arrival or a withdrawal of larger size fish into or from the fishing area. If these suppositions are valid, then it would mean that in 1989 the withdrawal of larger size hake took place somewhen in the middle of May while in 1990 the process started as early as in the third decade of April and had the consequences of larger scale. As to the difference between the mean length estimates, it should be beared in mind that in 1989 the fisheries was based on the strong year-classes of 1985-1986 (at age 3 and 4) while in the following year the fisheries was recruited by the strong 1988 year-class (2-year-olds) and some decrease in abundance of larger fish was observed in the same period. A very strong year-calss of 1985 did not significantly support the 1990 fisheries, Thus, in 1990, some rejuvenation of the population took place which resulted in mean length variations over the whole period of observations.

The amount of food in the stomack, expressed here as a mean index of stomack fullness is another important biological parameter directly related to the fish behaviour and distribution during the feeding period. Trends in this index by 5-day period are presented in Fig. 3. From data in the Figure it is seen that during the larger part of the observation period the trends in the mean indices were mainly similar while the absolute levels of stomack fullness, especially in the second half of June-start of July, were noticably different. In some periods of 1989-1990 a rather significant negative correla-

tion between the CPUE estimates and the mean stomack fullness indices did exist (Table 2) while in others it did not. The year-to-year differences were found here as well. The negative correlation observed in April 1966 (Rikhter, 1968) may be explained by the fact that silver hake forming dense concentrations was feeding poorly in the majority of cases. When the density level of those concentrations went down the mean stomack fullness index started to go up. The dispersal of the concentrations was started by the leaving of the larger fish.

The features refered above were observed earlier in Barents Sea cod and other fish species (Mesiatsev, 1939). In our case the feeding intensity in late June - early July could be effected by the fact that more and more hakes attained their spawning stage. In that period mean stomack fullness index had to decrease but in mid July 1990 this index sharply increased again. Those conflicting data can hardly be explained in one way only. Both the differences in feeding conditions (the availability of food) for hake in the area south of SMGL in 1989 and 1990 and the differences in length compositions could result in the phenomenon observed. In Figs. 4 and 5 the trends in male and female maturation are presented. In 1989, a higher maturation rate in males through the whole observation period and in females in June-early July as compared to 1990 was evident. In general, the curves in the figures show that in 1989 the majority of the males were at the spawning stage as early as in mid-June while the females - in early July. The 1990 maturation trends were less distinct. Even in early July the mean maturity stage for males and females was lower than 4.5. That lagging behind in maturation could be related both to the smaller hake lengths and the earlier leaving of the larger (and more mature) fish from the fishing area in 1990. The latter is supported by the data obtained by R/V Evrika on the 9-th of July in the shallow waters north of SMGL (43°49N, 90°57'W). Mean length of the hake caught there was 29.3 cm and the mean maturity stages for males and females were 4.7 and 4.6, respectively. Their stomack fullness indices were approaching 0.

In a conclusion, let us consider the dynamics of the immature

fish (maturity stage II) occurrence in the commercial catches (Fig. 6). From the data presented it is seen again that there were significant year-to-year variations, especially noticable in May-June. The variations in numbers of immature fish during the whole season are also significant which fact most probably can be explained by the movements (arrivals and withdrawals) of hake of different length-groups. Thus, in some periods the correlation between the percentage of fish at maturity stage II and CPUE (Table 3) may exist. Indeed, in June-July 1990, a strong negative correlation was observed between the parameters in question, i.e. in this period the increase in percentage of fish at maturity stage II was a result of the withdrawal of larger mature fish and vice versa. The same processes although not so distinct seem to have place in other periods of 1989-1990 as well.

CONCLUSIONS

The results obtained from this study allow to come to the following conclusions:

1. The biological parameters and catches per unit effort for silver hake from the waters south of SMGL examined in the present paper did significantly differ in 1989 and 1990.

2. The combined analysis of the variations in mean length, mean stomack fullness index, percentage of fish at maturity stage II and CPUE seem to allow the scientists (during the feeding season, April-June) to make quite accurate conclusions on the short-term trends in the hake commercial concentration densities caused by the fish horizontal movements (arrival and withdrawal of fish of different length-groups).

