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Biological Characteristics and Biomass Estimate of the Squid (*Illex illecebrosus*) on Scotian Shelf (Div. 4VWX) in Late Summer 1982

by

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I. Introduction

A squid survey was carried out on board French R/V Cryos (stern trawler class 5) from August 18 to September 21 on Scotian Shelf (N.A.F.O. Div. 4 V W X). This paper presents data collected on abundance, size distribution, maturity stages, of Illex illecebrosus with reference to hydrographic conditions. A biomass estimate is also provided per stratum. Moreover comparisons with the situation observed in 1980 and 1981 during similar surveys is made.

II. Material and method

The gear used was the Lofoten bottom trawl with following specifications : 31.20 m headrope, 17.70 footrope and 50 mm stretched mesh in the codend. A total of 116 tows were made during the trip on which 102 were used to estimate biomass, the remaining sets being in deeper water, out of the boundary of the strata or incomplete because the trawl was dammaged on the bottom. After each tow, an hydrographic station was occupied using XBT thermograph. Moreover 5 hydrographical sections were made and analysed in another paper.

On the surveyed area (fig. 1), the stations were distributed randomly using the stratification sheme proposed by HALLIDAY and KOHLER (1971) and recommanded by N.A.F.O., for Divisions 4 V W X. The boundary of strata 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.Three additional stations were made on the slope of the shelf between 450 and 600 m for a better knowledge of migration.

Tows were of standard duration (30 minutes). Then the area swept by the trawl 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 km²).

After each tow, the catch was sorted by species. The total quantity of squid was weighted and if necessary, a representative subsample (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 AMARATUNGA and DURWARD (1979). Furthermore, individual weight by length keys were obtained for males and females.

III. Results

Squid, Illex, represented the seventh commercial species by the weight with 418 kg (against 5 880 for haddock, 5 225 for silver hake, 5 221 for redfish, 2 979 for pollock, 2 112 for cod and 440 for halibut) and the fourth by the number (4 000 individuals) for the whole survey, but great variations were observed in its distribution and biological characteristics.

A. Geographical distribution in relation to hydrographic situation

Squid were found in 106 on a total of 116 tows. The mean catch per 30 minutes was close to 4 kg or 35 individuals of Illex. The yield per tow was very low in most of the whole area surveyed (fig. 2). The best catches were obtained in the south of La Have Bank with yield up to 125 kg per 30 minutes (stratum 77) and in the vicinity of the Western Gully (32 kg in stratum 66). The corresponding bottom temperatures were 7°4 and 8,2°C respectively (fig. 3).

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

- the surface water (0 to 30 m depth) was ranging from 10° to 20°C with salinity from 30 to 32 ‰ ;
- the intermediate water (30 to 100 m depth) covering most of the sallower strata with low temperatures (1° to 6°C) and salinity from 31 to 33 ‰ ;
- the slope water, characterised by warm temperatures (5° to 11°C) and high salinity (33 to 34,5 ‰) 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 (fig. 3). The comparison of these data with hydrological situation observed in September 1980 (DUPOUY, 1980) and in September 1981 (DUPOUY and MINET, 1982) indicates a decline in surface and bottom temperatures (3° to 5°C for surface and 1 to 2° for bottom).

In figure 4, the catch rates were expressed by bottom temperatures and minimum intermediate temperatures. It appears that :

i) very few squid were caught for bottom temperatures lower than 5°C ;

ii) squid are also scarce for intermediate temperature lower than 2°C and greatear than 8°C ;

iii) highest catch rate were observed for bottom temperature ranging from 6°C to 10°C and intermediate temperature from 3° to 8°C. But when the same bottom temperatures are associated with lower intermediate temperatures catch rates are low.

These observations are consistant with those made in 1980 and 1981. The role of intermediate temperature on distribution of squid can be explained by the diurnal vertical migration of Illex. Too large differences in temperature between the two layers are possibly insuitable for vertical migration.

B. Biological characteristics of squid

The length-frequencies distributions (fig. 5), each sex apart, are expressed in consideration of depth interval of trawling. The size distributions for the wole survey are very noisy and modal groups are difficult to separate particularly in shallower strata (50 to 100 fathoms). This resulted from the variability of size groups from tow to tow but also because the survey was extending on one month and that growth during this period is suffisantly high for youngest individuals to shift modal distribution of small and medium groups on the right (SQUIRES, 1967, calculated a growth rate of 4.7 cm/month for the squid < 15 cm assuming a 12 months life cycle).

So, a selection of tows were largest yields were made is presented in figure 6 for a better comprehension and separation of size groups distributions. In the top of figure 6, two tows made in stratum 77 during September 1 are combined : the mode of small ranged from 7 to 12 cm and the medium from 13 to 18 cm ; no squid pertaining to the large group were caught, avoiding then a possible overlapping between medium and large. On the bottom of figure 6, two others tows made in stratum 66 on September 14 are combined : only squid from large group were caught and they ranged from 17 cm to 23 cm for males and 17 cm to 24 cm for females. Very few squid larger than 25 cm were caught instead in previous years a significant percentage of females reached this size.

