Northwest Atlantic Fisheries Organization

Serial No. N311

NAFO SCR Doc. 81/VI/32

SCIENTIFIC COUNCIL MEETING - JUNE 1981

On Dates of Short-finned Squid, *Illex illecebrosus*, Immigration onto the Scotian Shelf

by

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INTRODUCTION

During the joint Soviet-Canadian cruise aboard the RTM BELOGORK in February-May, 1979, distribution of young short-finned squid Illex illecebrosus were located in waters between the northern boundary of the Gulf Stream and the continental slope of Nova Scotia (Amaratunga et al. 1980; Froerman 1980). These data showed that a close relationship exists between the young squid spatial distribution and the water mass structure and dynamics in the area investigated (Fedulov & Froerman, 1980). It is believed that the variability of the environmental conditions influence the developmental processes, mortality and abundance of short-finned squid that subsequently immigrate onto the Scotian Shelf.

Long-term catch data indicate that the dates of squid immigration onto the Scotian Shelf may fall between early April and mid-June but these dates vary considerably from year to year. Mean mantle lengths of squid arriving on the shelf are also noticably variable from year to year (Amaratunga, 1981).

In the present paper an attempt is made to determine relationships between temperature characteristics of the water masses in areas where the young squid were

found and dates of immigration onto the Scotian Shelf. Data on squid size composition and dates of immigration in the spring of 1977-1981 are considered.

MATERIALS AND METHODS

Data from 1977, 1980, and a majority of the information from 1978 were reported by the international observers. The 1979 data were mainly obtained during the RTM BELOGORSK cruise 1979-05. Only the data on catches taken by bottom hauls were used. Mean mantle lengths of squid, from size composition data combined by weekly time intervals (Amaratunga, 1980, 1981) and with sexes combined, are listed in Table 1 for the first week when squid arrived on the Scotian Shelf (Div. 4VWX) and for the week when catches first exceeded 4 metric tons.

Table 1. Mean mantle lengths of short-finned squid caught in Div. 4VWX from when squid first arrived on the Shelf (A) and when catches exceeded 4 MT (B).

		Mean mantle length (mm)			
		1977	1978	1979	1980
First Arrival	(A)	100-115	135.9	136.4	134.7
catches > 4 tons	(B)	122.9	152.7	144.1	158.3

The 1977-80 monthly mean sea-surface temperatures within 1 degree rectangles were obtained from the monthly periodical GULFSTREAM by NOAA, U.S. Department of Commerce. (These periodicals were kindly made available to us by Woods Hole Laboratory, Northeast Fisheries Center, USA.) Data collected during the BMRT ATLANT cruise as well as the satellite maps of the water mass distribution in the area under investigation were used to analyze thermal conditions in 1981.

It is desirable to use some criterion, such as a fishing effort value in a directed squid fishery or a defined

proportion of squid as a by-catch, to determine the dates of their arrival on the Scotian Shelf in different years. In the absence of such data, two methods were used to estimate these dates (Table 2). The first estimation (A) gives the date when the first squid cathces were reported by the bottom trawl fishery. When exact dates of the first report of squid catch were not available, the beginning of the week a squid catch was first reported to Canada (FLASH system) was taken as such a date. The second estimation (B) corresponds to the dates when relatively stable squid catches were being reported in the bottom trawl fishery (Roberge and Amaratunga, 1980). 1977-1980 weekly international squid statistics reported to Canada (FLASH) were used to determine these dates, and they correspond to the first day in the week when total squid catches exceeded 4 MT.

The Soviet fishing trawlers, which entered the Scotian Shelf on April 17, 1981, reported the date of first report of squid while 1981 FLASH data provided the date squid catches exceeded 4 MT.

Table 2. Estimated dates of short-finned squid immigration onto the Scotian Shelf (Div. 4VWX) in 1977-81.

		1977	1978	1979	1980	1981
First arrival	(A)	Apr 3	Apr 23	May 6	Apr 28	Apr 28
Catches > 4 tons	(B)	May 2	May 7	May 20	May 26	May 14

DISCUSSION

Since maximum abundance in the 1979 BMRT Belogorsk survey was observed within the water band adjacent to the northern edge of the Gulf Stream (Fedulov and Froerman 1980), it was assumed here that the environmental variability in this zone may have greatest effect on short-finned squid development and

migration patterns. Therefore, a band was taken, 180 nautical miles wide and 270 miles long, corresponding to an area north of the Gulf Stream's historical mean yearly position bounded by 39°N-41°N and 58°W-64°W (Fig. 1). A monthly mean sea-surface temperature anomaly value for the band in March was taken as a parameter characterizing a year-to-year variability of the temperature field. (March was chosen since it apparently corresponds to the start of intensive feedings of the young squid within the chosen period.) The anomaly is the difference between the monthly mean surface temperature in the year analyzed and the historical (approximately 100 years) mean monthly value. Using the sea-surface temperature anomaly values for March in 1-degree rectangles (GULFSTREAM periodical the anomaly values (Δt) for the zone under investigation in each year were calculated (Table 3). Small size changes in the chosen band did not change Δt significantly.

