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Update of the distribution, biomass estimates and length frequency of *Illex illecebrosus* from Canadian research cruises, 1970-78

by

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Since 1970, using a standard Yankee #36 otter trawl with small mesh liner in the codend, stratified, random groundfish surveys have been conducted on the Scotian Shelf (ICNAF Div. 4VWX) by Canada (Maritimes). These surveys provide a useful data bank for the study of finfish resources and associated species like Illex, found in the area. In our surveys, squid are measured to the nearest centimeter (mantle length) and weight is recorded in grams.

Results

Data from 1977-78 (Fig. 1) indicate widespread distribution of squid on the Scotian Shelf. Some squid were taken in the Bay of Fundy in 1978. Scott (1978) observed the same phenomenon on a larger scale in 1976. The 1977 biomass estimate is the second largest since 1970 but a continuous decrease was recorded since 1976 (Table 1).

An increase in mean bottom temperature (Table 1) occurred during 1976-77, corresponding to the years of highest abundance. Mean bottom temperatures during 1976 and 1977 were 6.9 and 6.5°C respectively, compared to a mean of 5.6°C for the remaining years. The presence of Illex concentrations inshore (south of Nova Scotia) in 1976-77 might be the result of the increase in temperature registered in these two years. The percentage of tows with squid in 1978 was as high as in 1977 but the average number per tow was lower (Table 2).

The size distribution of Illex for 1970-78 (Fig. 2, Table 3) shows unimodality except in the years 1970-71. Three modes (8, 13, and 16 cm) apparently occurred in 1970 and two (12 and 17 cm) in 1971. The size range of the principal mode (1970-78) remained between 16-20 cm.

Weighted mean length, mean bottom temperature and estimated biomass (Table 1) were analysed for functional relationships. Results of multiple regression analysis are presented in Table 4. Temperature has emerged as the dominant factor in the regression analysis. Table 4A(c) and 4B(c) are evidence of the influence of temperature on the two factors' biomass and size. The second variable in both equations did not make any significant (statistically) contribution to the dependent variable.

Since the sampling (cruise) dates varied over the different years (mean sampling date was July 4 in 1972 and July 24 in 1975), correlations were run for mean sampling time vs mean length to test whether difference in sampling time might have influenced the size of squid. There was no significant correlation (r=0.52) between mean length and sampling date (Table 1, columns 3 and 5) strengthening our earlier hypothesis about the environmental factors, particularly temperature.

The interpretation of these statistical findings could best be summarized as follows:

a) The arrival and concentration of squid are influenced by prevailing environmental conditions, especially temperature - warmer years seem to favour larger catches.

b) The apparent lack of better correlation of biomass to length is puzzling. Perhaps this is due to better growth (in weight) related to favourable environmental conditions, especially temperature or to other factors interacting with them.

It is fully realised that the method of analysis adopted (global annual averages for the variables under study) might be masking the delicate biological mechanisms that regulate the migration, growth and concentration of squid. It is hoped that detailed scrutiny of the data for 1976 and 1977 might throw more light on the influences of these highly correlated variables i.e. depth, temperature, date of sampling on mean size (length) and estimated biomass.

References

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

Steel, R. E. D., and J. H. Torrie. Principles and Procedures of Statistics. McGraw-Hill Book Company Inc., N. Y., 1960.

Footnote: It has been suggested by Amaratunga (personal communication) from his experience at sea that the smaller squid taken particularly in 1970-72 may have been *Gonatus fabricii*, which is superficially similar morphologically to *Illex illecebrosus* and which can attain a size of about 12 cm.

Table 1. Biomass estimates, weighted mean lengths. Mean bottom temperatures and mean sampling dates calculated from groundfish cruises on the Scotian Shelf, 1970-78.

Year	Biomass est. ('000 mt)	Weighted mean length (cm)	Mean bottom temperature (°C)	Mean sampling date (Jan. 01 = 01)
1970	1.9	15.0	5.3	199
1971	14.7	16.7	5.6	192
1972	3.2	16.7	5.6	187
1973	8.9	18.7	5.8	203
1974	9.5	18.5	5.7	203
1975	24.8	17.5	5.4	207
1976	262.5	20.5	6.9	205
1977	50.5	19.6	6.5	201
1978	11.0	18.5	5.9	201

Table 2. Summary of squid catches from summer (June-August) research survey cruises on the Scotian Shelf, 1970-78.

