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Preliminary observations on commercial squids (*Loligo pealei* LeSueur and *Illex illecebrosus* LeSueur)  
on Georges Bank - R/V *Cryos cruiss*, September-October 1973

by

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INTRODUCTION

A trawl survey was carried out by R/V *Cryos* in ICNAF Subarea 5 from 3-9 September and 3-10 October 1973. We present here preliminary results obtained from the samples of the two commercial squids, *Loligo pealei* and *Illex illecebrosus*, which are found on Georges Bank at this time of year. This study was motivated by the increasing interest in exploiting the stocks of these species. ICNAF fishery statistics for 1970, 1971 and 1972 show that fishing effort is being intensified and that squid landings continue to increase.

MATERIAL AND METHODS

We have used the same strata in the survey area as were used in US and USSR sampling surveys. Trawling was made according to the accepted technique for these surveys (Grosslein, 1969). The strata were delimited by the following isobaths:

- Less than 50 m for strata 19 and 20
- From 50 to 110 m for strata 13, 16, 21 and 23
- From 110 to 180 m for strata 14, 17, 22 and 24
- From 180 to 360 m for strata 15 and 18 (Fig. 1).

Trawl hauls of 30-minute duration were made by bottom trawls of the Lofoten type (31.20-17.70). Each haul was followed by a BT cast which gave the thermic profile at the station.

The data on yield in kg/half-hour, size distribution and sex ratio are analyzed here. The same procedure was followed for both species. The squids were weighed and sexed and the mantle length (Lm) measured to the nearest half-centimeter. According to analytical needs, the measurements could be regrouped as necessary to the nearest centimeter.

RESULTS

Hydrography

We considered only the bottom temperatures, that is, those at the trawl level.

The warmest waters are found on the shelf, the temperatures being between 15° and 17°C. To the north and south, the 12° isotherm encircles the bank approximately at the level of the edge of the slope. Descending to the north of Georges Bank and the Gulf of Maine, a lobe of colder waters (10-11°C) intermixes in the 12° layer of water south of the bank. Penetration towards the west-southwest of this colder lobe is made following the general direction of the currents (Bumpus, 1960). Finally, there is an overflow of cold, sometimes close to 6°C, waters on the bottom of the slope (Fig. 2).

Study of the Stocks

Yield

Generally, catches were small: 0.1 to 65 kg/half-hour for *Loligo pealei* and 0.1 to 378 kg/half-hour for *Illex illecebrosus*. Only strata 18 can be considered commercially productive, 390.5 kg for 1-1/2 hours fishing time. The global results are given in Fig. 3.

The detailed distribution of each species shows significant differences.

The whole of the southern part of Georges Bank is occupied by *Loligo pealei*. No individual was captured north of 41°30' lat (Fig. 4). Inside the distribution area, the yield is distributed on a east-west axis. The greatest values are found in the western part of the survey area, between the 40- and 90-m isobaths and sometimes below (strata 14). The best captures did not surpass 65 kg/half-hour. The results are given by strata as follows:

Strata 19	- 95.3 kg	for 3 hrs 30 min	fishing time		
" 20	- 0 kg	" 1 hr 00 min	" "	" "	" "
" 13	- 53.5 kg	" 2 hrs 00 min	" "	" "	" "
" 16	- 1.7 kg	" 6 hrs 00 min	" "	" "	" "
" 21	- 0 kg	" 2 hrs 00 min	" "	" "	" "
" 23	- 4.0 kg	" 1 hr 30 min	" "	" "	" "
" 14	- 64.5 kg	" 2 hrs 30 min	" "	" "	" "
" 17	- 8.0 kg	" 2 hrs 30 min	" "	" "	" "
" 22	- 0 kg	" 2 hrs 30 min	" "	" "	" "
" 24	- 0 kg	" 3 hrs 00 min	" "	" "	" "
" 15	- 0.5 kg	" 0 hrs 30 min	" "	" "	" "
" 18	- 2.0 kg	" 1 hr 30 min	" "	" "	" "

We have tried to establish a relationship between the yields on the one hand, depth and bottom temperature on the other, these being two of the factors studied. We have already stated that the majority of the good captures were made between the 40 to 90-m depths. In any case, the relationship, yield to depth, does not appear to be evident. Strata 16 delimited by the same depths as strata 13 was much less productive than the latter. On the other hand, the yield was equivalent to or even greater than at strata 14 (110-180 m).

At this stage, temperature does not seem to have a great influence. However, the *Loligo pealei* are not found, or very little, in waters of temperatures lower than 12°C. This could explain their absence in sections north and east of Georges Bank. At positive stations, we have found an average correlation: correlation coefficient,  $r = 0.44$ , with a regression line equation of type  $Y = bx + a$ ;  $R = 3.74 T - 36.78$  ( $R = \text{yield}$ ,  $T = \text{temperature}$ ).