These three groups were yet observed in September 1980 and 1981 but the proportion of large was respectively of 80 % and 88 % of the catch (DUPOUY, 1981 and DUPOUY and MINET, 1982). In 1982 survey, large squid represented only 37 % against 24 % for small and 39 % for medium.

Consequently, the characteristics of squid, presented in the following table, indicates lower mean weights and sizes (4 to 5 cm in strata ranging from 50 to 100 fathoms and 2 to 3 cm in strata from 100 to 200 fathoms) and a higher standard deviations of size.

	Males		Females		Males + females
Depth level (faths)	50-100	100-200	50-100	100-200	Overall 50 - 200
Mean length (cm)	15.86	19.91	16.53	20.45	17.46
Standard deviation (cm)	3.74	2.90	3.74	3.54	4.05
Mean weight (g)	87.2	162.6	97.9	176.0	116.4
Number measured	712	322	685	311	2 030

Moreover, a lower proportion of advanced maturity stages were noted for males and females.

C. Biomass estimates

The biomass of squid present on the surveyed area during this survey (August 18 to September 21, 1982) is estimated using the swept area method based on stratified random sampling.

Assuming that the efficiency of the trawl used was 100 % for the squid present on the path of the gear, then the biomass Bi and variance Bi can be calculated in weight and number for each stratum, by following equations :

$$B_i = \bar{Y}_i \, A_i / b$$

$$Var.B_i = A_i^2 \times s_i^2 / n_i b^2$$

where $\bar{Y}_i$ is the mean catch of Illex by tow in the stratum i

A_i is the surface of stratum i

b is the surface swept by the trawl per 30 minutes (estimated to 0.015 sq. naut.miles)

s_i 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 4 600 metric tons representing 54 millions of individuals are affected by confidence level of 29 %. 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 Illex 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.

The evolution of abundance index in number and weight, in the same strata from 1980 is presented in the following table :

	Strata 50-100 fathoms		Strata 100-200 fathoms		Total (100 in 1980)	
Year	Number in millions	Weight in tons	Number in millions	Weight in tons	Number	Weight
1980	481	108 700	184	153 432	100	100
1981	167	39 292	55	53 231	33	35
1982	49	3 667	5	905	8	3

These values indicate a sharp decline of abundance in number and weight from 1980. In figure 7, the weighted distribution per km² are reviewed for the three last years. This figure shows that this decline of abundance affected mainly the group of large squid instead the medium was more abundant than in 1980 and 1981.

IV. Discussion and conclusions

In late summer 1982, squid, Illex illecebrosus, were widely distributed on Scotian shelf but no large concentration were noted as in previous years. The mean weighted number caught per 30 minutes standard tow was only 41 against 168 in 1981 and 503 individuals in 1980. The biomass estimate (about 4 600 tons) was only one tenth of 1981 and 3 % of 1980 level. This dramatic drop in availability of squid was also noted in inshore waters around St Pierre and Miquelon, Subdiv. 3 Ps (DUPOUY, 1983). This decline of abundance is principally due to the scarcity of the group of large squid (> 18 cm in September) which represents the basis of commercial fishery during summer and autumn fishing season. The group of small squid was also in lower abundance compare to the level of 1980 and 1981, instead the group of medium (13 to 18 cm) attained the highest level recorded during the last three years.

Although our time series is just extending on three years the relation between abundance of small squid a given year and abundance of large squid the following year as stated by MESNIL (1977) and LANGE and SISSENWINE (1981), don't appear at present, very consistant with our data since the large amount of small squid observed in 1981 resulted in very low abundance of large in 1982. But our observations are just restricted to the N.A.F.O. area 4 and so, they have to be confirmed by all pertinent informations on abundance collected particularly in more southern areas.

Acknowledgements

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Table 1.- Mean catch and biomass of Illex illecebrosus per stratum in NAFO Div. 4 V W X, R/V Cryos survey (18 aug. to 21 sept. 1982)
Campagne ENCANO 823 - Illex illecebrosus