Year	Mean no. per tow	Mean weight per tow (kg)	No. of tows	No. of tows with squid	% tows with squid
1970*	5.25	0.37	143	47	32.9
1971	23.46	2.41	124	62	50.0
1972	7.61	0.82	156	65	41.7
1973	7.73	1.10	146	53	36.3
1974	11.61	1.61	165	71	43.0
1975	35.03	4.05	145	64	44.1
1976	187.14	35.16	141	116	82.3
1977	50.97	9.63	145	85	58.6
1978	18.24	2.49	144	86	59.7

*Data 1970 to 1976 are from Scott (1978).

Table 3. Weighted length frequency and representation (%) of *Illex* from groundfish survey on the Scotian Shelf, 1970-78 (N.B. x10^{-3}).

Length (cm)	1970	%	1971	%	1972	%	1973	%	1974	%	1975	%	1976	%	1977	%	1978	%
4					16	0.05												
5	38	0.14	11	0.01	16	0.05					621	0.30						
6	76	0.28	84	0.06	0	0.00					0	0.00						
7	168	0.61	34	0.03	0	0.00					414	0.20	41	0.003				
8	433	1.57	22	0.02	0	0.00			22	0.03	431	0.21	0	0.00				
9	351	1.27	81	0.06	56	0.17			147	0.22	199	0.10	0	0.00				
10	94	0.34	116	0.09	46	0.14			51	0.08	640	0.31	54	0.01			67	0.08
11	1309	4.75	319	0.24	83	0.25			15	0.02	691	0.33	0	0.00			78	0.10
12	2787	10.11	2384	1.76	239	0.73	68	0.11	13	0.02	122	0.06	63	0.01			317	0.40
13	2818	10.23	1668	1.23	617	1.88	205	0.32	160	0.24	520	0.25	0	0.00	95	0.04	345	0.43
14	2305	8.36	8225	6.09	2033	6.19	995	1.55	1233	1.82	3654	1.75	347	0.03	538	0.21	524	0.66
15	4052	14.70	18083	13.38	4526	13.77	1537	2.40	3122	4.61	7309	3.51	229	0.02	1171	0.47	1355	1.71
16	4273	15.50	24305	17.98	7118	21.66	2946	4.60	4917	7.26	25931	12.45	3798	0.35	4858	1.93	2775	3.50
17	4106	14.90	34067	25.20	7694	23.42	5485	8.57	9354	13.82	65653	31.52	20449	1.90	15082	5.99	9656	12.17
18	2500	9.07	30812	22.80	5553	16.90	12847	20.07	17402	25.70	56524	27.13	67945	6.32	36603	14.55	26200	33.03
19	1347	4.89	11453	8.47	2873	8.74	21452	33.51	13156	19.43	27245	13.08	161945	15.05	71257	28.32	21688	27.34
20	663	2.41	2761	2.04	1458	4.44	12621	19.72	8171	12.07	12606	6.05	287938	26.76	56701	22.54	10369	13.07
21	76	0.28	617	0.46	510	1.55	4378	6.84	4280	6.32	4030	1.93	264799	24.61	35764	14.22	4100	5.17
22	0	0.00	92	0.07	0	0.00	1258	1.97	2697	3.98	780	0.37	168808	15.69	18012	7.16	1254	1.58
23	81	0.29	0	0.00	0	0.00	25	0.04	1862	2.75	889	0.43	68785	6.39	6913	2.75	280	0.35
24	41	0.15	0	0.00	20	0.06	0	0.00	752	1.11	0	0.00	20463	1.90	3083	1.23	218	0.27
25	41	0.15	0	0.00			0	0.00	164	0.24	0	0.00	7332	0.68	775	0.31	90	0.11
26			0	0.00			17	0.03	175	0.26	0	0.00	2634	0.24	354	0.14		
27			0	0.00			69	0.11	7	0.01	0	0.00	68	0.01	220	0.09		
28			32	0.02			110	0.17	6	0.01	31	0.01	64	0.01	23	0.01		
29											31	0.01	0	0.00	88	0.03		
30													0	0.00	41	0.02		
31													65	0.01				
Total	27559		135166		32858		64013		67706		208321		1075827		251578		79316	

Total (all years): 1942344.0

Table 4. Multiple regression analysis.