Table 3. March sea-surface temperature anomalies in the area bounded by 39°N-41°N and 58°W-64°W, 1977-1981.

Year	1977	1978	1979	1980	1981
Anomaly values (Δt°C)	+1.2	-0.1	-0.4	-0.5	-0.4

Figure 2 indicates that there exists a correlation between the March sea-surface temperature anomaly values and the dates of squid immigration to the Scotian Shelf. The higher the positive anomaly value is, earlier the squid arrives on the shelf. Such a correlation can be approximated by a consistent function which could be used as a basis for predicting the dates of squid immigration. As more data are accumulated this type of relationship can be verified.

For five points we have obtained a relationship which can be described as a linear one at first approximation. The linear relationship using the estimated dates of immigration in Table 2

have the form:

$D_1 = -15\ \Delta t + 28$ (estimated date type (A))

$D_2 = -12\ \Delta t + 45$ (estimated date type (B)),

where Δt is a sea-surface temperature anomaly in °C, D_1, D_2 are the dates of short-finned squid immigration onto the shelf calculated beginning from March 31 as a zero point.

The relationships described are preliminary since the factors determining early or late immigration dates are still unknown.

The temperature anomaly within the band was also correlated well with mean squid mantle lengths at squid arrival on the shelf in different years (Fig. 3). During the warm anomaly years mean mantle lengths of squid were smaller than those during the cold years. This phenomenon can result from the environmental temperature on squid growth rate, and possibly also related to different levels of food availability during the anomalous warm or cold years.

It is necessary to note that high year-to-year temperature variations can occur within the band of advective processes related to the dynamics of the Gulf Stream. Two mechanisms forming warm anomalies can exist: 1) the Gulf Stream is located closer to the shelf as compared to the non-anomalous years, and 2) intensive meandering of the Gulf Stream.

CONCLUSION

Good correlations were established between the dates of short-finned squid Illex illecebrosus immigration to the Scotian Shelf in Subarea 4VWX and (a) squid mean mantle length, and (b) March thermal conditions in the area of intensively feeding young between the Gulf Stream and edge of the Shelf. During the years of warm anomalies in the feeding area, the squid arrive on the shelf at earlier dates and have smaller mantle lengths as compared to the years of cold anomalies. The relationship established can be used to predict the approximate dates of short-

finned squid immigration to the shelf.

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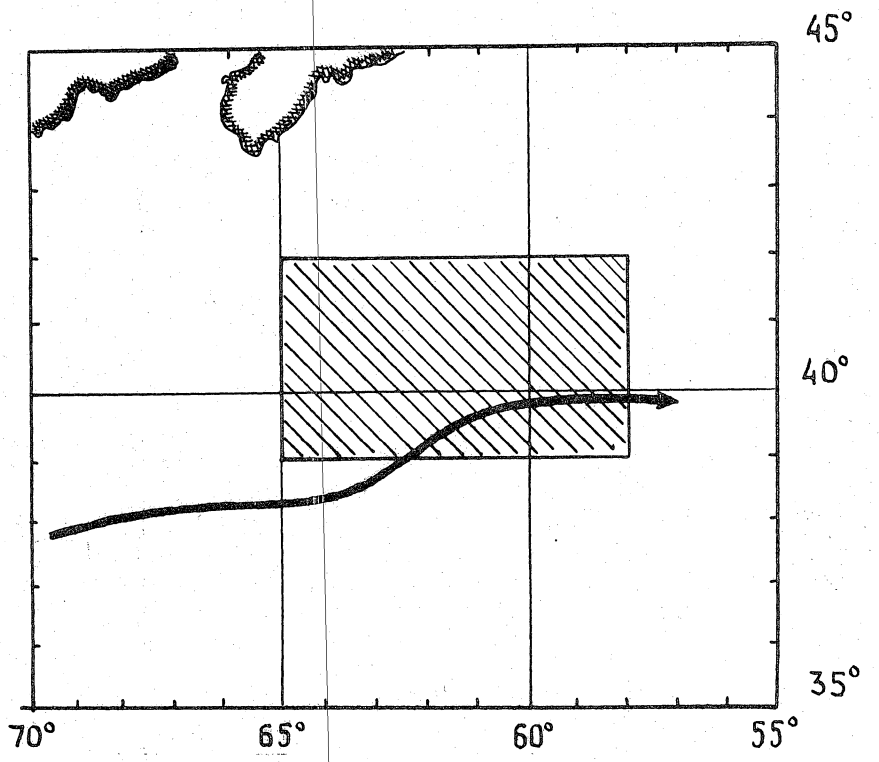

Fig. 1. Band adjacent to the northern edge of the Gulf Stream for which mean sea surface temperature anomalies were calculated. (Black arrow indicates historical mean position of the maximum Gulf Stream currents for March.)