*Illex illecebrosus* are found on the whole of Georges Bank (Fig. 5). The yields are variable according to strata. The areas on the north and south slopes of the bank seem richer than those on the shelf where the yields rarely surpassed 1 kg/half-hour. Results are given by strata as follows:

Strata 19	- 29.4 kg	for 3 hrs 30 min	fishing time		
" 20	- 94.1 kg	" 1 hr 00 min	" "	" "	" "
" 13	- 2.5 kg	" 2 hrs 00 min	" "	" "	" "
" 16	- 51.2 kg	" 6 hrs 00 min	" "	" "	" "
" 21	- 25.5 kg	" 2 hrs 00 min	" "	" "	" "
" 23	- 2.4 kg	" 1 hr 30 min	" "	" "	" "
" 14	- 6.6 kg	" 2 hrs 30 min	" "	" "	" "
" 17	- 8.9 kg	" 2 hrs 30 min	" "	" "	" "
" 22	- 30.8 kg	" 2 hrs 30 min	" "	" "	" "
" 24	- 7.2 kg	" 3 hrs 00 min	" "	" "	" "
" 15	- 24.5 kg	" 0 hrs 30 min	" "	" "	" "
" 18	- 388.5 kg	" 1 hr 30 min	" "	" "	" "

It should be noted that the greater densities of *Illex illecebrosus* are mainly found in the northern part of Georges Bank and the smallest densities in the areas where there are *Loligo pealei*. Similarly, as for the latter, there is no clear relationship between the depth of the trawl hauls and the quantities fished, although the largest haul (278 kg/half-hour) was made at 238 m. The temperature does not particularly influence the majority of the relatively important captures which were made in waters of temperatures varying from 7 to 14°C.

#### Size distribution

The distribution of length frequencies of *Loligo pealei* varies in that there is a decrease of large size classes according to depth. In considering all strata, the averages fluctuate between 10.13 and 12.40 cm (Fig. 6). These averages also vary according to sexes, the males being larger than the females (Table 1). The inverse relationship found with bathymetry is good since the correlation coefficient  $r = 0.72$ , and the regression line equation is  $L_m = -0.02 P + 13.15$  ( $L_m = \text{average mantle length}$ ,  $P = \text{depth}$ ). This is contrary to observations by Mercer (1969) for spring *Loligo pealei*.

No temperature-average length relationship could be shown.

The variability index from the samples ( $V = 100\sigma/\bar{x}$ ), being between 15.1 and 90.8% according to strata is often more than 50%. The high values of this index indicate heterogeneity of the samples, probably in relation to size distribution.

The situation is different for *Illex illecebrosus*. The average mantle lengths vary from 18.55 to 22.50 cm (Fig. 7) and the differences between sexes, the female being larger than the males, are minor (Table 2). The average size of the samples increases with depth, the correlation otherwise being excellent,  $r = 0.93$ , and the regression line equation being  $L_m = 0.01 P + 17.98$ . The size-depth correlation causes an inverse size-temperature correlation,  $r = -0.71$ ,  $L_m = -0.25 T + 22.74$ .

The homogeneity of the samples is relatively good, their variability being small, and the extreme values of the index vary from 6.3 to 16.6%. The unimportant size distribution can only be seen in strata of shallow depths.

#### Sexual dimorphism and sex ratio

Sexual dimorphism always clearly appears for both species, either in size groups or sampling strata (Tables 1 and 2). On the average, males are larger than females in the *Loligo pealei* species (Summers, 1968), the opposite occurring in the *Illex illecebrosus* species (Squires, 1967; Mercer, 1965).

On the other hand, both sexes are more or less equally distributed and in almost all cases, the sex ratio is approximately 1:1. For a 10% probability limit, the  $\chi^2$  tests do not show significant differences for either species ( $p < 0.1$ ).

### DISCUSSION AND CONCLUSION

Variations in the yields obtained can have two primary causes. On the one hand, the selectivity of the trawl type used, and on the other hand, the average size of the squids and their irregular distribution in the fishing areas. It is not impossible for a great portion of the small individuals, especially *Loligo pealei*, to escape from the trawl because of their small size. Nor is it impossible for *Illex illecebrosus* and *Loligo pealei* to have a vertical distribution of a weak enough density not to be detected but to be more or less uniform in the whole area. Because of this, a great number of animals could not be captured by bottom trawling.

All the data enables a better assessment of the stock composition during the fishing period concerned, that is, the beginning of autumn.

#### Geographic Distribution

At this time, *Loligo pealei* and *Illex illecebrosus* are distributed on the shelves, at least within the geographic limits of each species. This observation agrees with that by Grosslein and Bowman (1973) who indicated a *Loligo pealei* distribution in the autumn, whereas this species is rather concentrated on the slope in the spring.

This is also the case for *Illex illecebrosus* which migrate in the spring in compact groups along the slope of the banks (Hodder, 1964; Mercer, 1973), before spreading on the shelves during the warm season.

#### Size Distribution

Most of the *Loligo pealei* captured have a mantle length of between 8 and 18 cm (mean, 9-10 cm). This group generally consists of immatures with a small proportion of the animals at stages I and II of sexual maturity (Yovk, 1972). In referring to data by Summers (1968, 1971), these *Loligo pealei* would be 1 year old or more (Fig. 8). The other two groups, less than 8 cm and more than 18 cm, are represented by a small number of individuals. *Loligo pealei* more than 18 cm long belong to age group 2 years and older. These are at stages IV and V of sexual maturity and appear to be the remainder of the age groups 2 and 3 years old which seemed to have disappeared after reproduction. The animals less than 8 cm in length would be juveniles spawned during the year.

Most of the *Illex illecebrosus* captured measured between 15 and 25 cm (mean, 19-20 cm). All are mature but still far from spawning. According to data by Squires (1967), they would belong to the category of 1-year-old animals (Fig. 8).

#### Sexual Dimorphism and Sex Ratio

Results confirm the previous data for each species: in *Loligo pealei*, the growth rate is greater with age for males; in *Illex illecebrosus*, the opposite occurs. The sex ratio is approximately 1:1 in both species.

#### Environmental Relationship

This is not noticeable in raw data. On the other hand, bathymetry and temperature which varies according to depth influence size distribution. The relationship was found proportionately opposite for *Loligo pealei* and directly proportional for *Illex illecebrosus*.

In conclusion, stocks of commercial squids consist of animals 1 year or older, immatures for *Loligo pealei*, and matures for *Illex illecebrosus*. In other words, the irregular distribution of the squids on all of Georges Bank, during the period concerned, is not productive enough as far as industrial exploitation is concerned.

