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Age and growth of common American squid (*Loligo*) estimated from size composition

by

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Since, among other animals of Cephlopods, there is no clue to determine age of Loligo, a attempt was made in this paper to breakdown the catch into different age on the basis of size-composition.
Size composition of the catch by sex were brokendown into a portion of normal curve and the residue and probable growth equation was estimated from these two separated groups.

The squid fishery in Subarea 5 and Statistical Area 6 are operated during winter and early spring when squid migrate into the slope water. It is assumed, on the basis of change in CPUE values during fishing season, that squid imigrate to the fishing grounds in the first half of the season and emigrate to the coastal waters in the latter half. It is, therefore, difficult to observe successive change of the modes or mean in length composition because of considerable extent of incoming and outgoing groups.

SIZE COMPOSITION BY FISHING SEASON

Loligo caught by Japanese trawlers are classified aboard vessels into several size categories which were discribed by Ikeda et al. (ICNAF Redbook 1973, Part III, p.151), together with length composition by categories.

Catch in weight by size categories is easily converted to number of squid on the basis of the key table which shows the length and weight composition of each size category. The length composition and mean weight per individual, thus calculated, for each fishing season from 1968/69 to 1973/74 are given in Table 1.

SIZE COMPOSITION BY SEXES

From the observation by seientists aboard trawlers engaged in squid fishery, it is indicated that sex ratio, defined as percentage of number of female to the total, in each length class, generelly decrease with the increase of length. The decrease of sex ratio by size is greater in 22-23 cm class and no female is observed in the length of over 28 cm. This is shown in Table 2.

It is assumed that those differences of the sex ratio by size are originated from difference in growth and/or in mortality by sex. The length composition for each fishing season. therefore, should be treated separately by sex. The results are shown in Figs. 1 and 2, as accumulative frequency distribution made on the normal probability paper, for each sex.

It appears that all curves shown in Figures 1 and 2 are more or less convex. Departure from normal curve in small size will be caused by mesh selectivity. Departure in large size which is apparently greater in male than in female, probably implies another year class.

BREAKDOWN OF LENGTH COMPOSITION

Parameters of main normal curve for size composition are calculated from the frequencies between 12 and 16 cm. taking into consideration of deformation caused by emsh selectivity using the method of normal probability paper. The results are shown in Table 3 together with assumed retention rate. percentage of frequency in size composition to that in fitted normal curve, in mantle length of 7's cm. It is estimated that the mantle length of 7's cm is corresponding with the length of 50 percent retention on the condition of the mesh size used in ICNAF and the selection factor for Loligo in CECAF Waters.

As was mentioned in Table 3, assumed retention rate at 7's cm approximately agrees with the calculated value from mesh size currently in use and selction factor.

The residual part in size composition of larger ones from the fitted normal curve is shown in fig. 3 in the case of male by fishing season. Figure 4 indicates average frequency distribution of the residual part of squid by sex.

GROWTH CURVE

There are two groups to be estimated from breakdown of size composition. One is the most abundant in the catch with 11.5-13.3 cm for male and 10.5-12.6 cm for female in average mantle length. And other is minor part in the catch, say, 3.2 per cent for male and 1.2 per cent for female, with the average length of 24 cm for male.

Supposing that the two groups are corresponding to different age, and refering that growth of some squids in the Atlantic are in range from 14 to 20 cm at their first full age, it is assumed that the main group in catch is of 0-age and the second group is of 1-age. The mean mantle length of 12.5 and 24.0 cm for the respective group correspond to ages of 0.67 and 1.67. It is, therefore, assumed that growth of the squid starts at the first of June and most of the catch with the above mean values in mantle length must be taken in January.

Growth equation was calculated from the two sets of mean length and age for male as follows:

$$L = 38.3(1-e^{-0.59t}),$$

where L is mean mantle length at t-age in cm and t is age beginning on 1,June, in year.

Relation of age, month and the length for male are shown in Table 4. Growth of the female squid is smaller than that of the male by about 5 per cent of male's one.

As was mentioned above, survival into one year old and over is estimated to be negligible for stock assessment purpose.

Table 1

Size compositions of common American squid in Subareas 5 and 6 estimated from the catch composition by marcket size categories.

