Northwest Atlantic Fisheries Organization

Serial No. N049

NAFO SCR Doc. 80/II/17

SPECIAL MEETING OF SCIENTIFIC COUNCIL - FEBRUARY 1980

Distribution, Biomass and Length Frequencies of Squid (*Illex illecebrosus*) in Divisions 4TVWX from Canadian research vessel surveys: an update for 1979

by

P. A. Koeller
Department of Fisheries and Oceans, Biological Station
St. Andrews, N. B., Canada EOG 2X0

Since 1970, standardized groundfish surveys have been conducted on the Scotian Shelf (ICNAF Div. 4VWX) and in the southern Gulf of St. Lawrence (Div. 4T) by the staff of the Marine Fish Division, Resource Branch. Scott (1978) presented squid distribution on the Scotian Shelf from summer survey data collected from 1970 to 1976 and Dufour (1979) updated this information to 1978. Both authors noted a relationship between mean bottom temperatures and the survey estimates of squid abundance. The present report updates the preceding one to include the 1979 Scotian Shelf survey data and presents similar information for the southern Gulf of St. Lawrence from 1970 to 1978.

METHODS

All surveys used a stratified random sampling design (Halliday and Kohler 1971) and standardized procedures for sampling fish catches. Surveys on the Scotian Shelf were conducted mainly during July by R.V. A. T. Cameron and in the Gulf of St. Lawrence mainly during September by R. V. E.E. Prince. Both vessels used a standard "Yankee 36" survey trawl with 1/2" mesh liner in the codend. Total weight and numbers were recorded and a length frequency was obtained for all squid catches. Measurements were to the nearest centimeter mantle length. Observations made in conjunction with each set included, among others, depth and bottom temperature.

Biomass estimates were obtained by multiplying the mean catch per stratum by a stratum areal expansion factor and summing stratum biomass estimates over all strata. Mean lengths and length frequencies include expansion factors and therefore represent population estimates of these parameters. Mean numbers or weights per tow and mean bottom temperatures are unstratified means.

RESULTS AND DISCUSSION

The distribution of squid in July, 1979 (Figure 1) was again widespread over the Scotian Shelf but with apparent concentrations in the central LaHave and Emerald Basin area and along the edge of the Continental Shelf. Squid were caught at depths ranging from 18 to 192 fathoms with all large catches (>100 kg) made between 60 and 100 fathoms. Concentrations appeared to decrease on the western part of the shelf but a definite intrusion of squid into the Bay of Fundy was evident. Such intrusions have been observed only during 1976, a year of exceptional overall abundance, and on a small scale during the 1978 survey. Unusually large numbers of squid were observed by herring weir fishermen in Passamaquoddy Bay during the summer of 1979.

Table 1A presents survey data from 1970 to 1979 (revision of biomass estimates for 1976 through 1978 do not alter the observations made or conclusions drawn in the previous report). It is evident that the figures for 1979 follow the general trend of high biomass estimates during years with high mean bottom temperatures. The mean bottom temperature on the Scotian Shelf was the third highest while both the biomass estimate and the mean length were the second highest on record.

The length frequency distribution in 1979 (Figure 2) was unimodal with the mode at 20 cm as in 1976. All other years had modes below 20 cm.

A multiple regression was done as in Dufour (1979) incorporating the new and revised data. Analysis with biomass as the dependent and temperature and size as the independent variables resulted in a slight improvement of the multiple regression. The equation was:

$$(\text{m tons})\cdot 10^{-3} = -525.3483 + 129.0637.(^{\circ}\text{C}) - 10.9237.(\text{cm})$$

with $R^2 = 0.7138$. Standardized beta coefficients were 1.0928 for temperature and -0.2928 for size, indicating that the contribution of size to the estimate of biomass was relatively small. The matrix of product-movement correlation coefficients (Table 2) indicates that correlation is strongest between temperature and size, less marked between temperature and biomass and least apparent between size and biomass, although all r's were significantly greater than zero at $p < 0.05$. This result might be expected since temperature can influence size directly by increasing growth rate but would influence biomass only indirectly in any number of ways, for example, through larval survival, abundance of food organisms or changes in migration patterns. The small variation in mean size cannot account for the large fluctuations in biomass. These two variables would be correlated mainly because of the common factor, temperature, influencing both independently. Mean temperatures are plotted against mean lengths in Figure 3A and against biomass in Figure 3B for the ten years' data.