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Table 1. Comparison of mantle length frequencies from different strata for *Loligo pealei*.

Strata	S. 13		S. 14		S. 16		S. 17		S. 19		S. 23	
Mantle length: (cm)	M	F	M	F	M	F	M	F	M	F	M	F
5									2			
6		1				1			18	5		
7	1	8	3	1					12	5		3
8	6	17	20	27	1	3			9	12	6	3
9	10	21	79	67	4	7			26	31	5	7
10	23	28	54	46	7	4	5	4	32	32	8	6
11	16	27	27	30	4	4	25	20	13	17	6	9
12	37	42	24	23	7	6	32	30	6	4	3	6
13	52	39	22	14	4	3	16	19	9	3	5	1
14	41	27	3	2	5	1	2	5	14	13	1	1
15	17	12	1	1			2		13	19		3
16	8	1		2	1		2		10	13		
17	7	5				1			8	7	2	1
18	3	1		1					9	12	4	1
19	2	2							2	2		1
20	3	2							2	3		1
21	5										1	
22	1	1										
23									2			
24												
25									1			
26									1			
27									1			
28					1				3			
29												
30									1			
31									1			
Number of squid	232	234	233	214	34	30	86	87	195	178	41	43
Average mantle length cm	12.808	11.504	9.873	9.869	11.720	10.450	11.773	11.557	11.825	11.794	11.512	11.081
Variance	7.268	6.729	2.426	2.946	11.623	4.920	2.016	1.391	25.794	12.676	11.548	9.413
SD	2.695	2.594	1.557	1.716	3.409	2.218	1.419	1.179	5.078	3.560	3.398	3.068
SE	0.177	0.169	0.102	0.117	0.593	0.411	0.153	0.127	0.364	0.267	0.537	0.473

Table 2. Comparison of mantle length frequencies from different strata for *Illex illecebrosus*.

Strata	St. 13		St. 14		St. 15		St. 16		St. 17		St. 18		St. 19		St. 20		St. 21		St. 22		St. 24		
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
Mantle length (cm)																							
7																		1					
8																							
9							1											1					
10							2																
11							1																
12	1	1					1							2									
13							2							1									
14							3							2									
15	1						4							1									
16							1							1									
17		1					17	8						1									
18							9	4						4									
19	1	1					14	10						25	16								
20	4	3					16	14						21	16								
21							26	19						9	8								
22							24	20						4	5								
23							17	20						5	1								
24							6	14						1	1								
25							1	3						1	1								
26							2	4						2	1								
27								3							1								
28								2							3								
29								2							1								
Number of squid	7	12	11	9	6	8	139	130	27	25	231	249	70	57	144	136	101	94	49	57	12	12	
Average mantle length cm	17.785	19.500	19.454	20.944	21.916	22.500	18.906	20.150	19.000	19.740	20.435	21.431	17.928	18.710	18.236	18.485	18.252	19.186	18.755	19.745	19.916	20.833	
Variance	10.268	8.681	2.246	2.986	0.976	3.142	6.767	10.661	10.846	10.253	2.035	2.595	4.030	6.510	1.487	1.325	4.366	4.867	3.609	4.222	5.930	6.576	
Standard deviation SD	3.204	2.946	1.498	1.728	0.987	1.772	2.601	3.265	3.293	3.202	1.426	1.612	2.007	2.551	1.219	1.151	2.089	2.206	1.899	2.054	2.435	2.564	
Standard error SE	1.308	0.888	0.473	0.611	0.441	0.659	0.221	0.287	0.645	0.653	0.094	0.102	0.241	0.340	0.101	0.099	0.208	0.228	0.274	0.274	0.734	0.773	