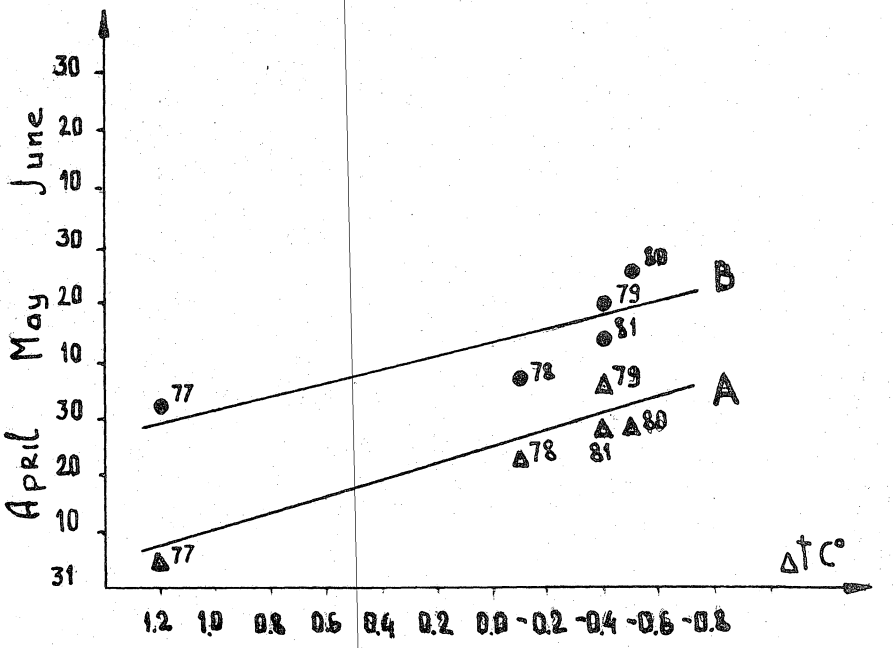

Fig. 2. Relationships of the dates of squid arrival on the shelf and temperature anomalies (Δt) A refers to time when squid were first recorded on the shelf (▲) and B refers to time when the total weekly catches were greater than 4 MT (●).

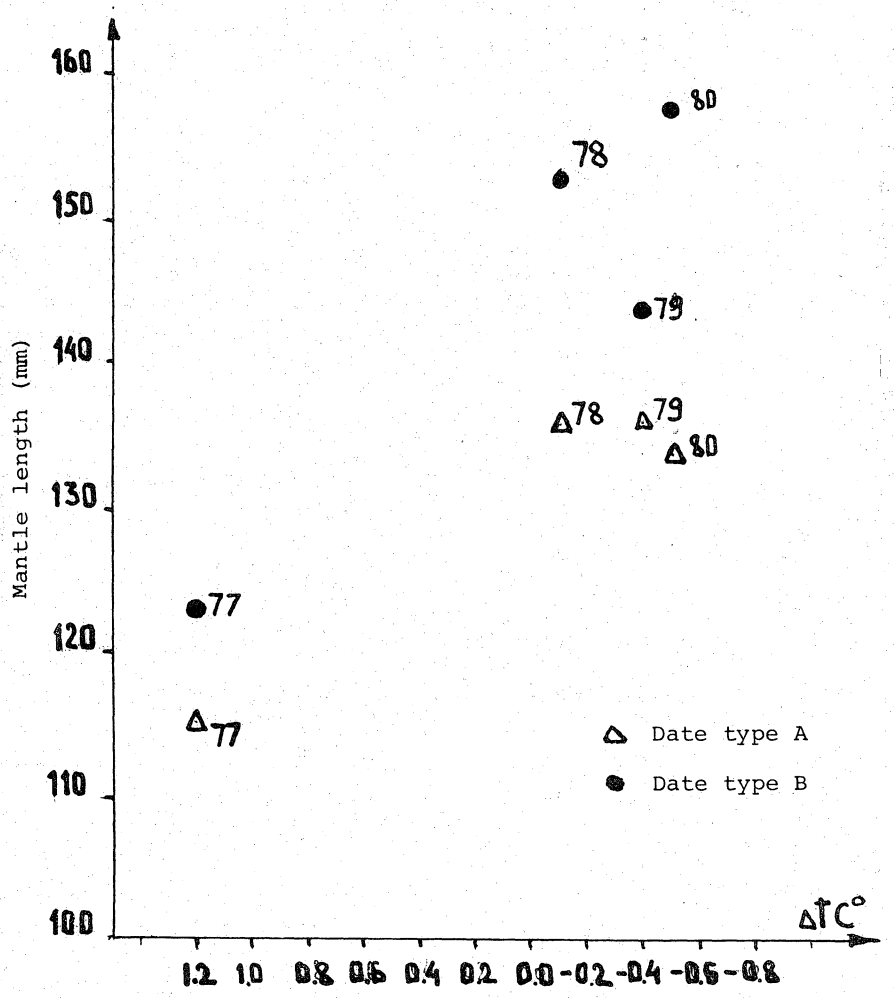

Fig. 3. Relationships of mean mantle lengths of squid and the temperature anomalies.