Mantle Length in cm	Fishing Season					
	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74
4		0	0	0	0	0
5	0	0	2	2	3	3
6	3	3	9	9	13	12
7	13	12	25	25	38	33
8	37	32	50	47	77	62
9	77	68	79	69	116	89
10	117	105	105	84	137	104
11	141	132	126	97	137	110
12	143	142	137	106	122	112
13	128	135	131	109	102	108
14	100	113	108	103	78	97
15	71	86	80	90	55	82
16	48	62	56	74	39	64
17	31	39	37	56	27	45
18	18	22	22	40	17	29
19	12	12	13	30	11	18
20	11	8	8	22	8	11
21	12	8	5	12	5	8
22	11	7	3	9	4	5
23	10	6	2	5	3	3
24	7	4	1	3	2	2
25	4	2	1	2	1	1
26	2	1	0	1	1	1
27	1	0	0	0	1	1
28	1	0	0	0	1	0
29	0	0	0	0	1	0
30	0	0			0	0
31	0	0			0	0
32	0	0			0	0
33	0	0			0	0
34	0	0			0	0
35	0				0	
36					0	
Total in permillage	998	999	1,000	998	999	1,000
Mean weight per individual in g	71	70	65	77	59	68

Table 2
Sex ratio for each size of common American squid in Subareas 5 and 6 in 1972/73 and 1973/74 fishing seasons.

Mantle Length in cm	1972/73			1973/74			Combined
	Total	Female	Sex ratio	Total	Female	Sex ratio	Sex ratio
3				2	2	1,000	1,000
4				4	2	500	500
5	3	1	333	17	12	706	650
6	19	9	474	14	8	571	515
7	53	23	434	22	12	545	467
8	70	33	471	27	17	630	515
9	67	33	493	32	16	500	495
10	68	29	426	38	18	474	443
11	84	38	452	45	23	511	473
12	96	42	438	41	20	488	453
13	106	44	415	61	25	410	413
14	99	38	384	46	20	435	400
15	77	30	390	54	15	278	344
16	70	26	371	58	21	362	367
17	71	29	408	53	23	434	419
18	60	28	467	61	37	607	537
19	63	30	476	68	32	471	473
20	58	26	448	57	34	596	522
21	33	11	333	58	23	397	374
22	28	4	143	46	19	413	311
23	22	3	136	26	4	154	146
24	19	2	105	32	2	63	78
25	16	0	0	33	2	61	41
26	9	1	111	18	1	56	74
27	7	0	0	22	2	91	69
28	3	0	0	22	0	0	0
29	8	0	0	12	0	0	0
30	4	0	0	12	0	0	0
31	6	0	0	7	0	0	0
32	2	0	0	7	0	0	0
33	2	0	0	5	0	0	0
34	1	0	0	7	0	0	0
35				2	0	0	0
36				1	0	0	0
37				4	0	0	0
38				1	0	0	0
Number of fish measured	1,224	480		1,015	390		

Table 3 Parameters of calculated main normal curve and assumed retention rate at 7's cm in mantle length.

Fishing season	Male			Female		
	$\bar{x}$	SD	Retention rate at 7'	$\bar{x}$	SD	Retention rate at 7'
1968/69	12.50	3.339	0.24	11.71	3.505	0.22
1969/70	12.77	2.990	0.33	12.13	3.277	0.22
1970/71	12.47	2.964	0.67	11.82	3.341	0.43
1971/72	13.31	3.515	0.77	12.66	4.105	0.64
1972/73	11.45	3.600	0.53	10.54	3.940	0.44
1973/74	12.59	3.451	0.78	11.80	3.935	0.58
Mean	12.52		0.55	11.78		0.42

SD: Standard deviation

Assumed retention rate is estimated from both frequencies in the size composition and the fitted normal curve.

Table 4 Age and growth of common American squid of male.

