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Biomass estimate of the northern deepwater shrimp, *Pandalus borealis*, in NAFO Divisions 1B and 0B - R/V *Thalassa* survey, September-October 1979

by

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Introduction.

A trawl survey on the offshore shrimps grounds was carried out on board the french R/V Thalassa, in the Davis strait from September 27 to October 16, 1979. Results of previous surveys have shown that most extensive grounds for shrimp, Pandalus borealis, were found in NAFO Division 1B for the eastern part of Davis strait (HORSTED, 1978) and NAFO Division 0B for the western part (MINET and al., 1978a); this was confirmed by JONES and PARSONS in 1978. So, during this cruise, investigations were restricted to the continental slope west of Greenland from 66° N to 69° N latitude and east of Cumberland from 64° N to 66° N latitude. Minimum biomass estimate presented refer to the "swept area" method.

I - Materials and methods.

The standard gear was a SPUTNIK Shrimp trawl, headline 43 m and groundrope 51 m, with 36 mm stretched mesh in the codend. After difficulties encountered trawling with this gear on rough bottoms, we changed to a Lofoten bottom trawl for the rest of the cruise ;

its specifications are : headline 31,2 m, groundrope 17,7 m and 30 mm stretched mesh in the codend.

A total of 51 hauls were realized during the trip, that is to say 31 with the SPUTNIK and 20 with the Lofoten trawl.

On the surveyed area, the station were distributed randomly using the stratification scheme designed by HORSTED (1978) for Division 1B and by MINET et al. (1978b) for Division 0B. A number of 35 tows were made in 1B for strata between 200 and 600 m depth and 16 in 0B for strata between 150 fm (183 m) and 300 fm (549 m).

The duration of tows was fixed to 30 minutes and the speed close to 3 knots. The positions and the distance covered by the trawl were plotted with accuracy by a satellite navigator. The time was noted in local time (GMT - 3). After each tow an hydrological station using XBT was made. In addition, two hydrological sections were carried out define water masses in Davis strait and their influences on shrimp distribution.

All the catches were sorted in species and weighted. Moreover the commercial species were sexed and measured. Biological data on shrimp are exposed in other communication by FRECHETTE and DUPOUY (1979).

II - Results.

1. Distribution and abundance.

In Division 1B shrimps were present in each tow (table 1) corresponding depths ranged from 202 to 539 m. Largest concentrations were noted in strata 3, 4, 9 and 11 with respectively 463, 317, 291 and 277 kg per 30 minute set.

In Division 0B (Table 2), 13 hauls on 16 were productive in shrimps and yielded only a total of 63 kg. The largest catch (set No. 42) produced scarcely 20 kg, for a depth of 387 m.

2. Estimate of shrimp biomass.

- Comparative efficiency of Sputnik and Lofoten trawls.

The changing of trawl in the course of the survey resulted in drop of shrimp catches with the Lofoten bottom trawl.

So, we made a comparison of the trawls efficiency ; on one hand the Thalassa making two sets of 60 minutes, using the Lofoten trawl and on the other hand the trawler Svalbard (from Faeroë) fishing with the Sputnik at the same time, on the same location. The mean catch per hour was for the Lofoten trawl 87 kg and for the Sputnik trawl 191 kg.

The width of the path of the Lofoten trawl is about 14 m (MINET et al., 1978) and the one of the Sputnik trawl is about 30 m (HØYDAL, 1978). Moreover, the speeds of the two vessels were not exactly identical and the mean distance covered per hour by the Thalassa was 3.25 n.miles against 2.78 n.miles for the Svalbard. Accordingly, the catch expressed by unit of surface by the trawls was :

Lofoten trawl : $87 / (3.25 \times 1.852 \times 0.014) = 1032$ kg/km^2

Sputnik trawl : $191 / (2.78 \times 1.852 \times 0.030) = 1236$ kg/km^2

the ratio 1236/1032 represents the conversion factor that we applied to the catches (kg/km^2) by the Lofoten trawl, for giving comparable data with shrimp catches by Sputnik trawl, used as standard gear for biomass estimate.

- Diurnal corrective factor.

Then, because of the diurnal variation in availability of shrimp, the catches of Pandalus, in each haul, were adjusted to the "noon plateau" using the conversion factor calculated by CARLSSON and al. (1978) for October.

- Biomass estimate in Div. 1B and adjacent areas.

The stratification scheme used by HORSTED in Div. 1B (1978), was extended to south part of Div. 1A up to the 69° N latitude, and down to the 600 m depth contour line in east part of Division 0A (Figures 1). So, the surfaces of strata 2, 4, 5 and 10 are more important than those of HORSTED.