The relationship between temperature, size and biomass was further examined using the 1976 survey data. Correlations between weight of catch, bottom temperature, mean length and fishing depth for n = 92 stations showed coefficients significantly greater than zero ($p < 0.05$) only for temperature vs. depth and temperature vs. catch (Table 2).

The former relationship is obvious and the latter might be expected given the results discussed above. No linear relationship is obvious between temperature and catch (Figure 4A) although there was some tendency for squid catches, particularly large ones, to occur between 8-10°C. Most catches were made between 60 and 140 fathoms (Figure 4B). That the correlation between temperature and catch is not greater, and between temperature and size is absent despite the large number of observations and the relatively accurate estimation of parameters at individual stations is not surprising. The global averages used in the previous analysis represent events which occurred prior to the survey and subsequent events, particularly migration, would tend to mask any functional relationships that once existed. However, further analysis of individual trawl set data using these and other environmental parameters should be conducted. The importance of major oceanographic events on the productivity of the Scotian Shelf has been recognized only recently (e.g. Fournier et al. 1977, 1979; Houghten et al. 1978; Herman and Denman 1979). Studies relating such phenomena as nutrient enrichment at the "shelf break" and cross-shelf mixing to the early life history of Illex may clarify the relationship between temperature and abundance of this species.

The distribution of squid in the Gulf of St. Lawrence during September is shown in Figure 5 for the three years of greatest abundance. Distribution was well defined along the edge of the Laurentian Channel between 50 and 100 fathoms. The occurrence of squid in the shallower water of the southwestern Gulf was rare except in 1978, the year with the highest biomass estimate (Table 1B). Seasonal distribution of Illex from bottom trawl surveys on the continental shelf southwest of Nova Scotia (Lange, 1978) suggest that this species moves offshore towards the edge of the Shelf during the fall.

In general, abundance data from the Gulf reflect those from the Shelf (Table 1). Abundance from 1970-74 was relatively low, with 1971 having the highest estimate of this period in both areas. Abundance was relatively high in both areas during the last five years. Although the catch per tow and biomass estimates in the Gulf appear to be comparable to those of the Shelf, commercial squid catches from Div. 4RST are negligible relative to 4VWX.

Mean lengths in the Gulf were always longer than on the Shelf. Most of this difference probably represents growth between July and September. The 10-year mean length increase from 18 cm in mid-July to 21 cm in mid-September is not unreasonable in light of growth rates given by Amaratunga (1978). The length frequency distributions in the Gulf (Figure 6) were not symmetrical like those from the Shelf (Figure 2 and Dufour (1979), Figure 2). The right-skewed distributions particularly evident in 1976 and 1977 are probably due to different growth rates of the sexes which do not become apparent until August (Amaratunga 1978).

The relationship between mean temperature, biomass and mean length was not apparent in the Gulf data (1970-78) with the multiple regression giving an R^2 of only 0.3524. The highest mean temperature and biomass did, however, occur in the same year (1978). Temperatures in the Gulf averaged almost 2.5°C lower than on the Shelf due to the influence of the Labrador current. It is possible that oceanographic conditions by September no longer represent conditions that prevailed when the year-class of squid was established. The relatively small number of sampling stations, restricted distribution and possible migration from the sampling area deeper into the Laurentian Channel may also have masked the relationships seen on the Scotian Shelf. It is also possible that the squid population in the southwestern Gulf originates from elsewhere.

REFERENCES

Armaratunga, T., M. Roberge, and L. Wood. 1978. An outline of the fishery and biology of the short-finned squid Illex illecebrosus in eastern Canada. In Proceedings of the workshop on the squid Illex illecebrosus. Dalhousie University, Halifax, Nova Scotia, May 1978. Fish. Mar. Serv. Tech. Rep. No. 833.