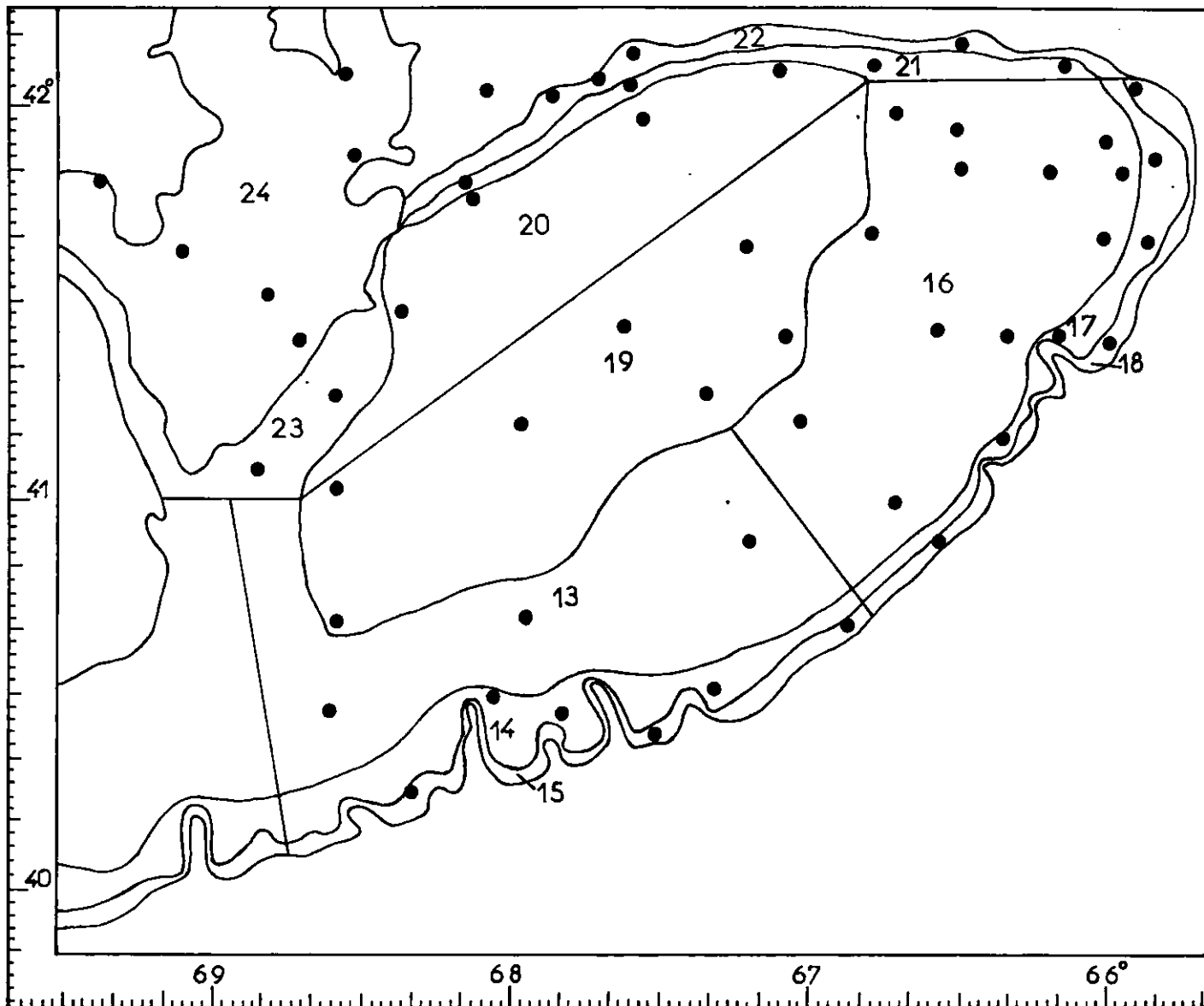


Fig. 1. Sampling strata and positions of trawling and hydrographic stations occupied by R/V Cryos, September-October 1973.

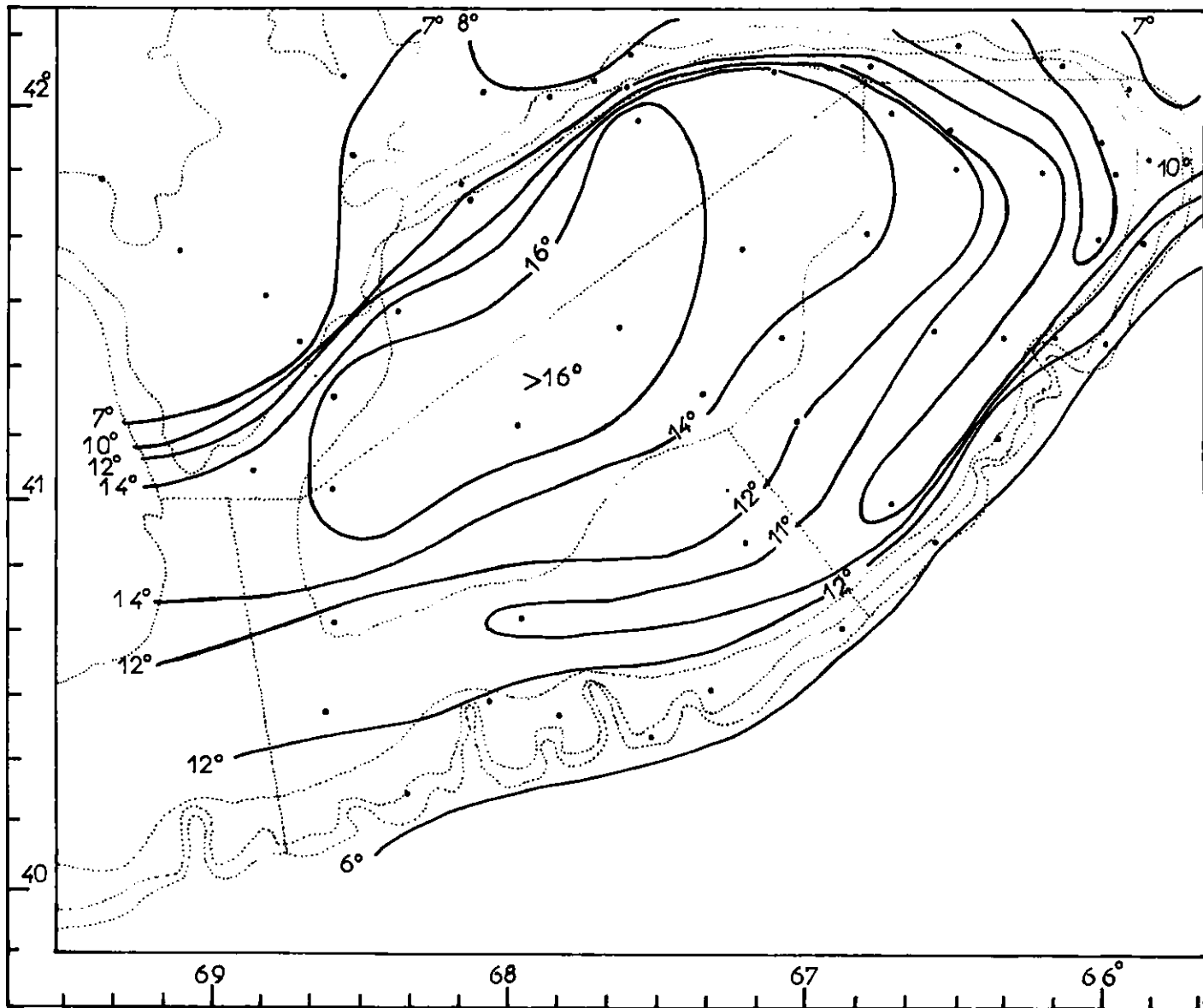


Fig. 2. Distribution of bottom temperatures.