For each stratum, the mean adjusted catch of shrimp (kg/km^2) was multiplied by the corresponding surface, to obtain the biomass estimate (table 3). Total estimate for the strata surveyed is close to 42,000 tons.

- Biomass estimate in Division 0B.

Only 6 strata were surveyed. The mean adjusted catch and the calculated biomass by stratum are given in table 4. Total biomass estimate is about 2,500 tons of shrimp, for the six strata surveyed.

3. Composition and biomass estimate of by-catches.

Three others significant commercial fishes were taken during the cruise : redfish, Sebastes marinus mentella, Greenland halibut, Reinhardtius hippoglossoides and American plaice, Hippoglossoides platessoides.

Among this species, redfish was the most abundant ; but important differences were noted between East and West of Davis strait. In Div. 1B, it was present in all the sets and the largest yield, about 1000 kg per half an hour, occured in set No. 16 (table 1), whereas in Division 0B, only few individuals were encountered (table 2).

Greenland halibut was the most common species. It was present in all the sets, except in set No. 21 (table 1). The largest catches per half an hour were respectively 69 kg and 63 kg for Division 1B and Division 0B.

American plaice was encountered principally in Division 1B for depths ranging from 200 to 300 m. Largest catch was about 100 kg per half an hour (set No. 22).

A rough estimate of biomass was attempted for these species. Catches were calculated in kg/km^2 and in each stratum, mean catch was extrapolated to the surface.

Total biomass estimates in Division 1B were found about 27,000 tons for redfish, 6,000 tons for Greenland halibut and 3,200 tons for American plaice.

In Division 0B, biomass estimate for redfish was only 2,000 tons against 6,500 tons for Greenland halibut, in the 6 strata surveyed.

In a shrimp fishery, it is obvious that by-catches are a problem in consideration with the small meshes used in the codend of the trawls. Length composition by depth of redfish and Greenland halibut are given for Division 1B in Figure 3 and Figure 4 respectively. The catch per hour in each depth range, obtained during the cruise, is also mentioned. As we can see, the most important captures of small individuals, for both species, occured between 200 and 300 m depth.

4. Hydrological data and influence of temperature on distribution of shrimp.

Hydrological situation in Davis strait was taken into account by KLIMENKOV and al. (1978) to explain the shrimp concentrations observed on the western slope of Store Hellefiske bank. Data collected during the Thalassa cruise confirm this hypothesis. In Figure 5, adjusted catch rate of shrimp in relation with bottom temperature, clearly show that no shrimp were present for temperature colder than -1.0° C. Largest concentrations occured for temperature ranging from +2.0° C to +4.2° C with a maximum of yield between +3.5° C and +4.1° C.

Two hydrological sections by 66° N and 68° N of latitude (Figures 6 and 7) show that only favourable temperatures are situated on western slope of Greenland banks. Arctic waters going down alongside the Canadian coast do not make possible important concentrations of shrimp on the slope of Cumberland banks.

III - Conclusions and discussion.

During the Thalassa cruise in Davis strait, in September and October 1979, the offshore shrimp grounds off west Greenland and off East Cumberland peninsula were surveyed.

In Division 1B and adjacent areas (south of Division 1A and east of Division 0A), biomass estimate is close to 42,000 tons for depths ranging from 200 m to 600 m, and between 66° N and 69° N of latitude.

In Division 0B, for strata between 64° N and 66° N of latitude and for depths ranging from 183 m to 549 m, biomass estimate is about 2,500 tons of shrimp.

Although a corrective factor was applied to the catches, for taking in account important diurnal variations in availability of shrimp, they are minimum estimates because all the shrimp encountered on the path of the gear were not caught.

In Division 1B, HORSTED (1978) gives a total biomass estimate for the year 1976, of about 55,000 tons for offshore shrimp grounds off West Greenland, between 66° N and 69° N of latitude. But more strata were surveyed because the positions of his stations were ranging from 150 to 600 m depth.

If we only consider strata restricted to depths from 200 to 600 m contour lines (table 5) and after correcting to the same surface strata 2, 4, 5 and 10, HORSTED estimate is then of about 45,000 tons. The difference of 3,000 tons between the year 1976 and the year 1979 is not significative.

In addition, shrimp is also present between 150 and 200 m depth since HORSTED (1978) gives a biomass estimate of 5,300 tons in an area of about 7,000 km^2.

For Division 0B, a minimum biomass estimate for the year 1977 by MINET and al. (1978) gives a figure of about 4,000 tons. If we consider only the 6 strata surveyed during this cruise, the difference is lower : 3,500 tons for the year 1977 against 2,500 tons for the year 1979. This decrease is probably due to lower temperatures observed this year.