Dufour, R. 1979. Update of the distribution, biomass estimates and length frequency of Illex illecebrosus from Canadian research cruises, 1970-78. ICNAF Res. Doc. 79/II/14.

Fournier, R. O., J. Marra, R. Bohrer and M. Van Det. 1977. Plankton dynamics and nutrient enrichment of the Scotian Shelf. J. Fish. Res. Board Can. 34: 1004-1018.

Halliday, R. G., and A. C. Kohler. 1971. Groundfish survey programmes of the St. Andrews Biological Station, Fisheries Research Board of Canada - objectives and characteristics. ICNAF Res. Doc. 71/35.

Herman, A. W., and K. L. Denman. 1979. Intrusion and vertical mixing at the shelf/slope water front south of Nova Scotia. J. Fish. Res. Board Can. 36: 1445-1453.

Houghton, R. W., P. C. Smith, and R. O. Fournier. 1978. A simple model for cross-shelf mixng on the Scotian Shelf. J. Fish. Res. Board. Can. 35: 414-421.

Lange, A. M. T. 1978. Historical trends and current status of the squid fisheries off the northeastern United States. In Proceedings of the workshop on the squid Illex illecebrosus. Dalhousie University, Halifax, Nova Scotia, May 1978. Fish. Mar. Serv. Tech. Rep. No.833.

Scott, J. S. 1978. Distribution of squid, Illex illecebrosus, on the Scotian Shelf, 1970-76. Int. Comm. Northw. Atlant. Fish., Selected Papers, No. 3.

Table 1A. Survey statistics for squid from the Scotian Shelf 1970-79.

Year	Mean no. per tow	Mean weight per tow (kg)	Biomass est. ('000 mt)	Weighted mean length (cm)	% tows with squid	No. of tows	Mean bottom temperature (°C)	Mean sampling date (Jan. 01 = 01)
1970*	5.25	0.37	1.9	15.0	32.9	143	5.3	199
1971	23.46	2.41	14.7	16.7	50.0	124	5.6	192
1972	7.61	0.82	3.2	16.7	41.7	156	5.6	187
1973	7.73	1.10	8.9	18.7	36.3	146	5.8	203
1974	11.61	1.61	9.5	18.5	43.0	165	5.7	203
1975	35.03	4.05	24.8	17.5	44.1	145	5.4	207
1976	187.14	35.16	203.7(262.5)	20.5	82.3	141	6.9	205
1977	50.97	9.63	46.6(50.5)	19.6	58.6	145	6.5	201
1978	18.24	2.49	11.2(11.0)	18.5	59.7	144	5.9	201
1979	73.14	10.82	70.3	19.5	74.8	147	6.4	197

Previous estimates (Dufour 1979) in brackets.

Table 1B. Survey statistics for squid from the Gulf of St. Lawrence 1970-79.

Year	Mean no. per tow	Mean weight per tow (kg)	Biomass est. ('000 mt)	Weighted mean length (cm)	% tows with squid	No. of tows	Mean bottom temperature (°C)	Mean sampling date (Jan. 01 = 01)
1970	0.28	0	0	19.8	29.2	24	3.7	263
1971	0.92	0.22	0.36	22.4	26.4	53	3.2	262
1972	0.15	0.02	0.02	17.9	5.4	56	2.8	259
1973	0.17	0.05	0.05	22.0	8.5	59	4.2	258
1974	0.09	0	0	18.8	5.7	53	2.9	258
1975	4.47	0.89	1.0	20.9	36.8	57	4.0	255
1976	57.63	15.71	16.93	22.88	38.9	54	2.8	260
1977	46.37	13.83	15.27	23.19	48.2	54	3.2	261
1978	60.24	18.06	30.83	22.11	71.2	52	4.8	266
*1979	26.0	7.8	-	-	64.0	61	4.4	261

*Preliminary data

Table 2. Correlation coefficients (r) for Scotian Shelf survey data.