Depth range	Stratum No.	Area of stratum (miles)	Number of hauls	Mean Yield per tow		Biomass		Standard error	
				Number	Kg	N thousands	W tons	N thousands	W tons
	50	383	5	1.8	0.3	46	8	13	5
	57	811	6	0.3	0.04	16	2	11	2
	60	1,344	4	31.0	4.2	2,778	376	1,553	184
	62	2,166	10	24.5	2.1	3,538	303	2,094	97
50-100 faths	65	2,383	11	71.4	5.0	11,343	794	3,988	264
(92-183 m)	70	920	4	21.8	3.4	1,337	209	433	60
	72	1,249	4	13.8	1.6	9,476	133	4,862	70
	76	1,478	7	5.6	0.8	552	79	264	36
	77	1,232	8	230.1	20.1	18,899	1,651	9,482	1,250
	81	1,875	6	8.0	0.9	1,000	112	370	37
Total			65	49.8	4.4	48,885	3,667	11,689	1,299
	46	491	3	0.7	0.1	23	3	22	3
	51	147	1	0	0.0	0	0	0	0
	52	345	4	5.3	0.7	122	16	98	1
	61	1,154	5	41.0	7.4	3,154	572	1,304	230
100-200 faths	66	226	7	44.6	7.9	672	119	309	60
(184-366 m)	71	1,004	7	1.9	0.4	127	27	37	9
	78	283	6	25.2	3.8	475	71	205	30
	82	1,042	4	8.5	1.4	590	97	151	29
Total			37	19.9	3.4	5,163	905	1,368	241
Overall			102	39.0	4.0	54,048	4,572	11,769	1,321

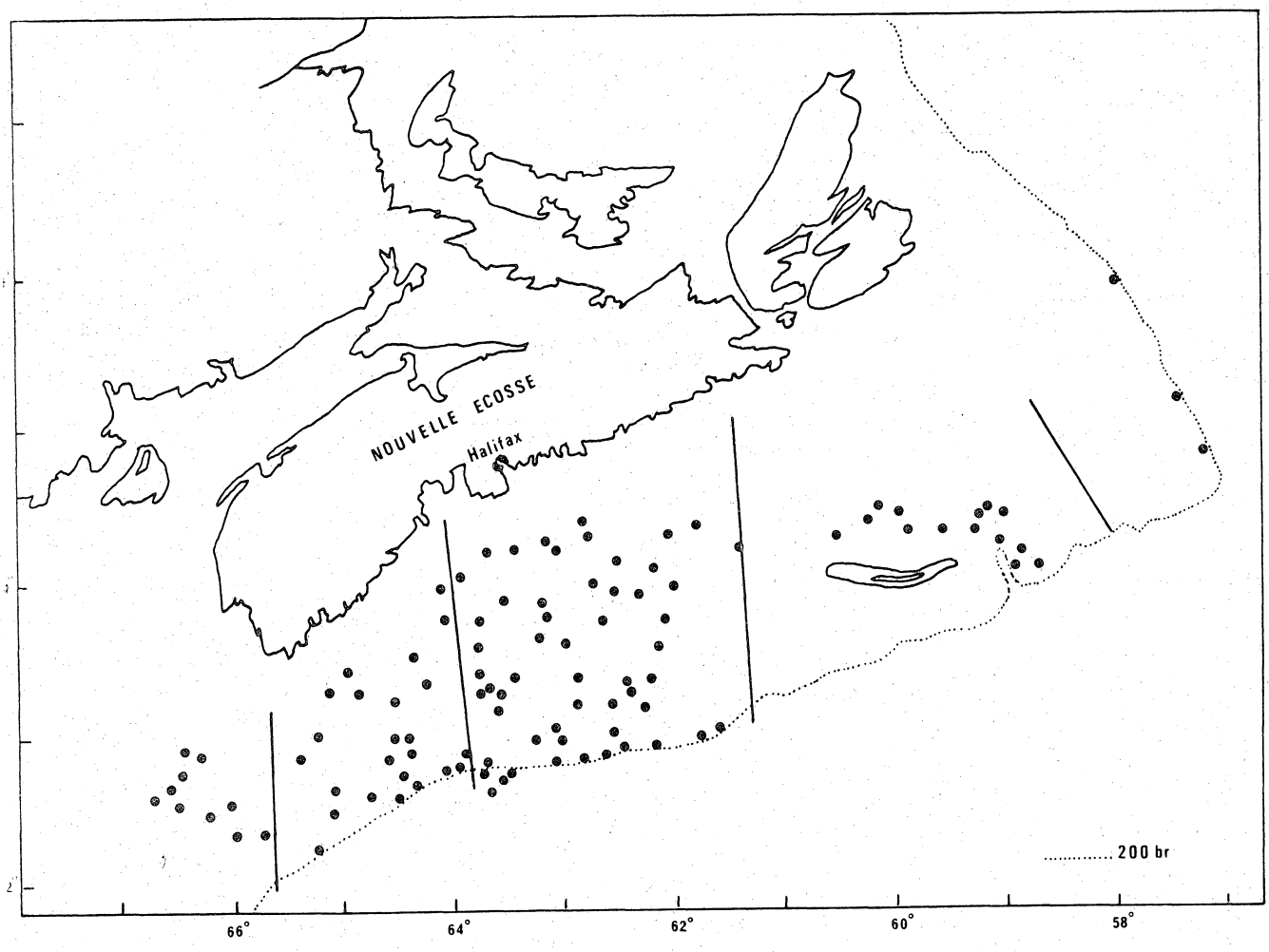

Figure 1 - Sampling strata and position of stations occupied during R/V Cryos survey (in N.A.F.O. Div. 4 V W X) (Aug. 18 - Sept. 21, 1982).