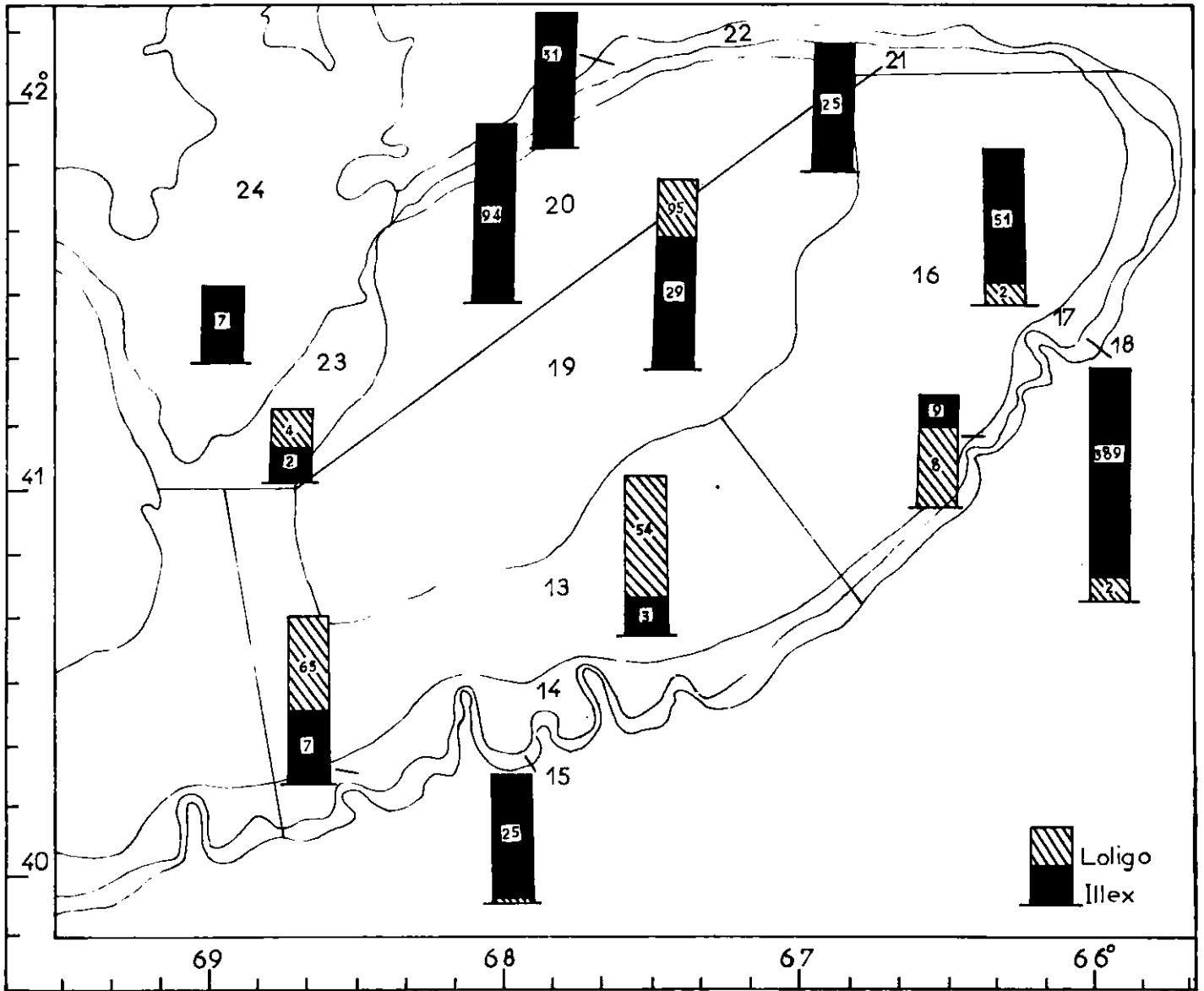


Fig. 3. Comparative catches by strata for *Loligo pealei* and *Illex illecebrosus* (logarithmic data).