1970-79		Biomass	Temperature	
n = 10	Temperature	0.8338		
	Length	0.6740	0.8847	
1976		**Catch Weight**	**Temperature**	**Length**
n = 92	Temperature	0.2081		
	Length	-0.0306	0.1225	
	Depth	0.1224	0.2916	0.1118

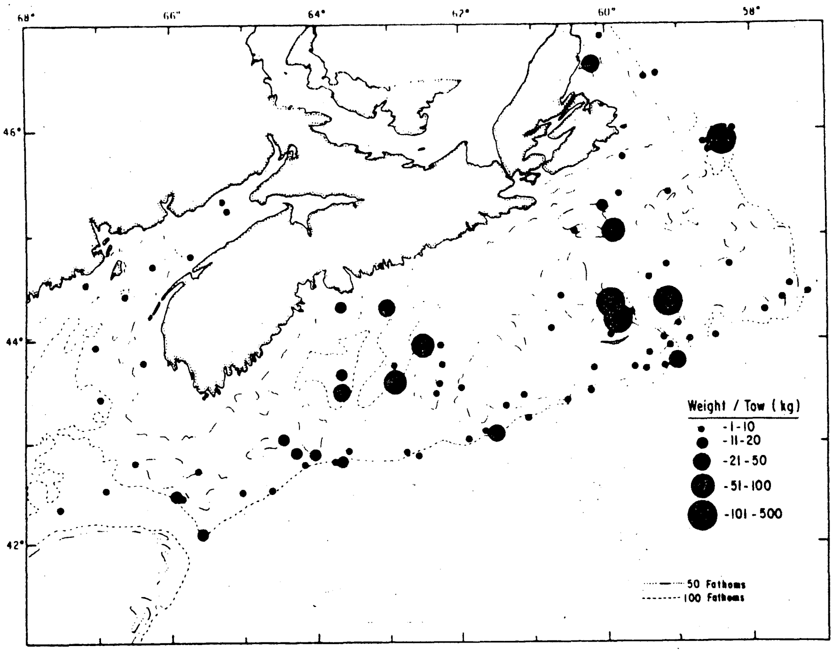

Figure 1. Distribution of <u>Illex illecebrosus</u> on the Scotian Shelf in July, 1979.

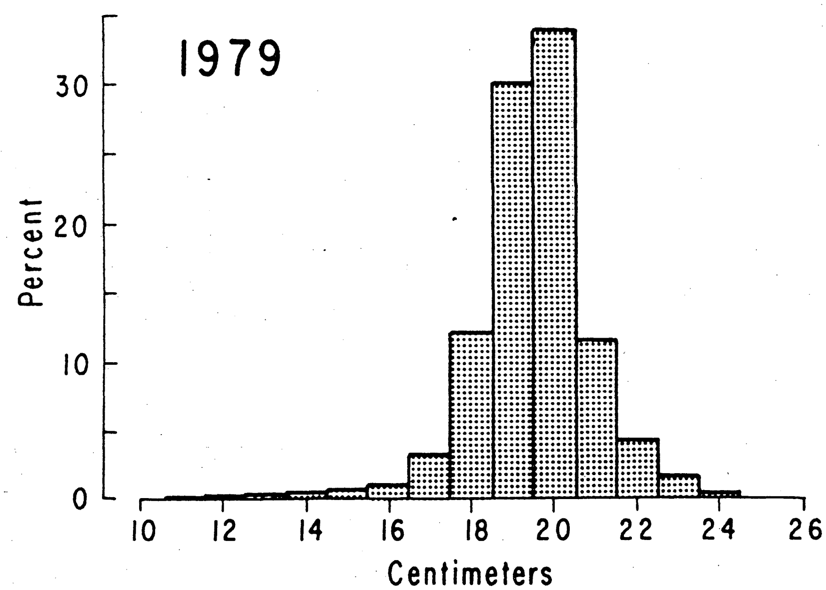

Figure 2. Length frequency distribution of <u>Illex illecebrosus</u> in July, 1979.