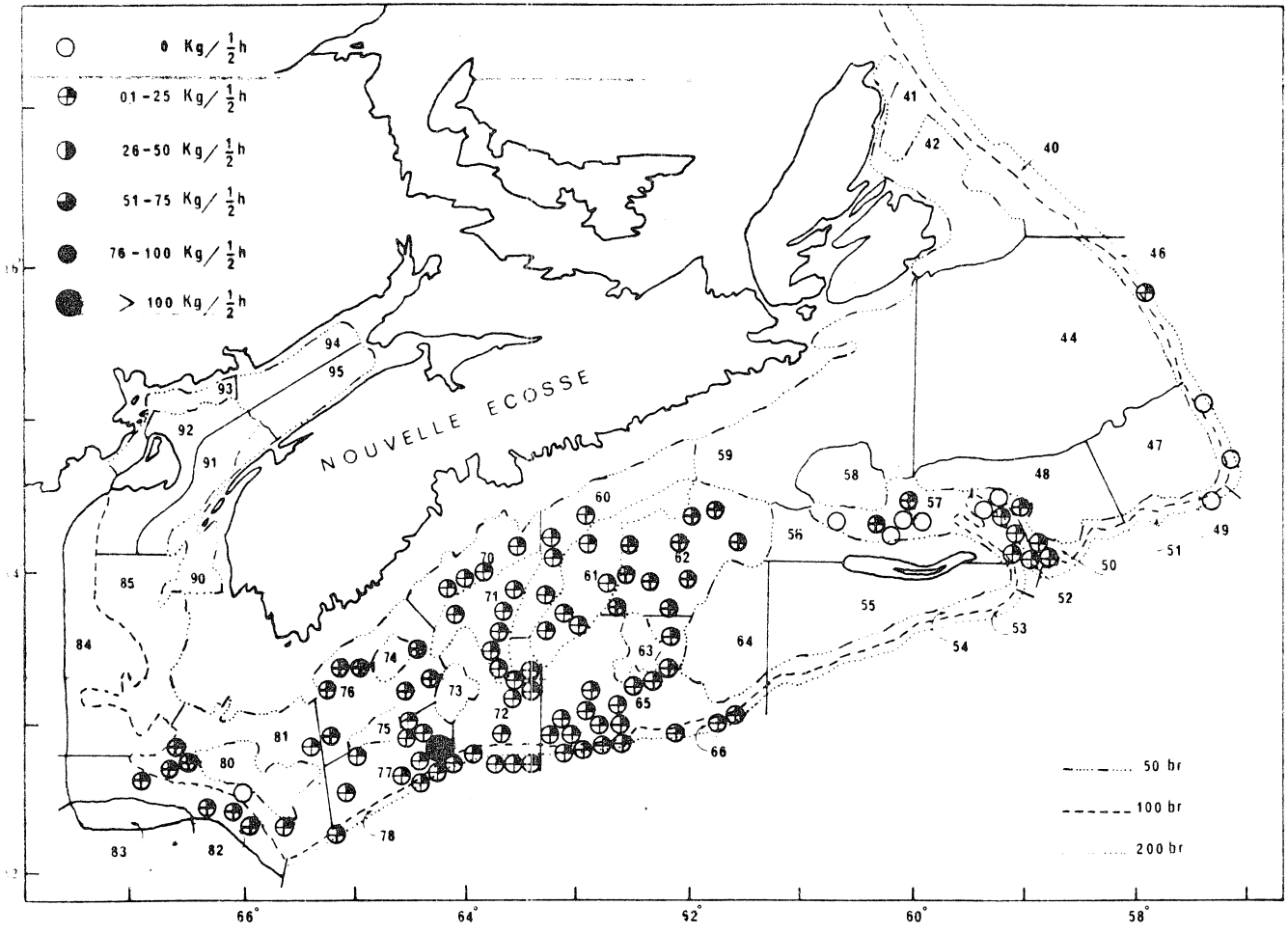

Figure 2 - Distribution and yield of squid, Illex illecebrosus, on Scotian shelf - R/V Cryos (Aug. 18 - Sept. 21, 1982).