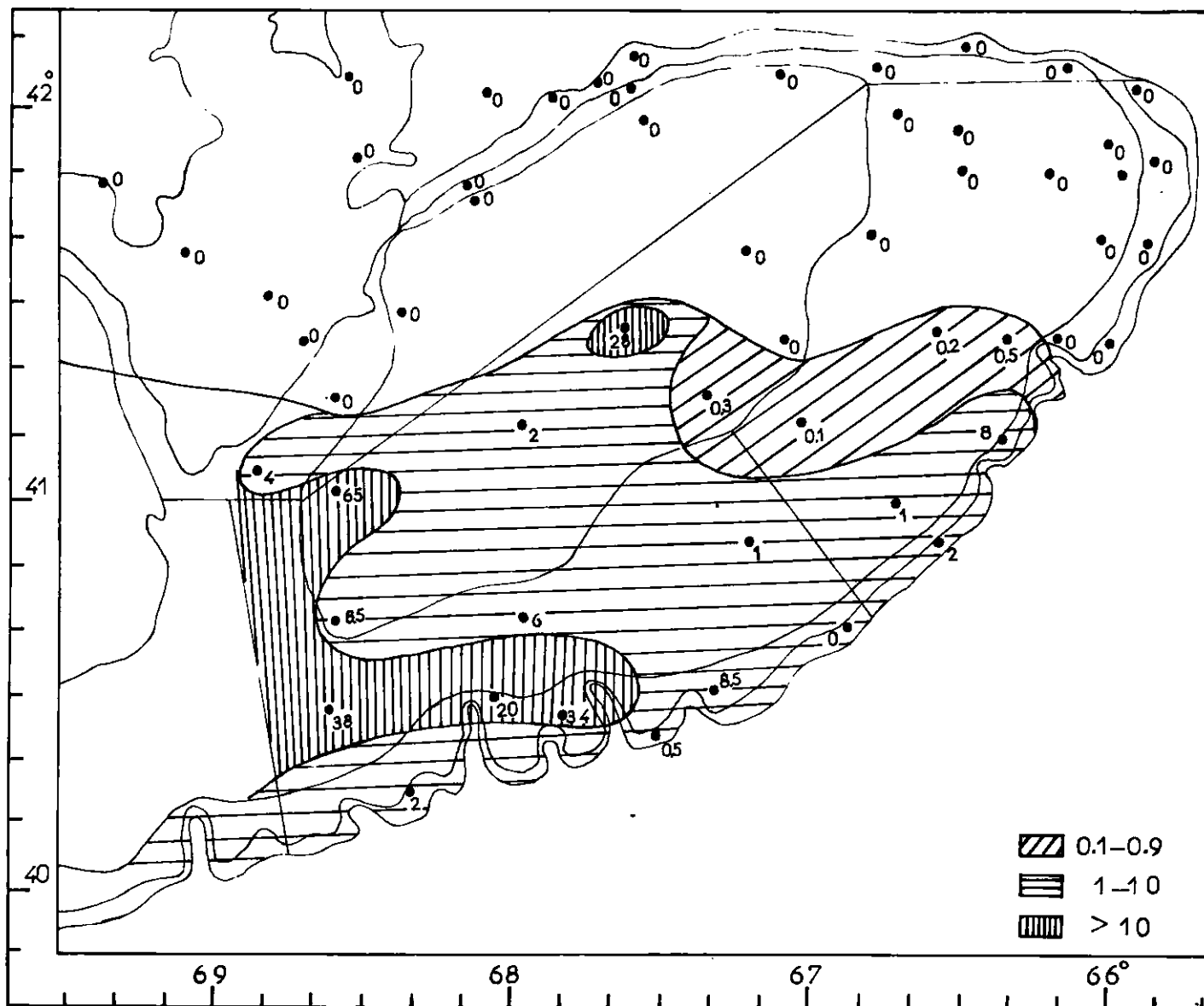


Fig. 4. Distribution of *Loligo pealei* and catches by station (kg/half hour).