3. Sharp decrease in CPUE in late April-eraly May 1990 was very likely caused by a withdrawal of a significant portion of hake (mainly of larger size) from the fishing area. The later variations in fishing conditions seem to be mainly caused by the hake distribution and behaviour features in the waters south of SMGL.

4. The CPUE value is to a great extent related to the peculiar features of the silver hake behaviour and distribution and, thus, is not always a reliable indicator of this fish stock status on the Scotian Shelf. In this connection the use of CPUE for 1990 to estimate silver hake stock seems doubtfull.

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Table 1 Correlation between CPUE of 1989 and 1990

Parameters	Periods	
	April-May	June-July
Intercept	18.86	4.86
Slope	0.16	1.17
r	0.27	0.79

Table 2 Correlation between CPUE, mean length and mean stomack fullness index for silver hake in 1989-1990

Correlation	Parameter	1989		1990	
		April-1-st half of June	2-nd half of June-July	April-early 5 days of May	2-nd 5 days of May-July
Mean length and CPUE	Intercept	-177.11	203.07	-157.50	106.55
	Slope	7.30	-5.57	6.77	-2.87
	r	0.82	-0.59	0.92	-0.17
Mean stmk fullness index and CPUE	Intercept	39.59	45.80	43.65	23.68
	Slope	0.02	-37.90	-18.41	3.42
	r	0.10	-0.70	-0.55	0.19

Table 3 Correlation between CPUE and percentage of hake at maturity stage II (male and females combined) in 1989 and 1990

Parameter	May-June 1989	1990			
		April-July	April	May	June-July
Intercept	40.79	31.20	40.72	24.21	33.61
Slope	-0.48	-0.24	-0.38	-0.02	-1.03
r	-0.34	-0.26	0.42	0.04	-0.83