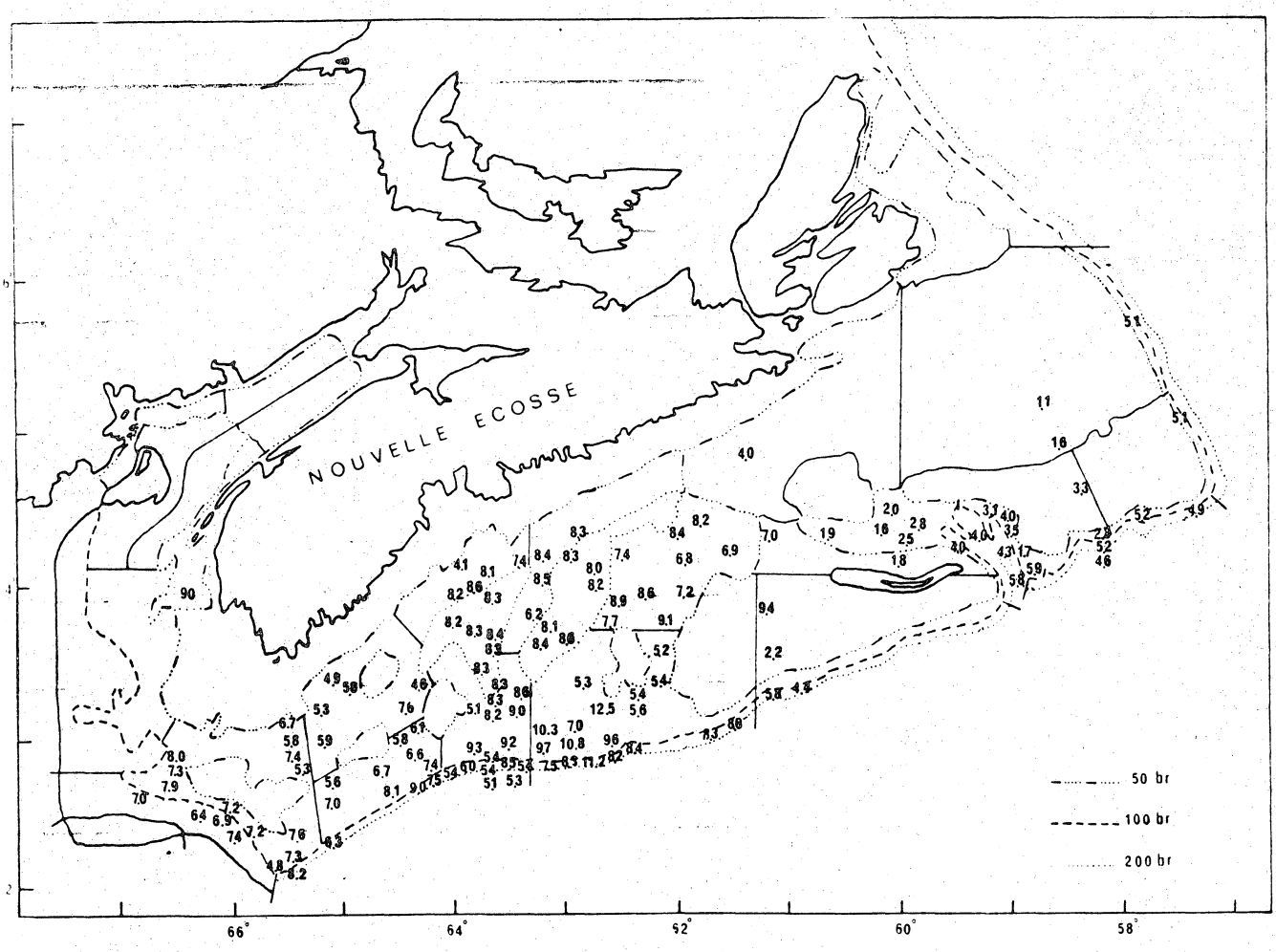

Figure 3 - Bottom temperatures registred on Scotian shelf during R/V Cryos survey (Aug. 18 - Sept. 21, 1982).