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TABLE 1. Basic data on yield of shrimp and by-catches for Division 1B - *Thalassa* survey September-October 1979.

Stratum No.	Set No.	Position Lat.	Position Long.	Date	Mean time	Depth meters	Distance N. Mile	Bottom temp.(°C)	Actual catch* (kg) Shrimp	Redfish	Gr. Hal.	Am. Plaice
SPUTNIK Shrimp trawl (36 mm codend mesh)												
02	1	68°18'	58°30'	4 Oct.	17:08	328	1.5	3.5	150	92	5	0
	2	68°28'	57°15'	5 Oct.	07:47	380	1.5	3.5	85	5	32	1
	3	68°22'	57°36'	5 Oct.	10:17	319	1.8	3.5	62	5	13	0
	4	68°50'	57°08'	6 Oct.	07:73	310	1.4	3.6	30	11	2	0
03	5	68°05'	58°23'	4 Oct.	13:88	408	1.4	3.7	463	20	37	1
	6	68°15'	57°18'	5 Oct.	13:66	411	1.5	3.6	113	10	12	0
	7	68°31'	56°10'	6 Oct.	13:90	410	1.5	4.0	113	12	13	0
	8	68°24'	56°02'	6 Oct.	17:11	525	1.3	4.1	63	4	17	0
04	9	68°08'	57°07'	5 Oct.	16:75	306	1.4	3.3	317	8	4	2
05	10	68°04'	58°59'	4 Oct.	10:62	274	1.4	3.4	178	772	2	4
06	11	67°49'	58°05'	3 Oct.	07:46	299	1.4	3.3	40	20	1	1
	12	68°06'	56°57'	5 Oct.	17:91	246	0.9	3.0	106	16	2	2
	13	68°14'	55°11	8 Oct.	14:50	274	1.2	2.5	7	5	1	0
	14	68°12'	56°09'	8 Oct.	18:16	202	0.7	2.4	48	4	1	0
09	15	67°21'	57°20'	2 Oct.	07:85	241	1.5	3.7	291	340	6	7
	16	67°02'	56°30'	2 Oct.	18:05	278	1.4	3.9	160	1020	13	4
10	17	67°12'	57°12'	2 Oct.	09:86	529	1.5	4.2	3	60	39	0
	18	67°04'	56°55'	2 Oct.	14:11	539	1.5	4.3	1	45	35	0
11	19	67°08'	56°48'	2 Oct.	16:21	399	1.4	4.1	278	108	16	0
13	20	66°34'	56°23'	1 Oct.	13:93	280	1.4	3.9	68	214	6	0
15	21	66°08'	55°13'	28 Sept.	11:67	208	1.9	2.2	2	215	0	95
	22	66°12'	55°35'	28 Sept.	15:55	221	1.8	2.0	67	52	3	105
LOFOTEN Bottom trawl (30 mm codend mesh)												
04	23	67°44'	58°23'	9 Oct.	18:25	306	1.6	3.2	6	37	17	3
	24	67°54'	58°31'	10 Oct.	14:88	384	3.1	3.7	95	21	61	1
	25	67°51'	58°25'	10 Oct.	16:62	373	3.4	3.6	79	50	69	3
06	26	67°40'	57°09'	9 Oct.	07:58	213	1.9	2.6	22	19	6	83
	27	67°47'	57°25'	9 Oct.	09:66	277	1.6	3.3	39	32	19	28
	28	67°39'	57°34'	9 Oct.	13:83	233	0.9	3.0	38	15	6	16
	29	67°44'	58°11'	9 Oct.	16:81	280	1.1	3.1	17	31	14	6
09	30	67°17'	57°09'	10 Oct.	08:08	255	1.2	3.7	15	28	5	2
11	31	66°41'	56°27'	13 Oct.	09:66	354	2.0	4.0	9	14	21	2
12	32	66°47'	56°34'	13 Oct.	07:53	516	1.5	4.4	4	41	63	0
	33	66°38'	56°31'	13 Oct.	11:25	444	1.6	4.3	9	18	22	0
	34	66°23'	56°28'	13 Oct.	14:26	406	1.5	4.5	3	12	36	1
13	35	66°10'	56°20'	13 Oct.	17:56	242	1.3	3.5	4	33	10	1

* all the sets were of 30 minutes duration except set n° 12 (20 mn), set n° 14 (17 mn), set n° 24 (60 mn), set n° 25 (60 mn), set n° 28 (18 mn), set n° 29 (17 mn) and set n° 30 (20 mn).