Age	Month	Mean mantle length
2/12	July	3.6
4/12	September	6.8
0.5	November	9.8
8/12	January	12.5
10/12	March	14.9
1	May	17.1
14/12	July	19.1
16/12	September	20.9
1.5	November	22.5
20/12	January	24.0
22/12	March	26.5
2	May	27.6

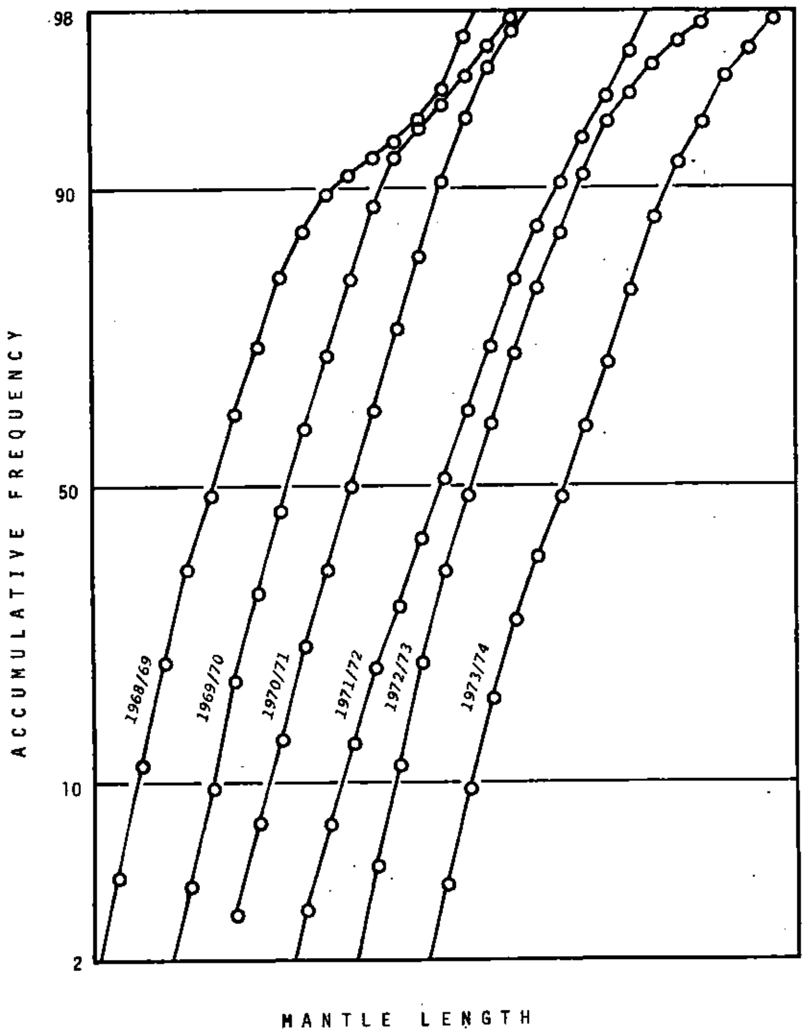


Fig. 1. Accumulative frequency, on graph of the probability paper with 1-cm interval, of male squid in Subarea 5 and Statistical Area 6 for each fishing season.