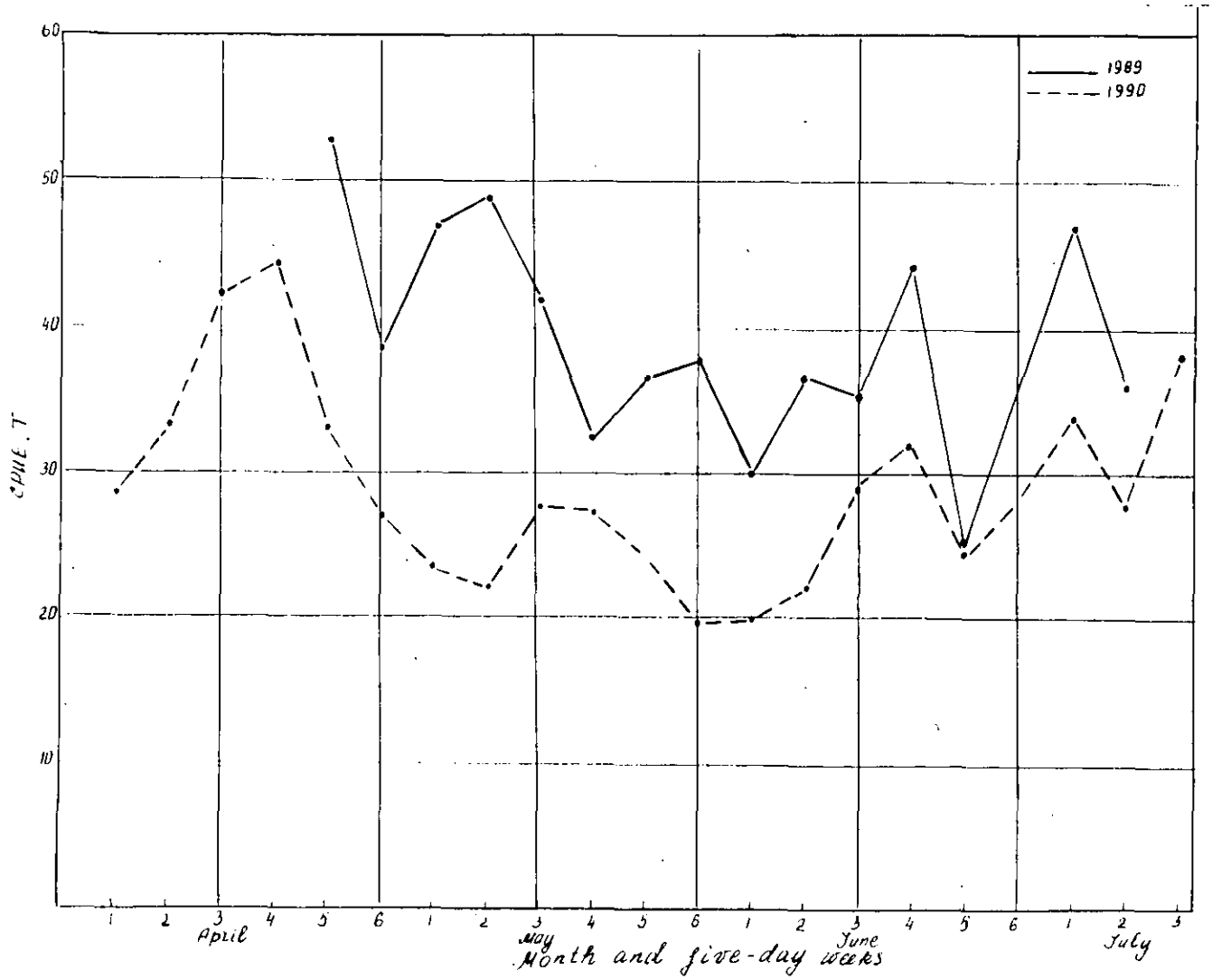

Fig. 1. Dynamics of CPUE (tons) of silver hake by 5-day period, 1989-1990.

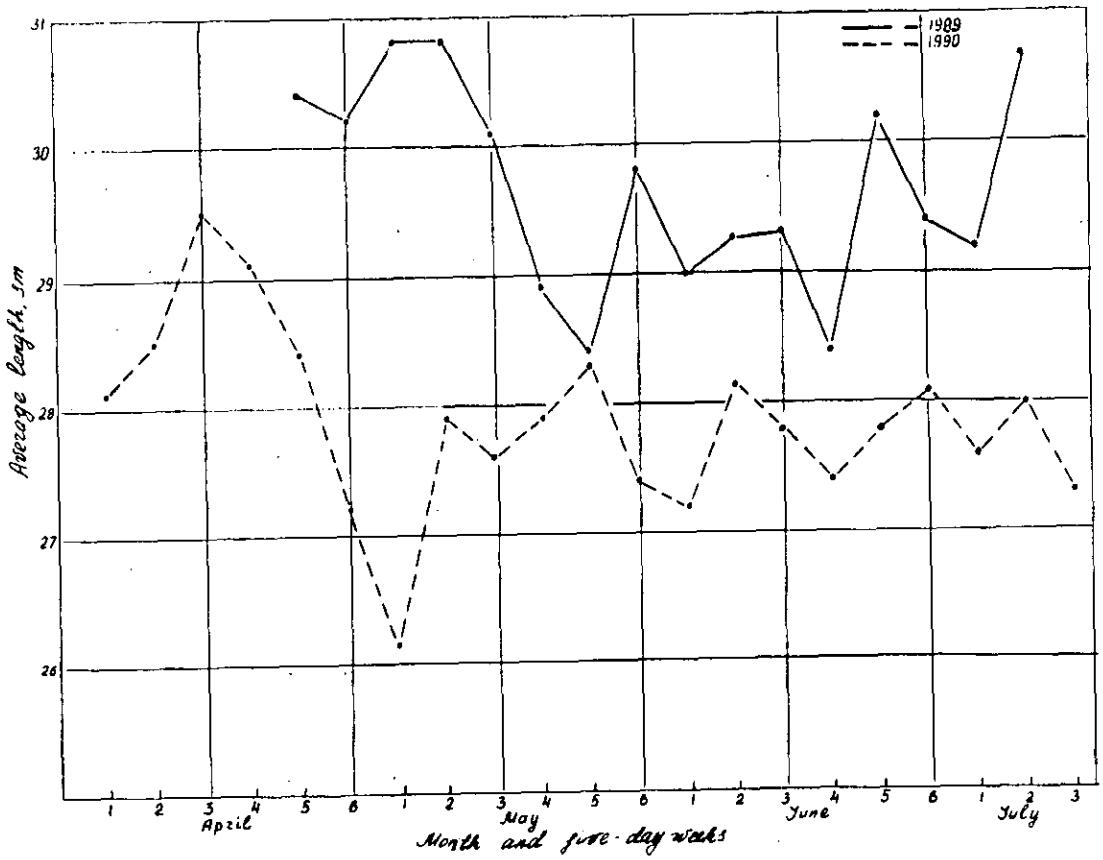

Fig. 2. Dynamics of the silver hake mean length (cm) by 5-day period, 1989-1990.