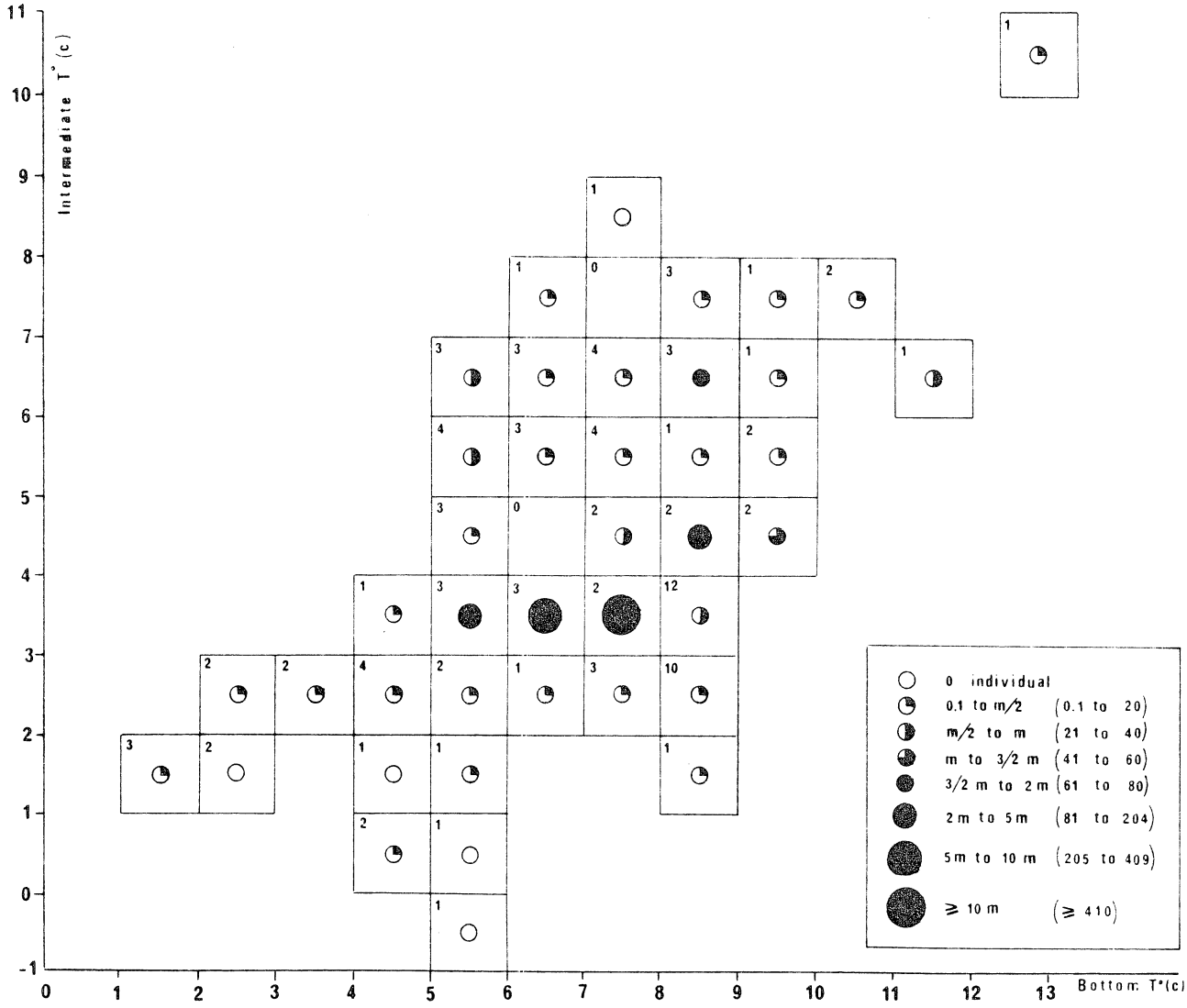

Figure 4 - Mean catch rate of Illex illecebrosus (in number per 30 minutes) related to bottom and intermediate temperatures : the number of tows is indicated in each block of 1°C x 1°C and m represents the weighted mean of individuals caught in 30 minutes tow calculated to 41 individuals for the 1982 survey.