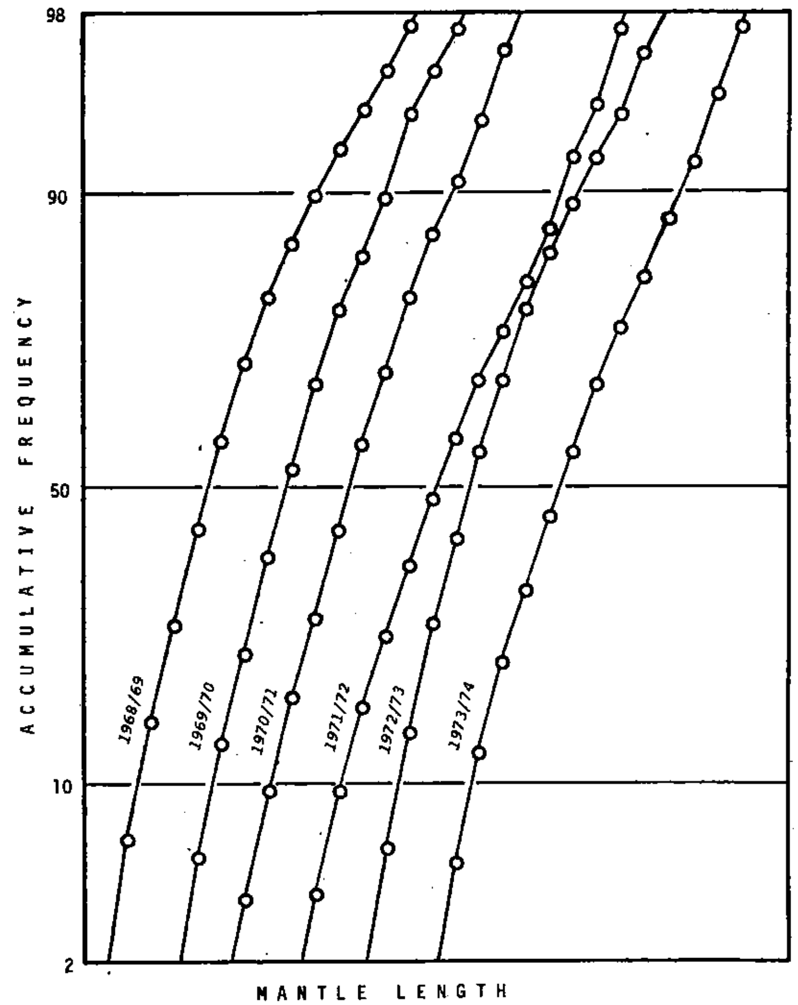


Fig. 2. Accumulative frequency, on graph of the probability paper with 1-cm interval, of female squid in Subarea 5 and Statistical Area 6 for each fishing season.

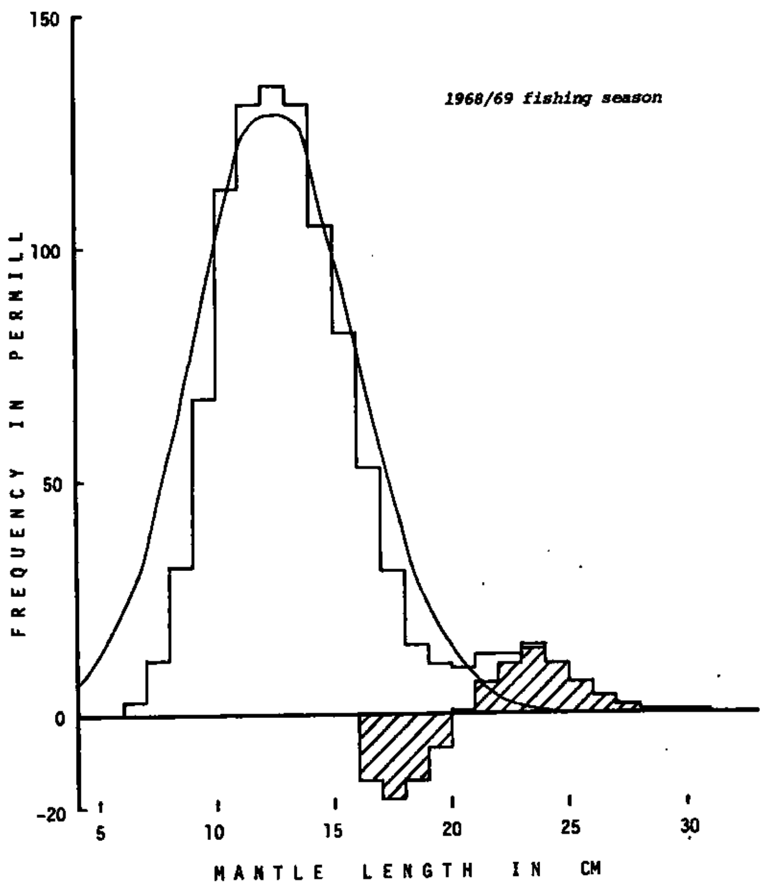


Fig. 3. Size composition (in column) of male squid caught by Japanese trawlers, fitted normal curve and residue from the normal curve on large sizes (in column with shadow).

