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Biological characteristics and Biomass estimate of the squid, <u>Illex illecebrosus</u>, on Scotian Shelf (Dav. 4VWX) in late summer of 1980

## by

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### I - Introduction.

During the course of a squid survey on Nova-Scotia Shelf (NAFO Div. 4VWX), carried out on board French R/V <u>La Perle</u> (stern trawler, class 4) from 4 to 24 September 1980, data were collected on catches, size distribution and maturity stages on <u>Illex illecebrosus</u> with reference to hydrographic conditions.

### II - Material and method.

The gear used was the Lofote: bottom trawl with following specifications: 31.20 m headrope, 17.70 footrope and 50 mm stretched mesh in the codend. A total of 75 hauls were made during the trip on which two were not used to estimate biomass because the trawl was damaged. During each tow, an hydrographic station was occupied using XBT thermograph.

On the surveyed area (Fig.1), the stations were distributed randomly, using the stratification scheme proposed by HALLIDAY and KOHLER (1971) and recommanded by NAFO, for Divisions 4VWX. Investigations were limited to depth ranging from 50 fath.(92 m) to 200 fath.(366 m) and a total of 22 strata were covered during the cruise.

Fows were of standard duration (30 minutes). Thus the area swept by the travl is assumed to be constant and was calculated on the basis of an horizontal opening of 13.5 m at the wings, in the 3.5-4 knots speed range. So, the mean area covered per tow is estimated to 0.015 square nautical miles  $(0.05 \text{ km}^2)_{\circ}$ 

After each tow, the catch was sorted by species. The total quantity of squid was weighted and a representative subsample (100 to 200 individuals by set) was analysed. Maturity stages by sex, related to length measurements (mantle length to the half-centimeter below) were recorded using maturity scales defined by MERCER (1973 a) for males and by AMARATUNGA and DURWARD (1979) for females. Furthermore, individual weight by length keys were obtained for males and females.

## III - Results.

Squid, <u>Illex</u>, represented the second species by the weight (6 500 kg against 6 600 kg for haddock) and the first by the number of individuals (about 28 000) for the whole survey, but great variations were observed in its distribution and biological characteristics.

#### A. Geographical distribution in melation to hydrographic situation.

Squid were found at each tow and the mean catch per 30 minutes was close to 90 kg or 384 individuals of <u>Illex</u>. The yield per tow (Fig.2) was very inequal depending on the area. Thus, largest concentrations were obtained on the central part of the shelf, with yield up to 1 538 kg in the western Gully (stratum 65) and 1 465 kg per 30 minutes set in the Emerald Basin (stratum 61). The corresponding bottom temperature was  $9.5^{\circ}$ and  $7.5^{\circ}$  C (Fig.3). On the other hand, squid were very scarce in the northeastern part of the surveyed area, all along the slope of the Banquereau Bank (strata 46 to 51). The bottom temperature recorded on these strata was generally low (1.4° to 8.5° C).

On the figure 4, the mean catch per tow is expressed versus bottom temperature. Although important variability is obvious from raw data, the general trend, obtained on smoothed data (using a running average over 3 classes), indicates a thermic preferendum of squid from 6 to 9° C.

During the survey, the three-layered structure of water masses described by SIGAEV (1979) and GOMEZ (1979) for the Scotian Shelf, was again observed :

- the surface water (0 to 30 m depth) was increasing from 14 to 17° C from east to west of the shelf,
- the intermediate water (30 to 100 m depth), covering most of the shallowere strata with low temperatures (1° to  $6^{\circ}$  C),
- the slope water, characterized by warm temperatures ( $6^{\circ}$  to  $12^{\circ}$  C), stretching all along the edge of the shelf and entering in the central area, in front of Halifax, by the depression between Emerald and La Have banks (see Fig.3).

Most of the squid were caught in the slope water, which corresponds to the thermic preference of this species, in this period of the year.

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B. Biological characteristics of squid.

1. Length-frequencies distribution.

The length-frequencies distributions (Fig.5), each sex apart, are expressed in consideration of depth interval of travling.

Three modal groups were found in September 1980 on the Scotian Shelf :

- a) a group of small squid caught principally in shallower strata from 50 to 100 fathoms and which principally appeared in the western part of the shelf. Their size ranged for both sexes between 8 and 13 cm and their weight between 10 and 50 g. All these specimen were immature. Because the selectivity of the trawl, their mean size close to 10 cm is probably overestimated and their relative proportion in the whole catch (2 %) underestimated.
- b) a group of medium squid, more abundant in the 50-100 fathoms level, specially found in the central area : the size of male ranged from 13.5 and 19.5 cm (mean size to 16.5 cm), the weight range and mean (underlined) were respectively 45-75-140 g for males and 50-95-180 g for females. The most part of these squid are still immature.
- c) the bulk of the population (about 80 % of the weighted number of individuals caught) was composed of large squid. Males size was ranging from 19 to 27 cm (mean 21.5 cm) and females one from 19 to 30 cm (mean 22.6 cm). The main part of these squid were maturing. However males presented a more advanced degree of maturation (15 % of males with spermatophore in Needham sac against only two females, on the 2 260 examined, with ova in oviducts).