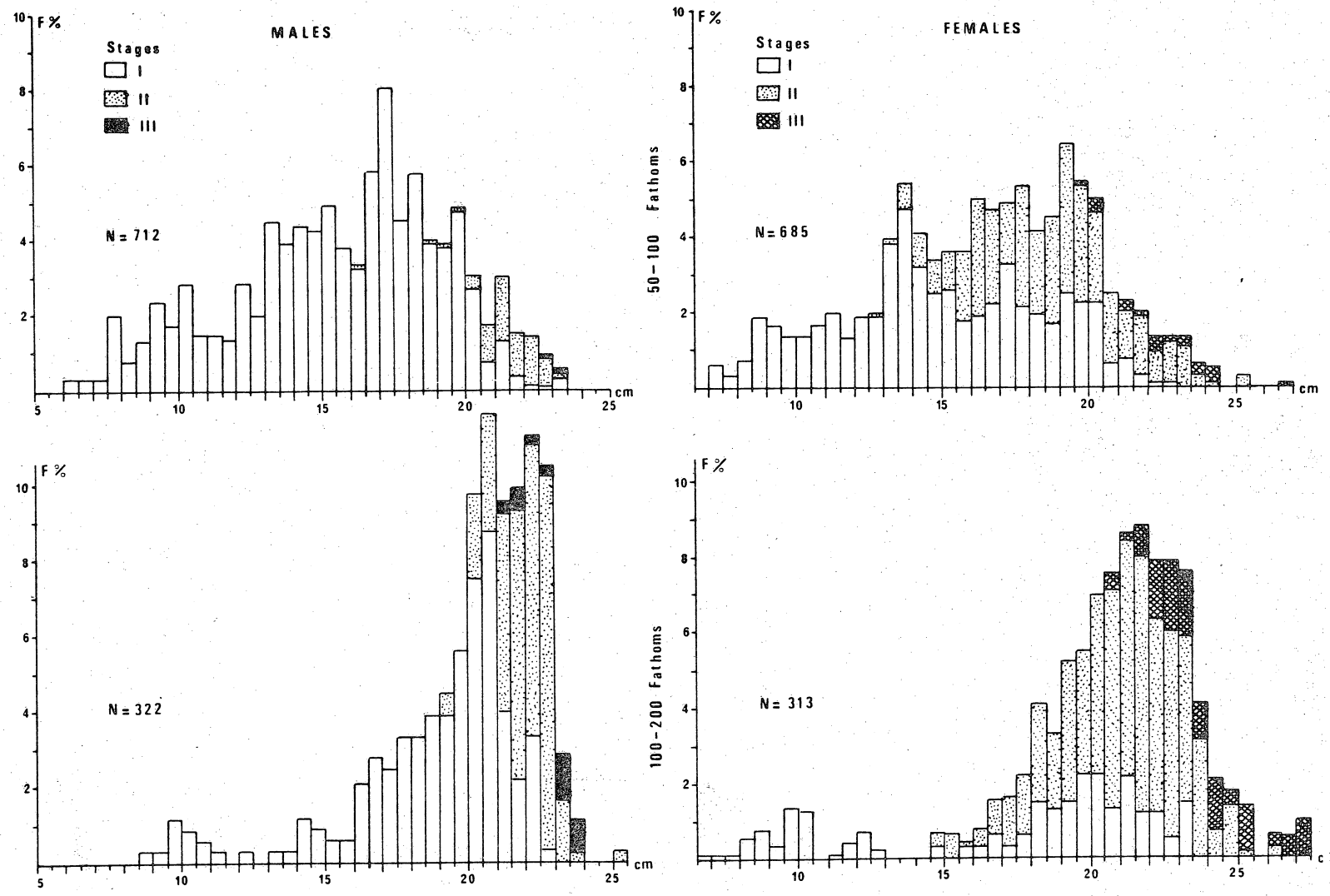

Figure 5 - Length frequency distributions by sex and maturity stages for Illex illecebrosus - R/V Cryos survey (Aug. 18 - Sept. 21, 1982).