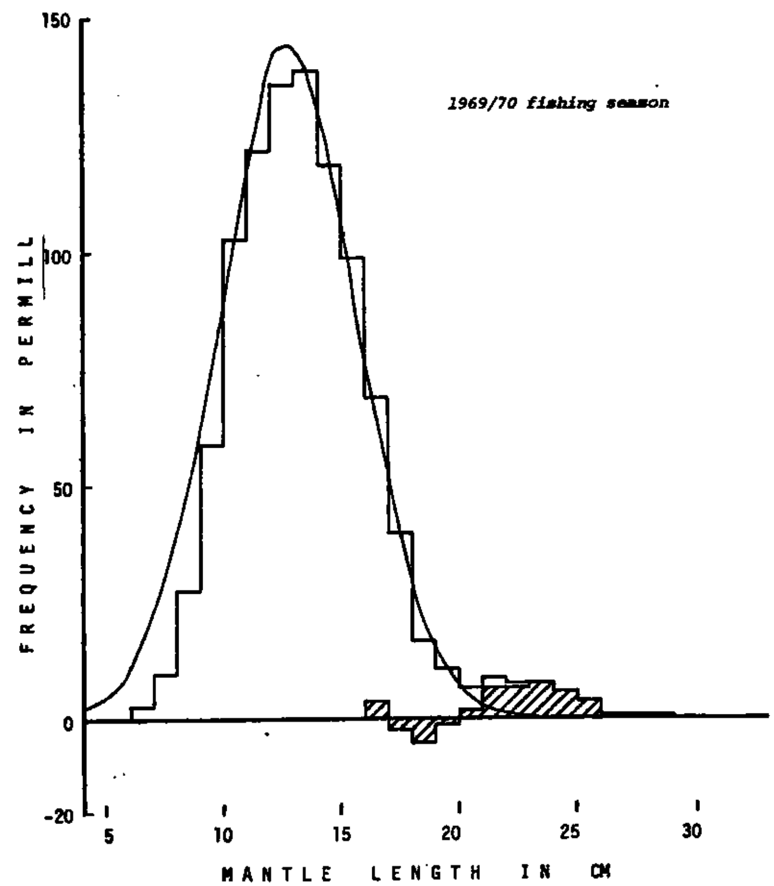
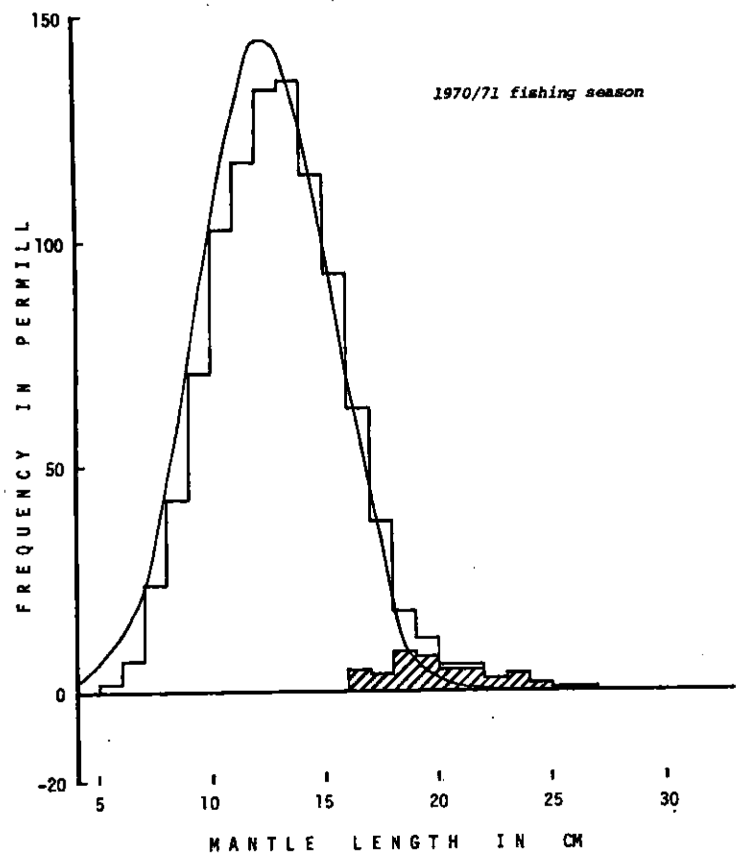


Fig. 3 (Continued)