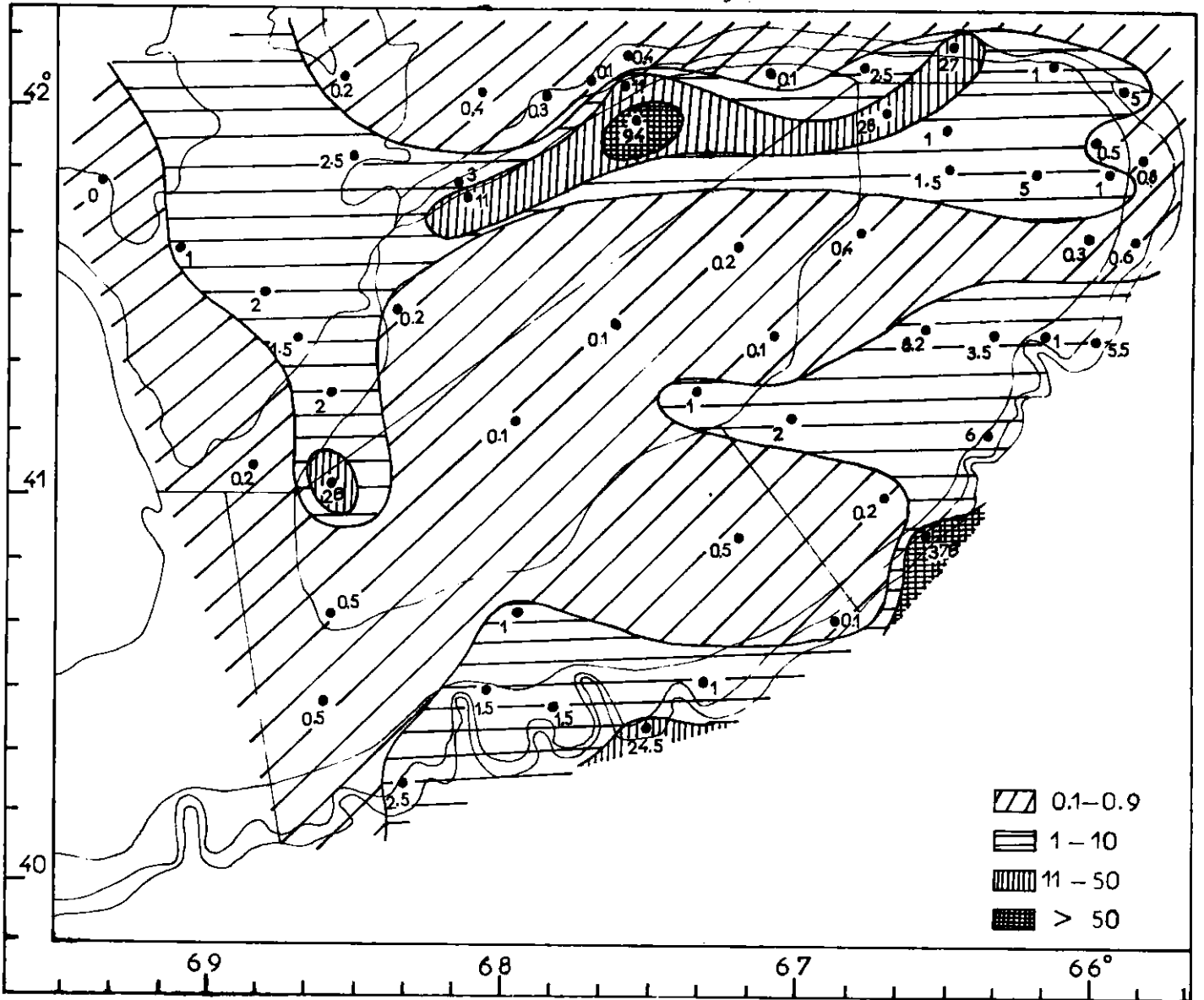


Fig. 5. Distribution of *Illex illecebrosus* and catches by station (kg/half hour).

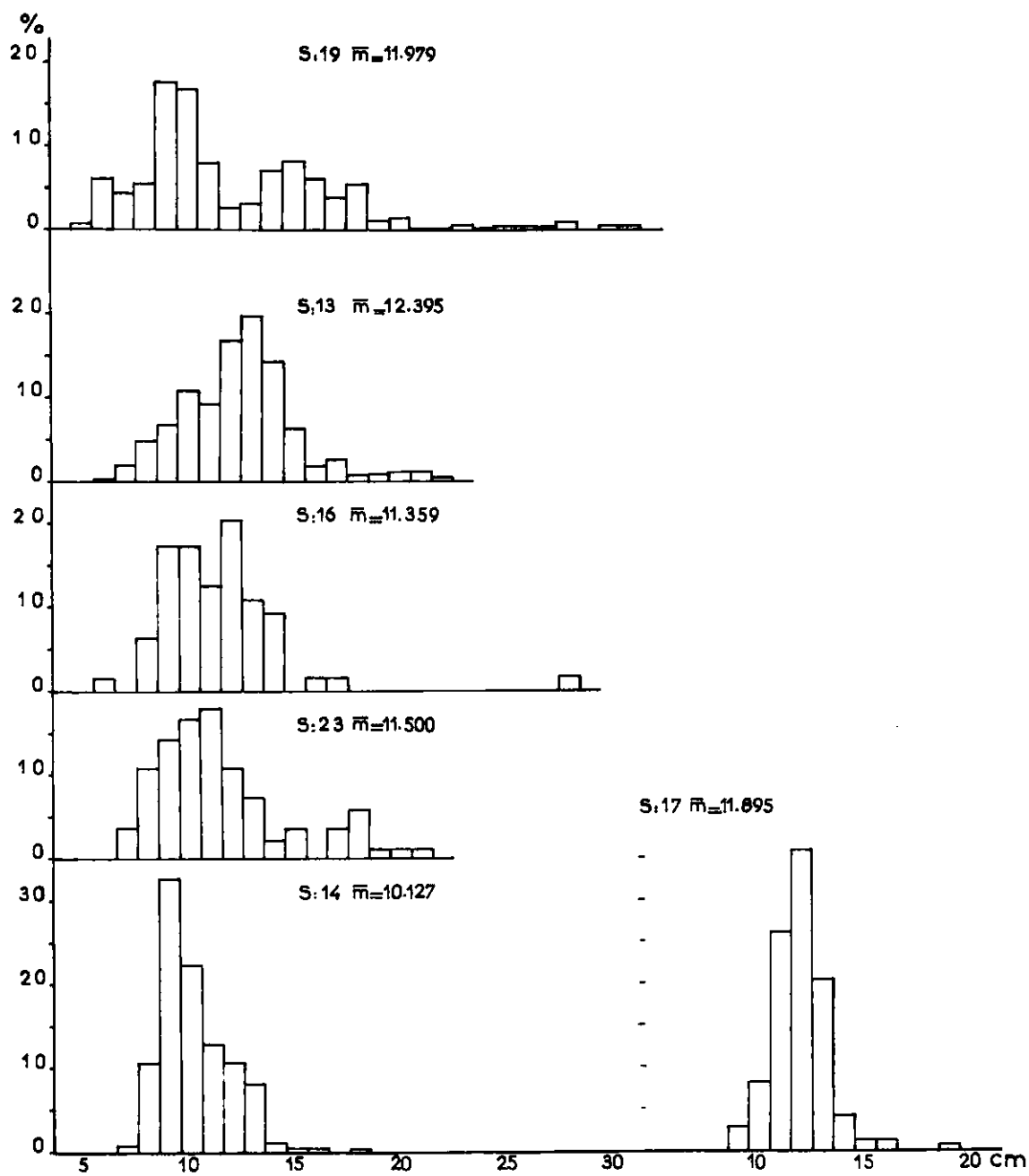


Fig. 6. Loligo pealei: distribution of length frequencies in each stratum.