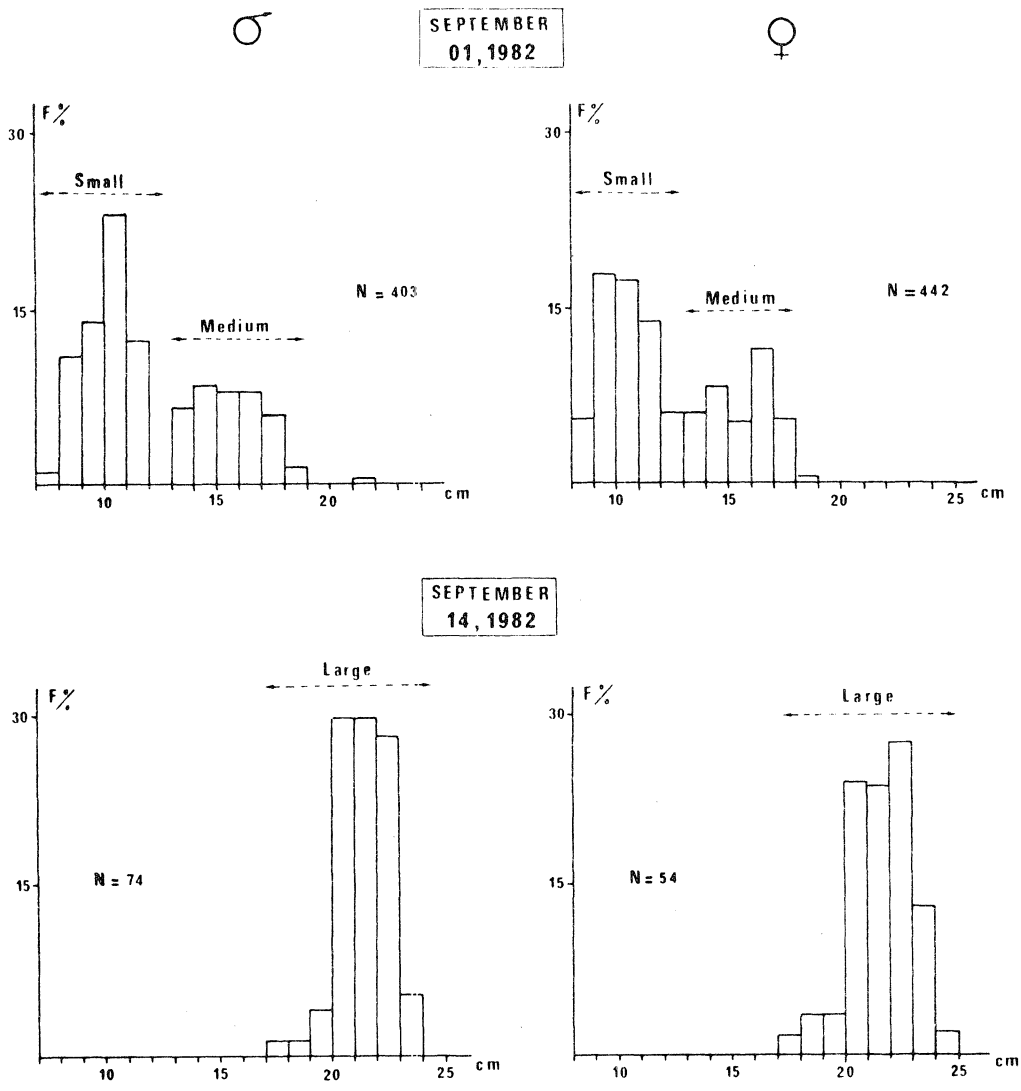

Figure 6 - Length frequency distributions by sex for selected tows in stratum 77 (top) and 66 (bottom) showing the three components of the population (small, medium and large).

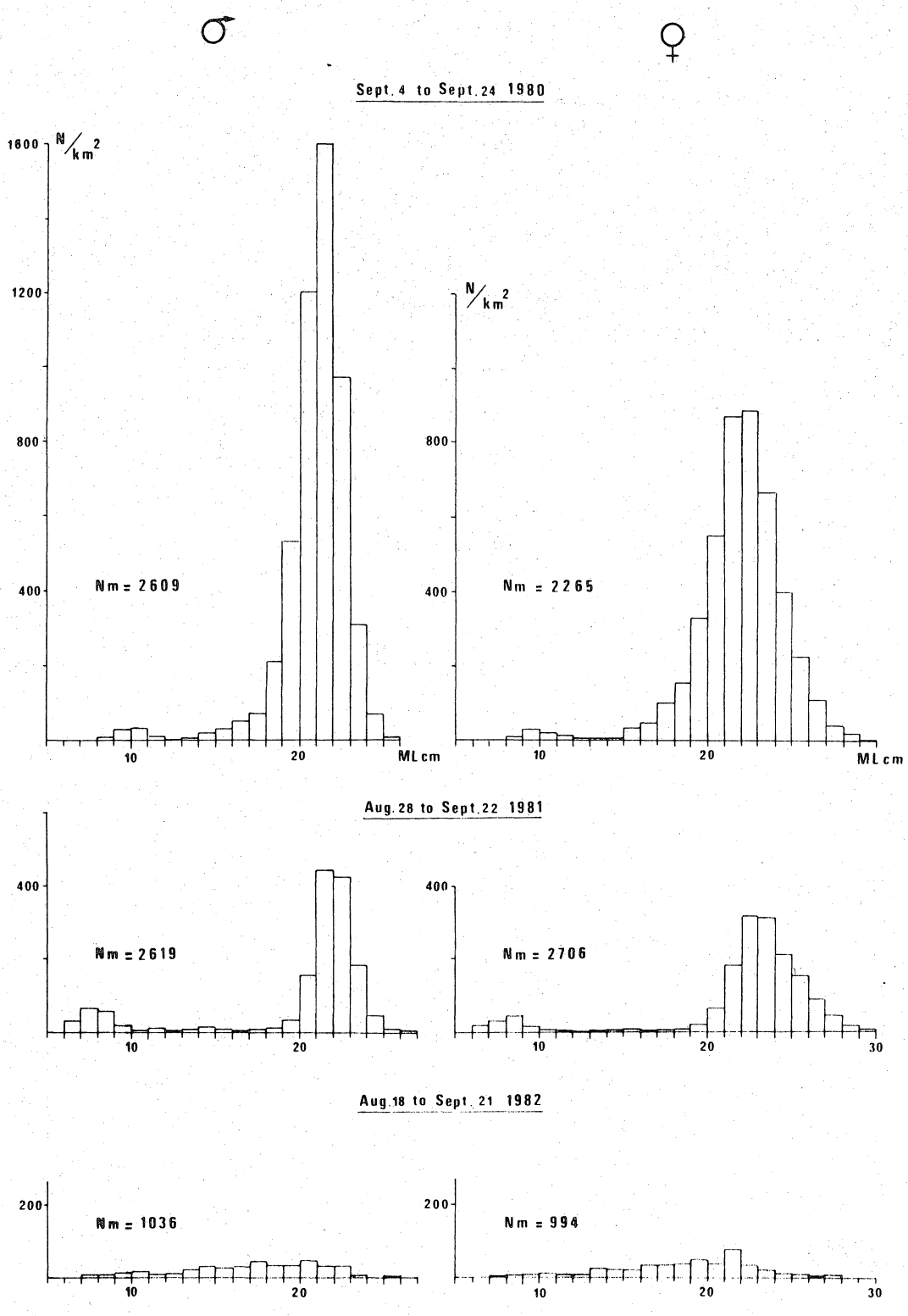

Figure 7 - Review of the weighted distribution in number of squid per km² caught during 1980-1982 surveys.