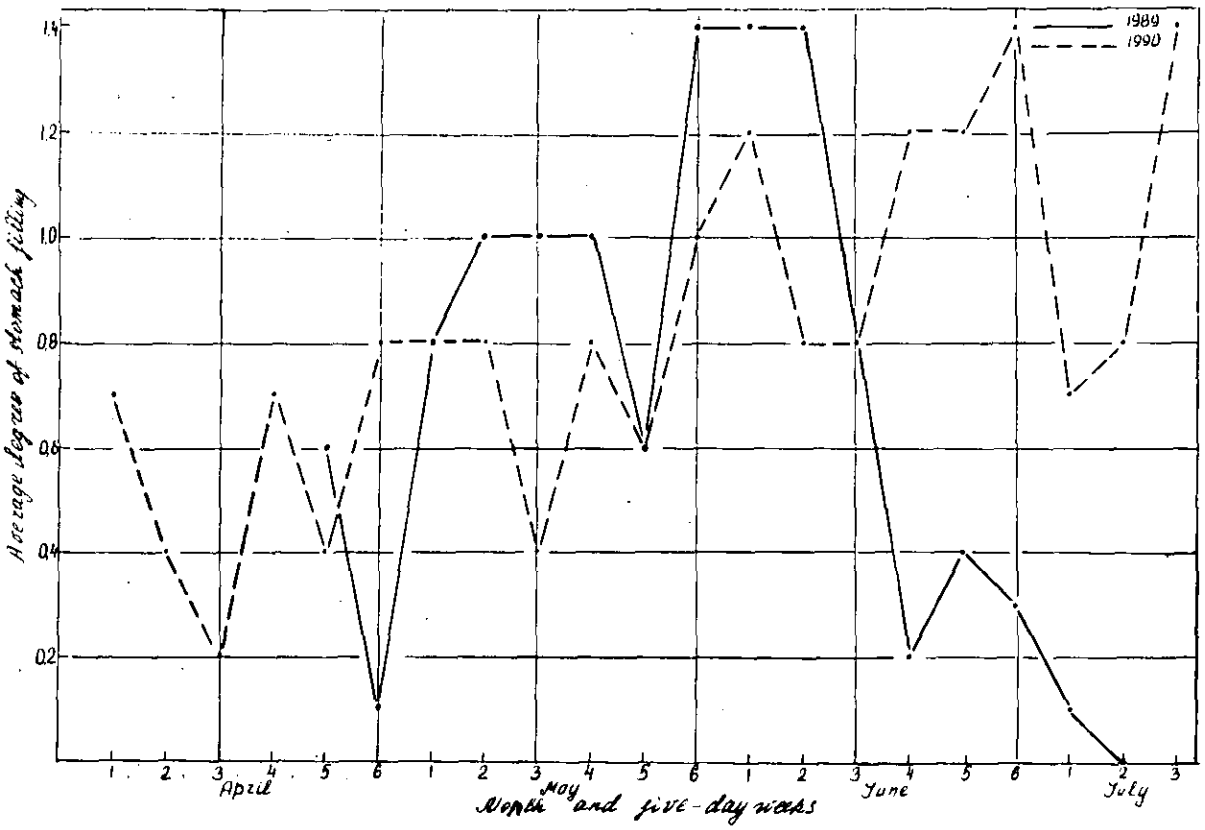

Fig. 3. Dynamics of the silver hake mean stomack fullness index by 5-day period, 1989-1990.