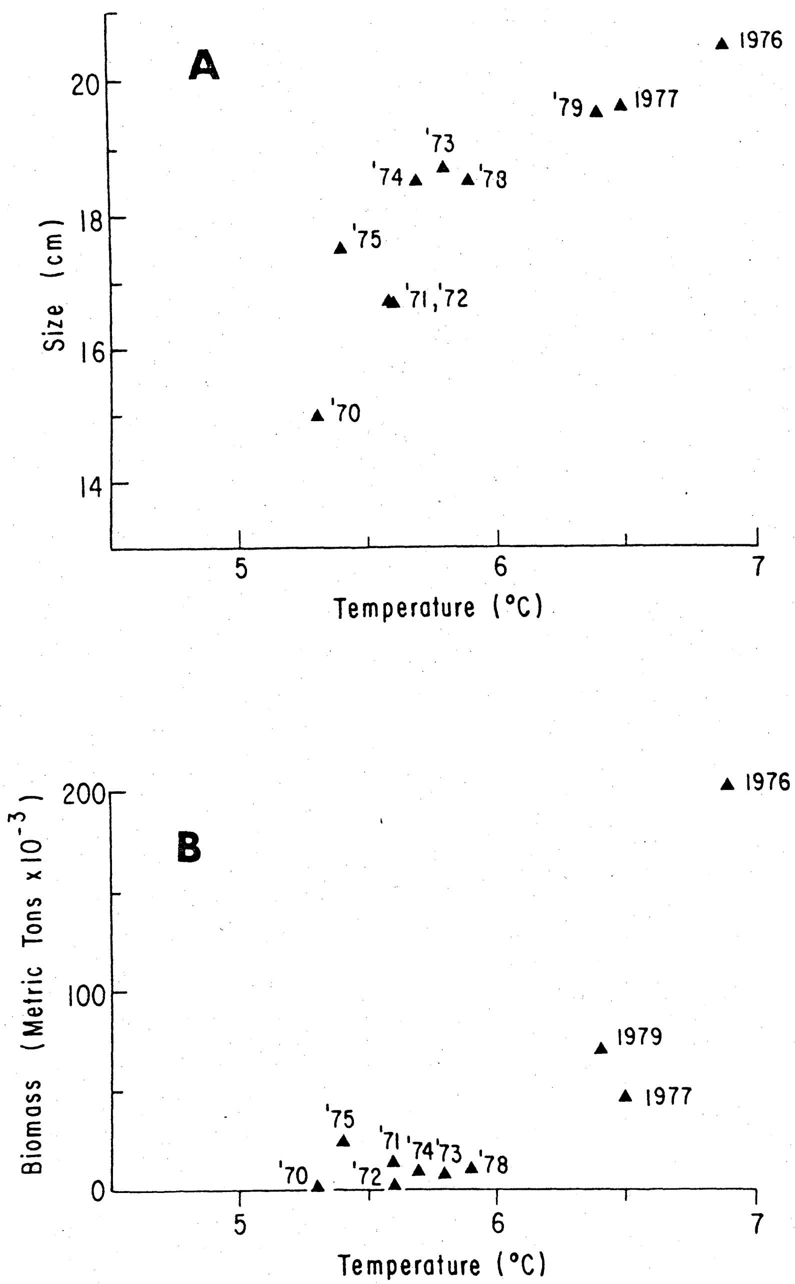

Figure 3. Mean bottom temperature versus A. mean size and B. biomass of Illex illecebrosus from groundfish surveys on the Scotian Shelf, 1970-79.