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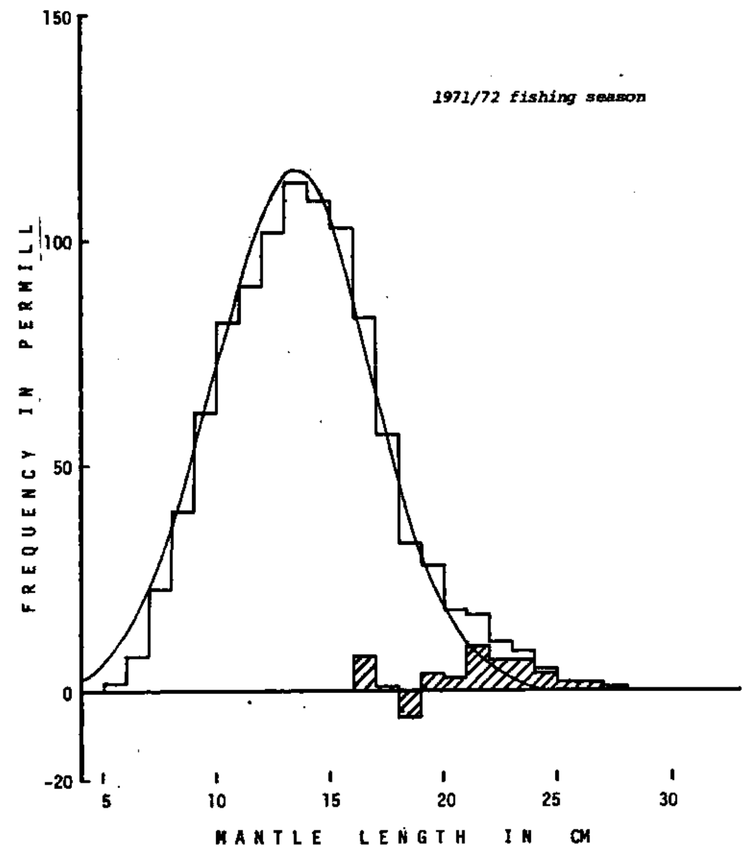

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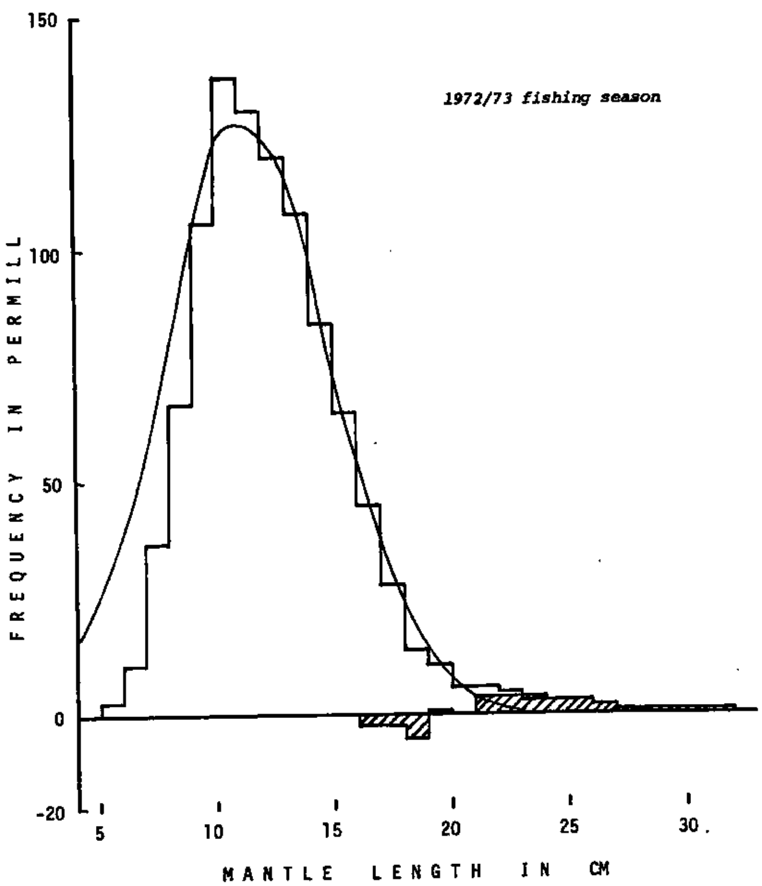