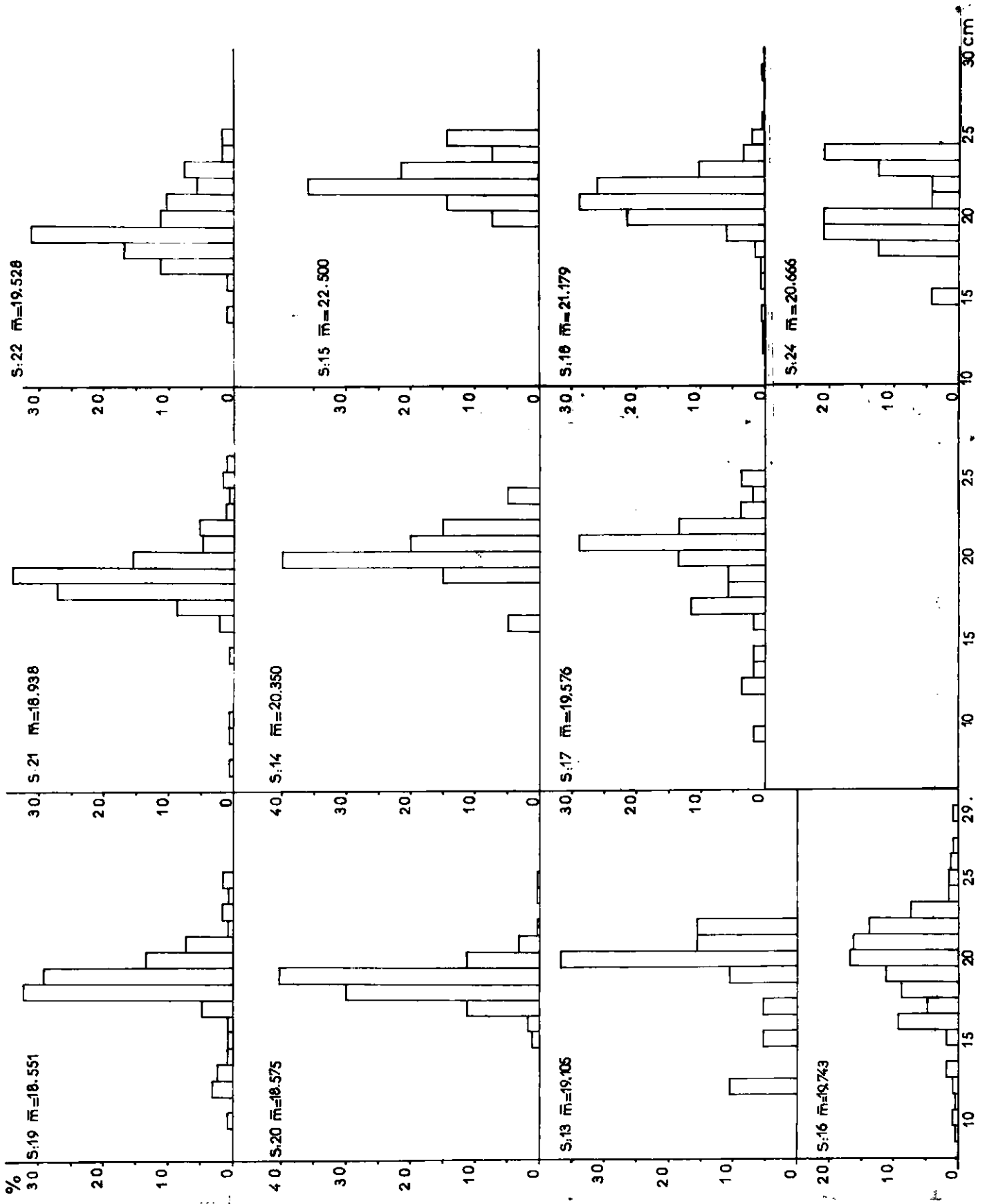


Fig. 7. *Illex illecebrosus*: distribution of length frequencies in each stratum.

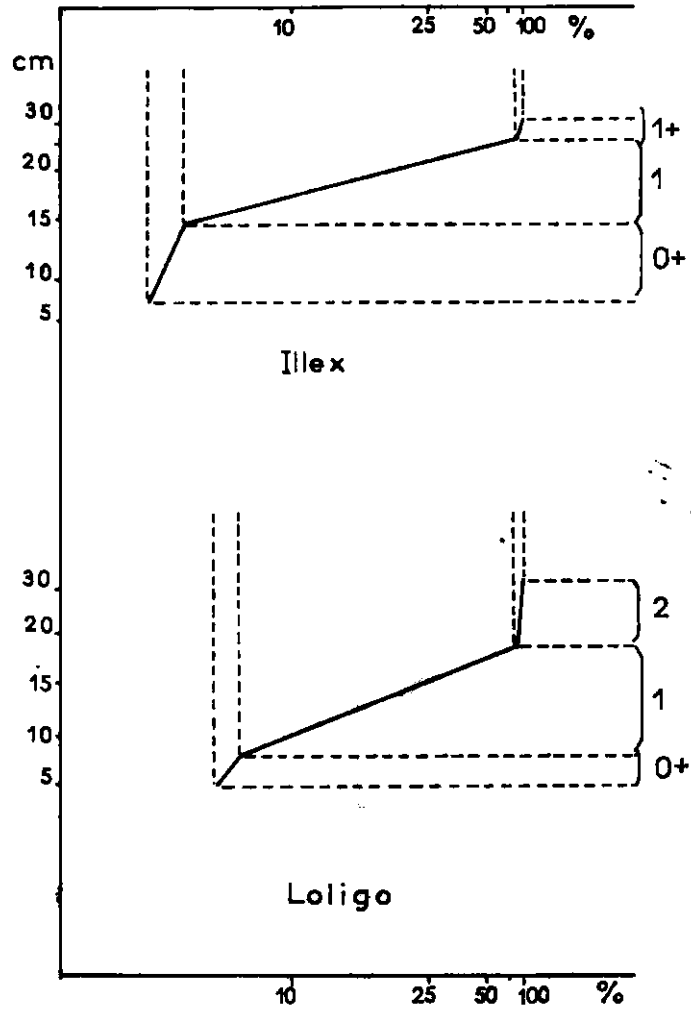


Fig. 8. Hypothetical age of Illex and Loligo. Lognormal presentation of the data.