A. <u>Biomass (Y) vs temperature (X_1) and mean size (X_2)</u>

a) Correlation matrix

	Y	X_1	X_2
Y	1.0000	0.8251	0.6474
X_1	0.8251	1.0000	0.8730
X_2	0.6474	0.8730	1.0000

b) Equation $Y = -706.3805 + 175.0006X_1 - 15.3254X_2$

c) R^2 $X_1 = 0.6807$

$X_1, X_2 = 0.7031$

d) Standardized B coefficients

X_1 (temp.) = 1.0929

X_2 (size) = -0.3068

B. <u>Size (Y) vs temperature (X_1) and biomass (X_2)</u>

a) Correlation matrix

	Y	X_1	X_2
Y	1.0000	0.8730	0.6474
X_1	0.8730	1.0000	0.8251
X_2	0.6474	0.8251	1.0000

b) equation $Y = -1.7613 + 3.4027X_1 - 0.0046X_2$

c) R^2 $X_1 = 0.7622$

$X_1, X_2 = 0.7789$

d) Standardized B coefficient

X_1(temp.) = 1.0616

X_2 (biomass) = -0.2285

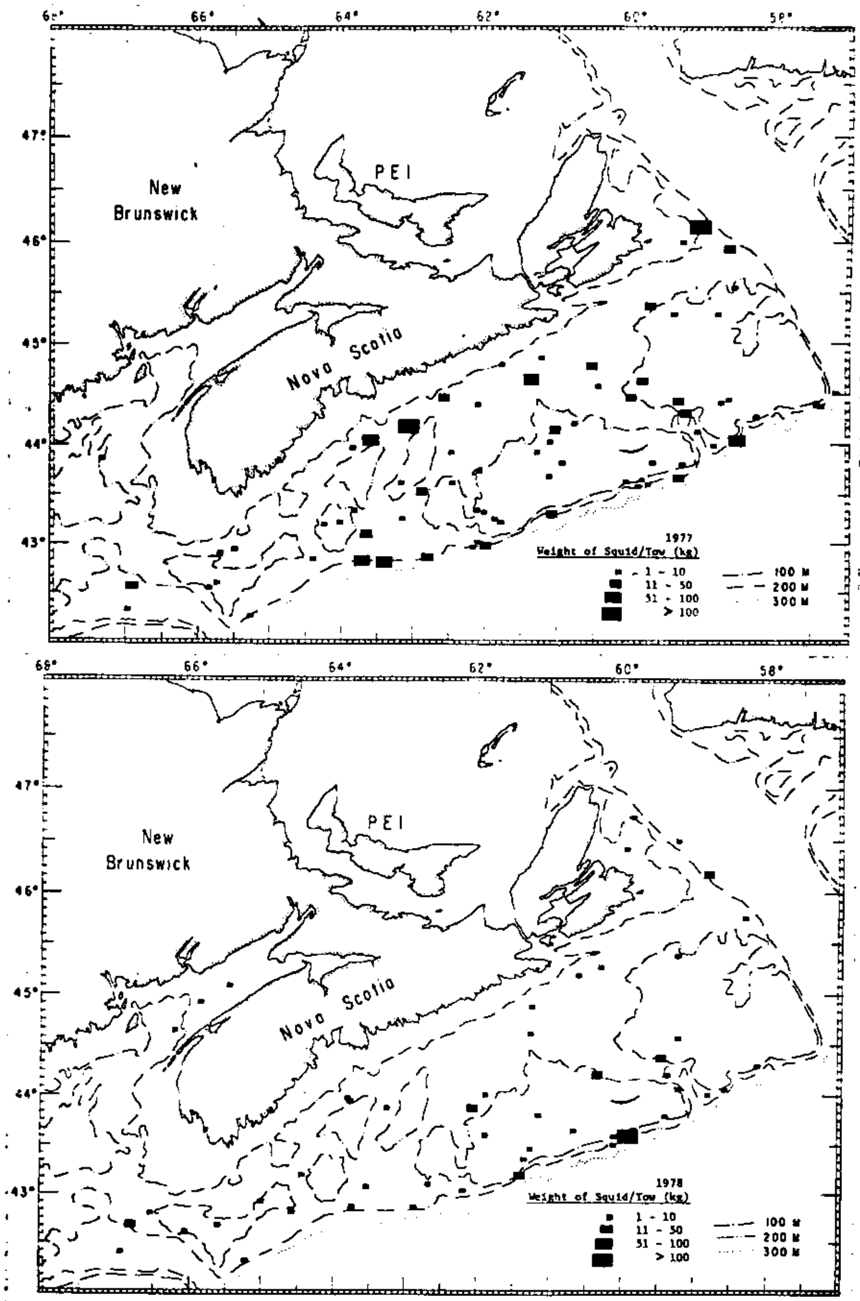

Fig. 1 Distribution of Squid catches (kg) on the Scotian Shelf in 1977, 1978.