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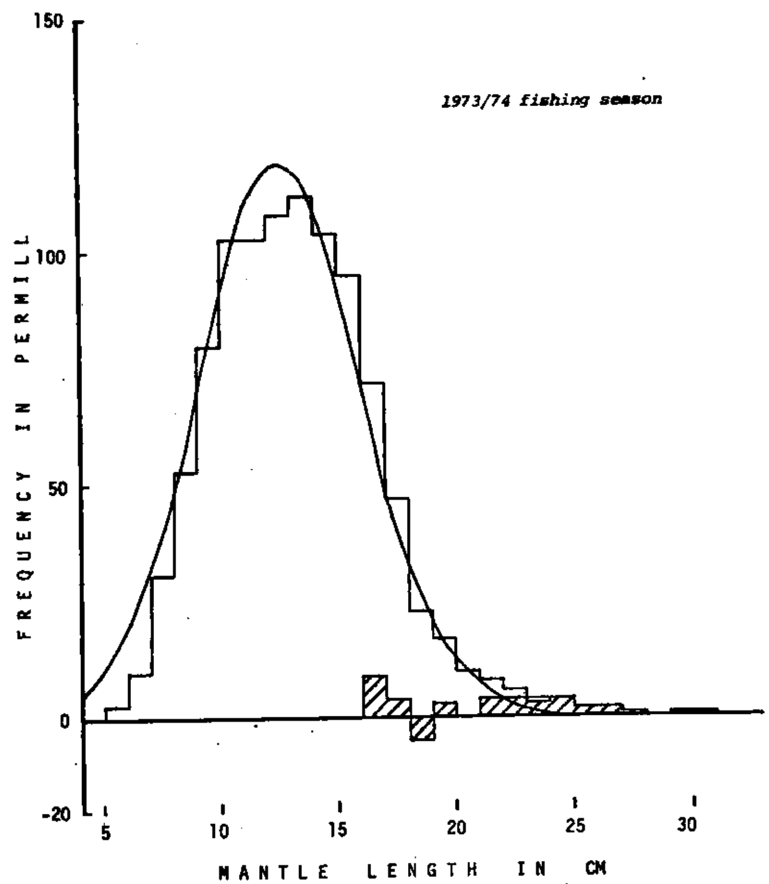

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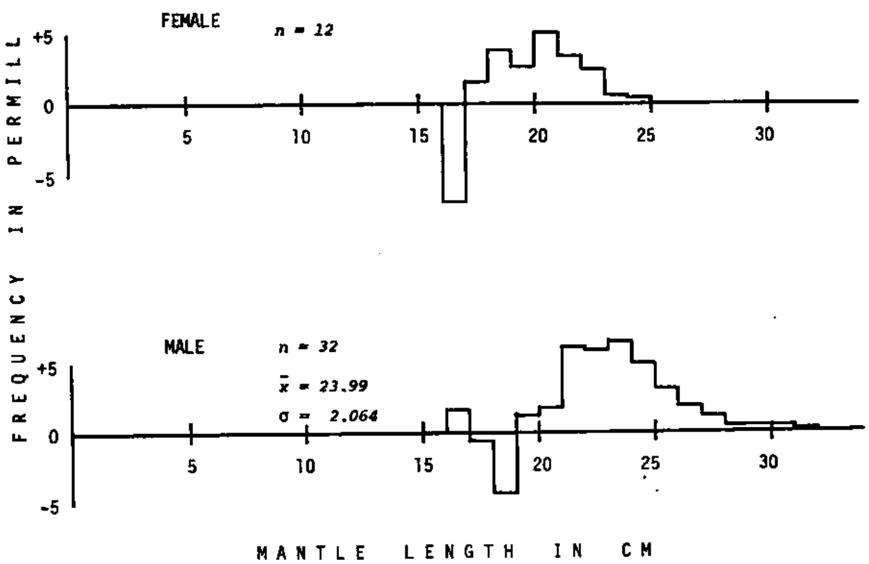

Fig. 4. Size composition, average of 6 fishing seasons, of the residue from fitted normal curve on the length scale bigger than 16 cm of mantle enght.