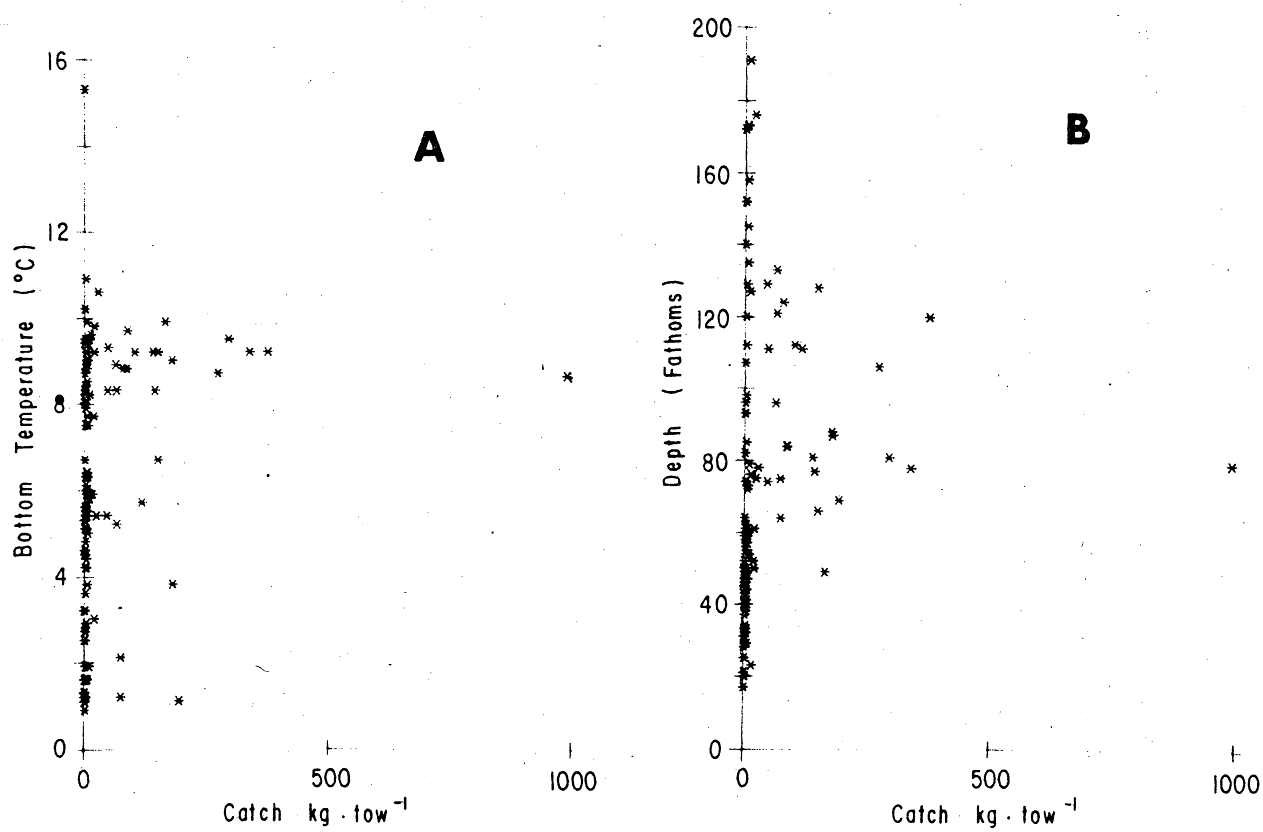

Figure 4. Catch weight of Illex illecebrosus versus A. bottom temperature, and B. depth, from the 1976 Scotian Shelf groundfish survey.