2. Variations of characteristics with depth.

Refering to the depth of trawling, some difference were noted in the characteristics of squid catches as indicated in the following table :

{:		Mal	es	Fema	Overall	
Depth level (fathoms)	50-	-100	100-200	50-100	100-200	50-200
( Mean length (cm)	20	0.60	: 21.46	21.41	22.57	21.31
Standard deviation(cm):	. 6	•29	1 1.43	2.93	2.19	2.31
Kean weight (g)	•	76	197 s	197	226	196
Number measured	٩,	566	; 1,038 ; ; 1,1 0,38 ;	1,373	890	4,867

3. Length-weight relation by sex.

During the course of the survey, 10 males and 10 females were weighted to the nearest gram, for each 0.5 cm interval of length. Males size ranged

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from 8.0 to 25.0 cm and females one from 8.0 to 28.5 cm. Individuals were taken in different tows, depth and strata.

The mean value of weight for each class interval was then used to calculate the parameters of Length-weight equation, by least-square method and resulted :

- for males : W = 0.00993 L<sup>3.222</sup> - for females : W = 0.01478 L<sup>3.082</sup>

where W represents the total body weight (fresh) in grams and L the mantle length in centimeters. The plotting of observed and calculated values (Fig.6) indicates a good overlap of points between males and females till the length of 20 cm. But beyond, males are heavier than females for a given length interval. However, females reach larger size and weight than males.

These results are in good agreement with those obtained by SQUIRES (1957) and MERCER (1973 b). The differences of length-weight relations between males and females are probably related to the differences observed in the maturation, the development of gonad being earlier in males.

### C. Biomass estimates.

The biomass of squid present on the surveyed area during September 1980 is estimated by aerial expansion method based on stratified random sampling.

If we assume that the efficiency of the trawl used was 100 % for the squid present on the path of the gear, then the biomass  $B_i$  and variance Var.B<sub>i</sub> can be calculated in weight and number for each stratum, by the following equation :

$$B_{i} = \overline{Y}_{i} A_{i}/b$$
  
Var\_B<sub>i</sub> =  $A_{i}^{2} \times s_{i}^{2} / n_{i}b^{2}$ 

where :  $\overline{Y}_{i}$  is the mean catch of Illex by tow in the stratum i

A, is the surface of stratum i

- b is the surface swept by the trawl per 30 minutes (estimated to 0.015 sq.naut.mile)
- $s_1^2$  is the variance of catch per tow in the stratum i

The standard error of biomass for each stratum is the square root of  $Var_{B_i}$ . The total biomass by depth level and the overall for the area covered by the survey, were obtained by adding each  $B_i$  and the corresponding standard error by extracting the square root of sum of variance. The results are expressed in Table 1. The overall values of biomass about 150 000 metric tons representing 665 million of individuals are affected by low confidence level of 35 %. The schooling behaviour of squid can explain such a variability from tow to tow. Thus, the random procedure for selecting stations avoids overestimates in our figures. Moreover, the low vertical opening of the trawl (3 m to 3,50 m) compared with the vertical distribution of <u>Illex</u> in the water column and, on the other hand, the assumption of 100 % efficiency of the gear rather irrealistic because the high velocity of the squid, tend to conclude to a strong underestimation of the biomass.

#### IV - Discussion and conclusions.

In September 1980, squid were widely distributed on NAFO Div. 4VWX, but largest concentrations were restricted to the central depression between Emerald and La Have banks. This was also observed in previous years during summer months (SCOTT, 1978). The slope warm water (8° to 10° C) which lays there, contrasts with colder waters observed in the surrounding shallower strata and coincids with the thermic preferendum of <u>lllex</u>.

Length distribution analysis revealed three components structure of <u>Illex</u> population. The large squid represented the bulk of the catch (about 80 % of individuals). Most of them were maximum or yet mature. Their greater size and their more advance degree of maturity in the deeper waters indicates that they mere leaving the shelf for reproduction. If we consider the higher percentage of males (54 %) it seems that this migration was just beginning.