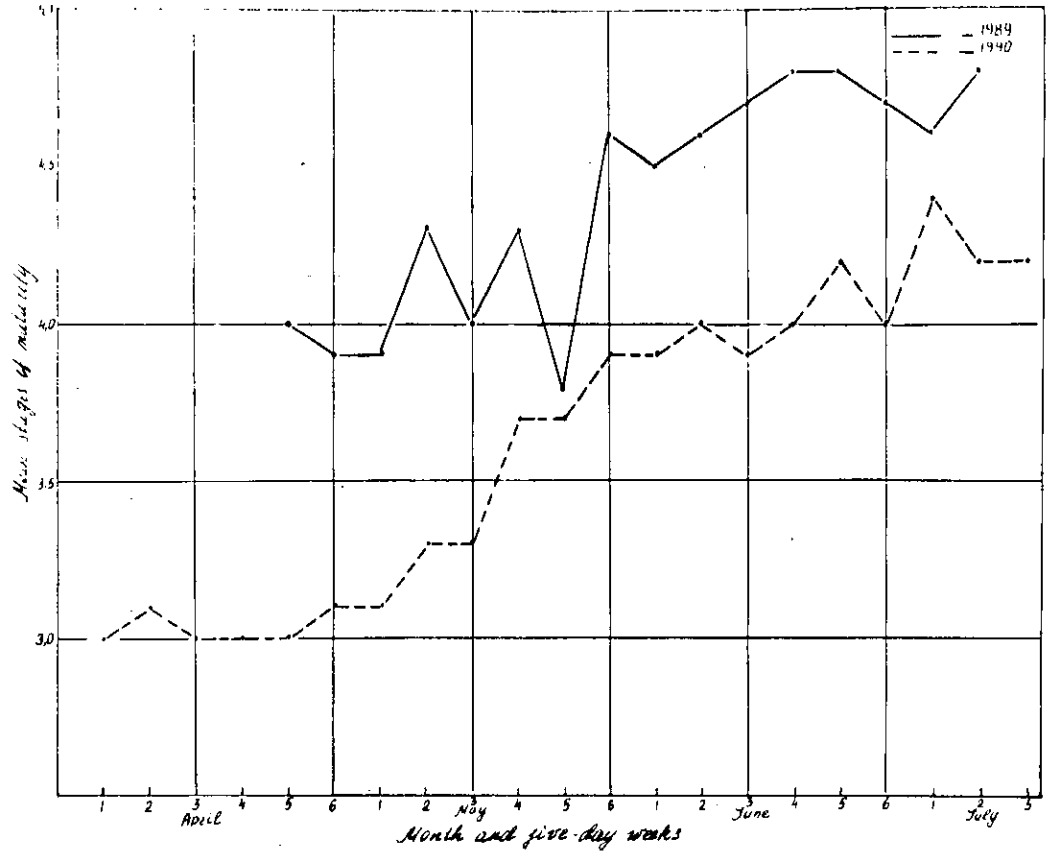

Fig. 4. Dynamics of the mean maturity stage index of the silver hake males by 5-day period, 1989-1990.