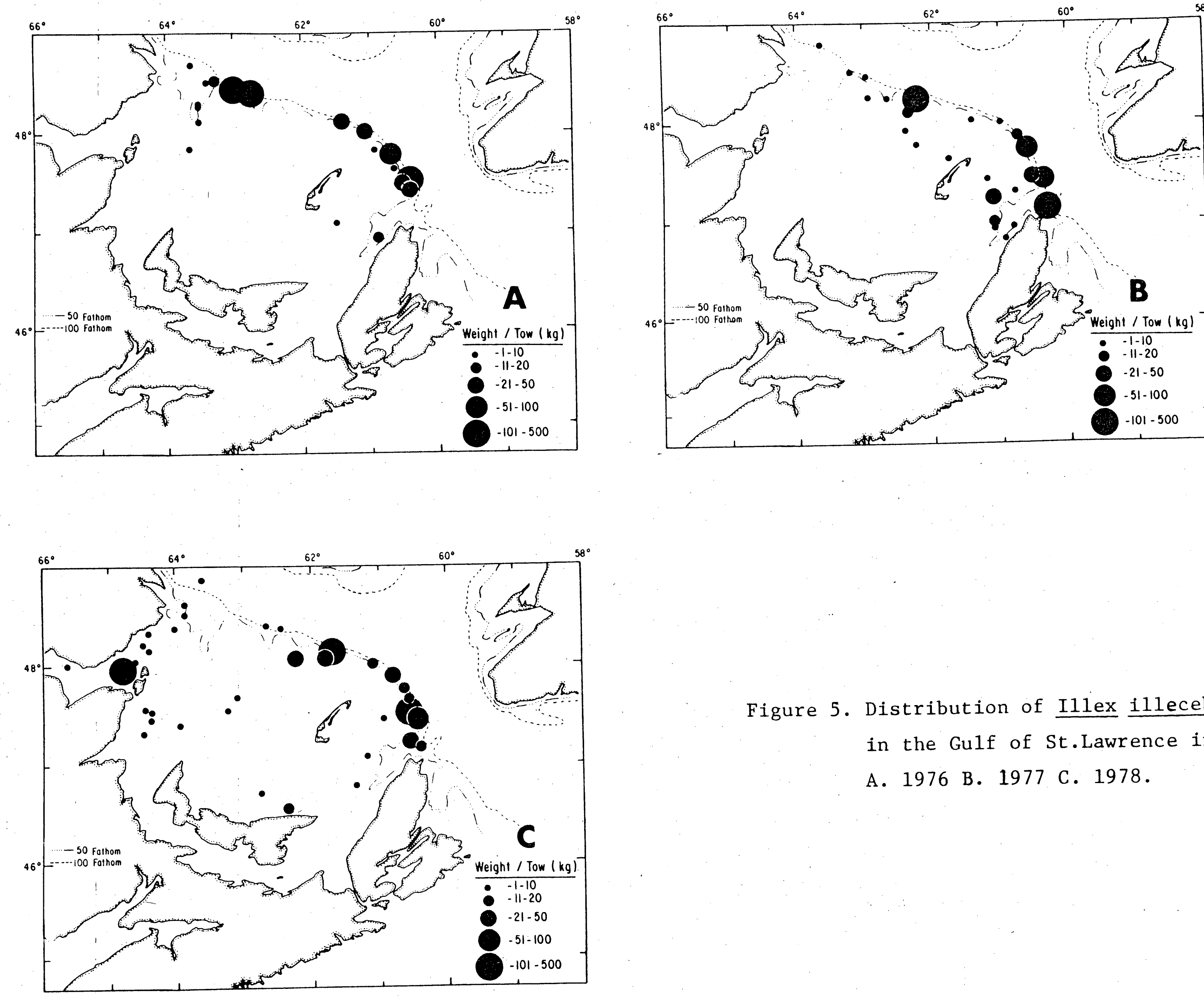

Figure 5. Distribution of <u>Illex</u> <u>illecebrosus</u> in the Gulf of St.Lawrence in September, A. 1976 B. 1977 C. 1978.

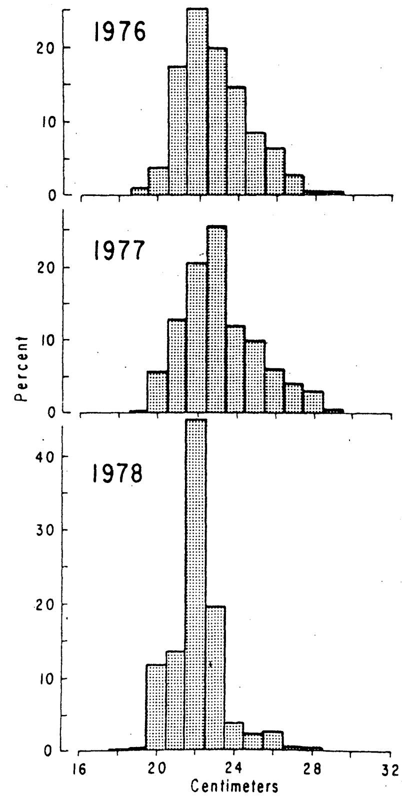

Figure 6. Length frequency distributions of Illex illecebrosus in the Gulf of St. Lawrence in September, 1976-78.