But it is unlikely that small and medium squid, still immature or just in first steps of maturation, can participate to this reproductive migration which takes place during the fall season. HESNIL <u>et al.</u> (1976) have observed during a survey carried out between November 22th and December 15th 1975 on southern Scotian Shelf and George bank, the same three modal structure, but with relative proportion quite different : the group of larger squid was only 8 % of total number and was more abundant in deepest strata (100-200 fath.) indicating that reproductive migration was finishing while the younger groups remained on shelf for Geeding.

We have noted (unpublished data), after compilation of raw data from French research surveys carried out during the 1972-1981 period, that a part of squid population stays during the winter season along the slope of the banks from south Labrador to northern Stratan Shelf.

Thus, the three group of squid observed participate to different breeding period as assumed by SQUIRES (1967) and MESNIL (1977).

The minimum trawlable biomass of squid was estimated by swept area method to about 150 000 tons and 665 millions of individuals on the surveyed part of Scotian Shelf. Using the same sampling method, on the same strata, SCOTT (1978) obtained abundance indices for the 1970-1976 period, ranging from 5 to 187 individuals of Illex per 30 minutes tows, during the summer season. Our survey in September 1980 resulted in a mean catch of 384 individuals per tow, that is to say more than twice the maximum indice obtained by SCOTT for 1976 (known as a year of exceptionnal abundance) and ten times the mean of 1970-1976 period. This comparison is just indicative, considering the differences between research vessels and trawls used, but revealed that <u>Illex</u> stock was important during 1980 season.

#### Acknowledgements

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Depth range :	Stratum	Area of	Number of	Mean Yiel	ld p <b>er</b> tow	: Bioma	S. S.	Standard	error
	Q.	stratum (miles);	hauls	Number	kg	: N thousands	: W tons :	N thousands	: W tons )
• ••	49	. 144 .	" <b>"</b>	N	0 <b>.</b> 4	22		14	3 (
••	20	: 383 :	4	23	3.7	: 462	: 94 :	198	: 37)
••	54	: 499 :	• •	159 :	20•5	: 3,957	: 682 :	1,783	: 339 )
••	57	: 811 :	•• ო	301	65 <b>.</b> 3	: 16,292	: 3,532 :	3,677	: 1,340 )
50-100 fath:	09	: 1,344 ::	•• ••	: 398	75.3	: 35,660	: 6,750 :	8,984	: 2,839)
(92-183 m) :	62	: 2,116 :	• •	264 :	48,82	: 63,140	: 10,627 :	22,664	: 4,010 )
••	65	: 2,383	:	1,411 :	363.1	: 224,376	: 57,684 :	210,845	: 47,322 )
••	20	: 920 :	•• •	243	43.7	: 14,924	: 2,678 :	10,582	: 1,852)
••	72	: 1,249 :	•• • •	810	172.7	: 67,446	: 14,377 :	36,322	: 8,740 )
••	76	: 1,478 :	•• • •	81	16.3	: 7,981	: 1,609 :	2,365	: 720
••	77	: 1,232	4	277 :	63.0	: 22,710	: 5,174 :	9,465	: 4,496 )
••	81	: 1,875 :	• 2°	194 :	44.0	: 24 225	: 5,500 :	8,387	: 2,035 )
••		••	••	••		••	••		
••		••							(
Total		•••	•••	347		. 481,196	108,700	216,018	. 48,684
••	46	491	~	16	3.0	: 524	• 86	65	-
	51	147	•• ~v	10	2°0	. 93	50	45	15 <
••	52	345	••	589	66 <b>.</b> 0	6.655	1.518	2.756	1.107 {
•••	23	259	•• • •	192	44 <b>•</b> 0	3,779	760	2,082	357 <
100-200 fath	61	1,154	4	1,686	428.5	129,671	32,966	91,159	26,705 <
(184-366 m)	99	226	• • •	306	56.7	4,610	854	2,215	439 <
·••••	71	1,004	4	469	100.8	31,425	6,744	19,323	4,253 <
•••	78	233	0	116	27.0	1,802	419	286	124
•	82	1,042		70	15.7	. 1,784	1,088	1,603	708 <
••••	83	532	сı		7.5	1,099	266	301	: 124
Total :		•• ••	•• ••	319	· · · ·	; 184,442	44,732	93,290	: 27,080
Overall :			•• ••	335		665,638	153,432	235,302	; 55 709 }

Table 1.- Mean catch and biomass estimate of Illex illecebrosus per stratum in NAFO Div. 4 V W X, R/V La Perle survey (4 to 24 sept. 1980)

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Shelf - R/V La Perle survey (Sept. 1980)

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- R/V La Perle survey (Sept. 1980)

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