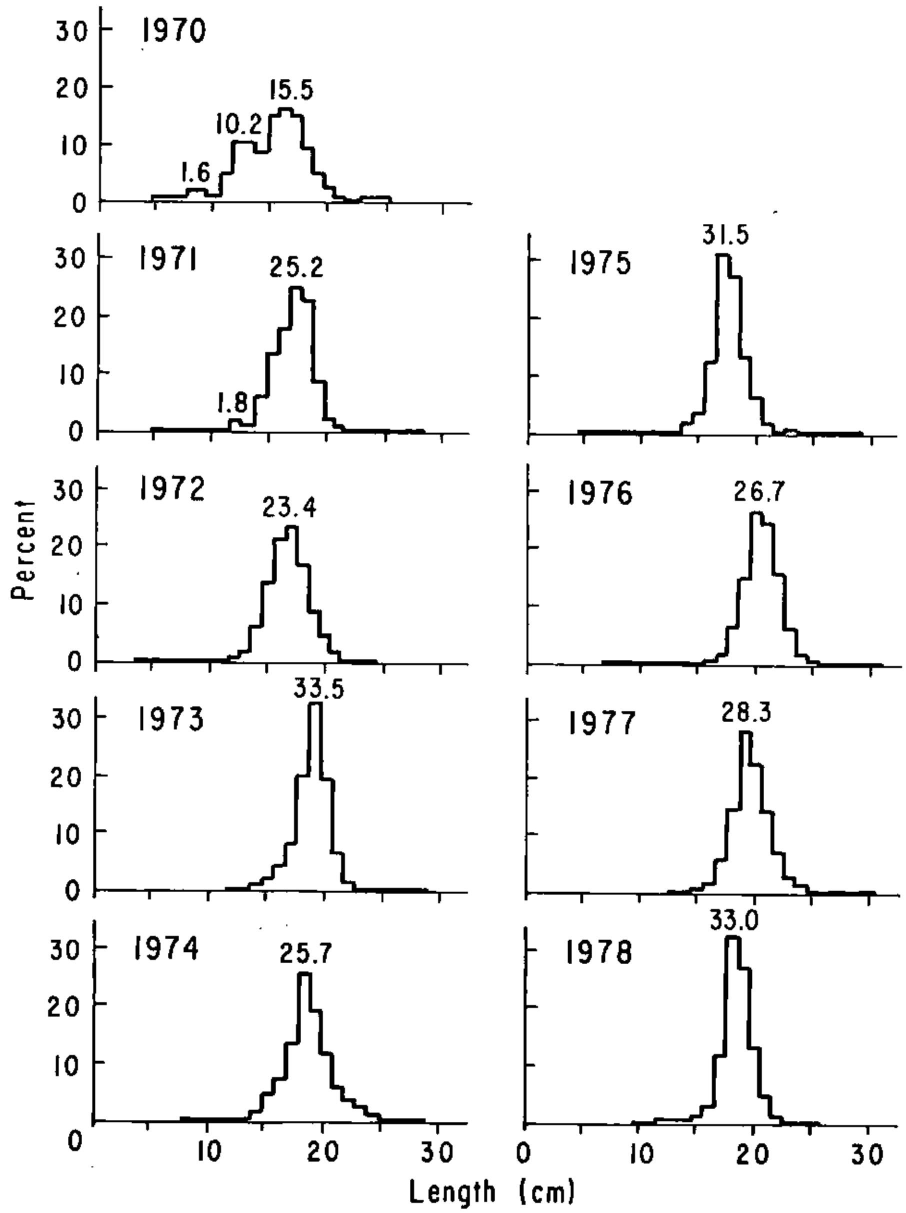

Fig. 2: size frequency distribution for Illex illecebrosus, 1970-1978
Numbers above modal length groups are percentages of total catch at that length.