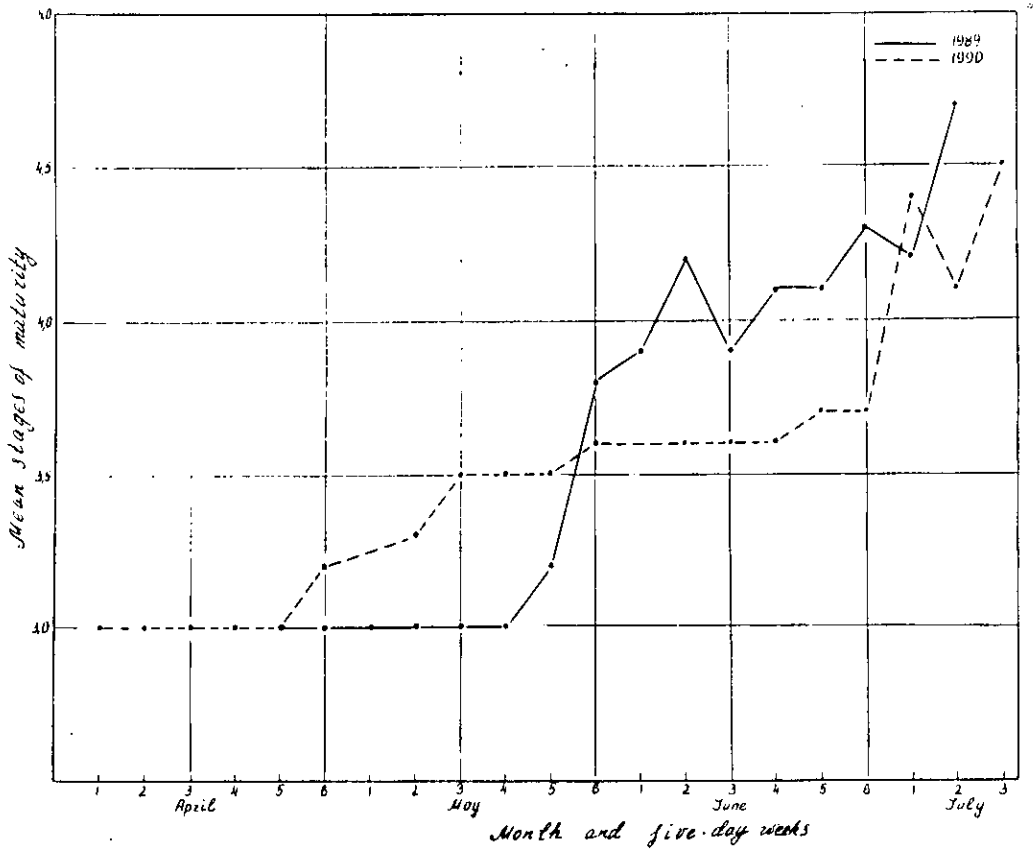

Fig. 5. Dynamics of the mean maturity stage index of the silver hake females by 5-day period, 1989-1990.

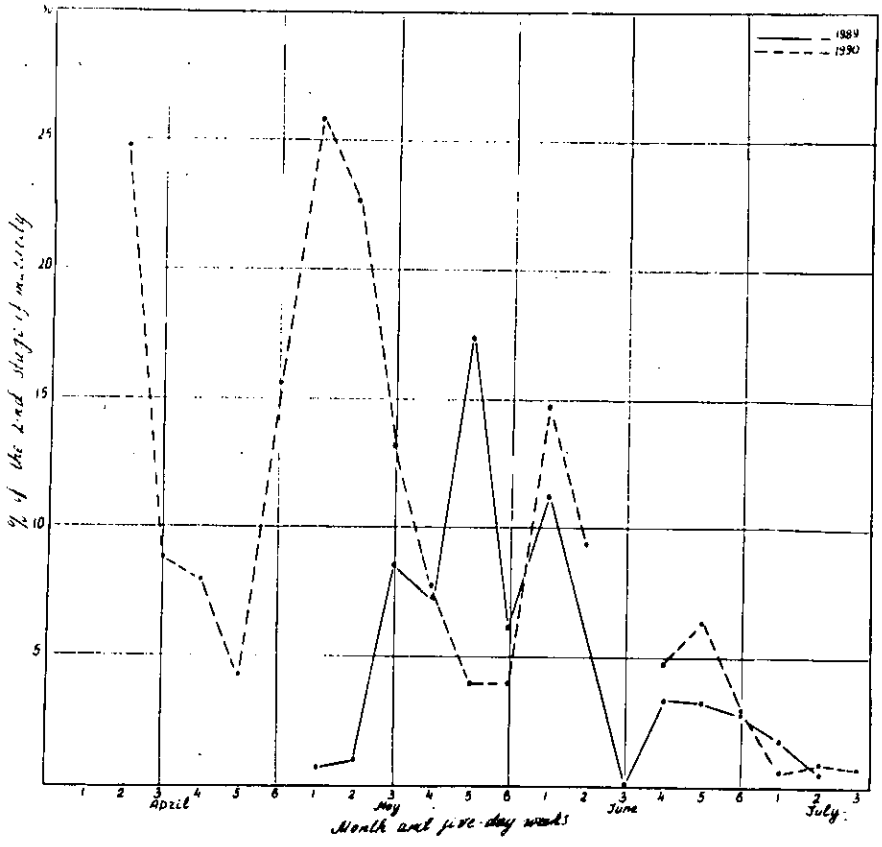

Fig. 6. Dynamics of the immature (maturity stage II) silver hake percentage by 5-day period, 1989-1990.