Table 2. Basic data on yield of shrimp and by-catches for Division 0B - *Thalassa* survey September-October 1979.

Stratum No.	Set No.	Position Lat.	Position Long.	Date	Mean time	Depth meters	Distance N. Mile	Bottom temp.(°C)	Actual catch* (kg) Shrimp	Redfish	Gr.Hal.	Am. Plaice
SPUTNIK Shrimp trawl (36 mm codend mesh)												
22	36	65°53'	61°17'	29 Sept.	14:56	211	1.6	-1.7	0	0	1	0
23	37	65°39'	61°23'	29 Sept.	17:48	279	1.4	-1.3	0	0	4	2
	38	66°09'	60°57'	29 Sept.	11:58	354	1.1	-1.4	0	0	4	0
	39	65°46'	60°39'	30 Sept.	07:77	356	1.5	-0.5	2.1	0	36	1
24	40	66°10'	60°45'	29 Sept.	07:63	396	1.8	-0.3	7.7	1	63	0
	41	66°13'	60°48'	29 Sept.	09:56	397	1.4	-0.3	3.4	0	16	0
	42	65°33'	60°29'	30 Sept.	10:02	387	1.5	+0.2	19.5	0	54	0
	43	65°41'	60°00'	30 Sept.	14:50	492	1.2	+0.9	4.1	1	28	0
26	44	65°32'	59°58'	30 Sept.	18:13	482	1.6	+1.2	4.3	1	24	0
LOFOTEN Bottom trawl (30 mm codend mesh)												
23	45	65°16'	60°33'	14 Oct.	14:95	356	1.6	-0.7	4.8	0	6	0
26	46	65°30'	59°05'	14 Oct.	07:27	457	1.5	+1.1	2.6	16	37	0
	47	65°19'	59°13'	14 Oct.	09:25	445	1.5	+1.3	2.2	68	34	0
	48	65°19'	59°36'	14 Oct.	11:10	465	1.7	+0.9	2.5	5	17	0
28	49	64°58'	60°20'	14 Oct.	18:28	320	1.7	-0.7	5.5	0	5	1
	50	64°37'	60°43'	15 Oct.	07:42	382	1.7	+1.7	2.1	1	28	1
29	51	64°23'	60°06'	15 Oct.	11:05	377	1.6	+0.5	2.4	1	8	0

* all the sets were of 30 minutes duration except set n° 38 (15 mn).

Table 3. Biomass estimates of shrimp for strata surveyed by the *Thalassa* in Division 1B and adjacent areas (East of 0A and South of 1A) - September-October 1979.

Depth range (m)	Stratum No.	Area of stratum km^2	Number of sets	Adjusted catch kg/km^2	Biomass tons
200-300	05	637	1	2,516	1,603
	06	3,665	8	1,427	5,230
	09	1,565	3	3,705	5,798
	13	610	2	514	314
	15	1,385	2	347	481
300-400	02	8,427	4	1,324	11,157
	04	3,032	4	2,018	6,119
	11	1,200	2	2,327	2,792
400-600	03	3,355	4	2,432	8,159
	10	1,420	2	31	44
	12	1,135	3	181	205
TOTAL		26,431	35		41,902

Table 4. Biomass estimates of shrimp for strata surveyed by the *Thalassa* in Division 0B, September-October 1979.

Depth range (m)	Stratum No.	Area of stratum km^2	Number of sets	Adjusted catch kg/km^2	Biomass tons
183-274	22	4,397	1	0	
274-366	23	3,896	4	46	179
	28	5,714	2	208	1,189
	29	5,227	1	73	382
366-549	24	2,545	4	125	318
	26	4,294	4	100	429
TOTAL		26,073	16		2,497

Table 5. Comparison of biomass estimates for strata ranging from 200 to 600 m, between 66° N to 69° N of latitude - The data for 1976 are reported by Horsted (1976).

Stratum number		Area of stratum (km^2)		Biomass estimate (tons)	
1979	1976	1979	1976	1979	1976
2	2	8,427	7,705	11,157	10,846*
3	3+4	3,355	3,355	8,159	2,544
4	5	3,032	2,930	6,119	3,014*
5	6	637	515	1,603	1,827*
6	7	3,665	3,665	5,230	10,731
9	10	1,565	1,565	5,798	4,658
10	11	1,420	300	44	2,428*
11	12+14+18	1,200	1,200	2,792	3,775
12	13+17	1,135	1,135	205	896
13	15+19	610	610	314	133
15	21+23	1,385	1,385	481	3,931
Total biomass				41,902	44,783

* Figure adjusted to the area of stratum used in 1979.

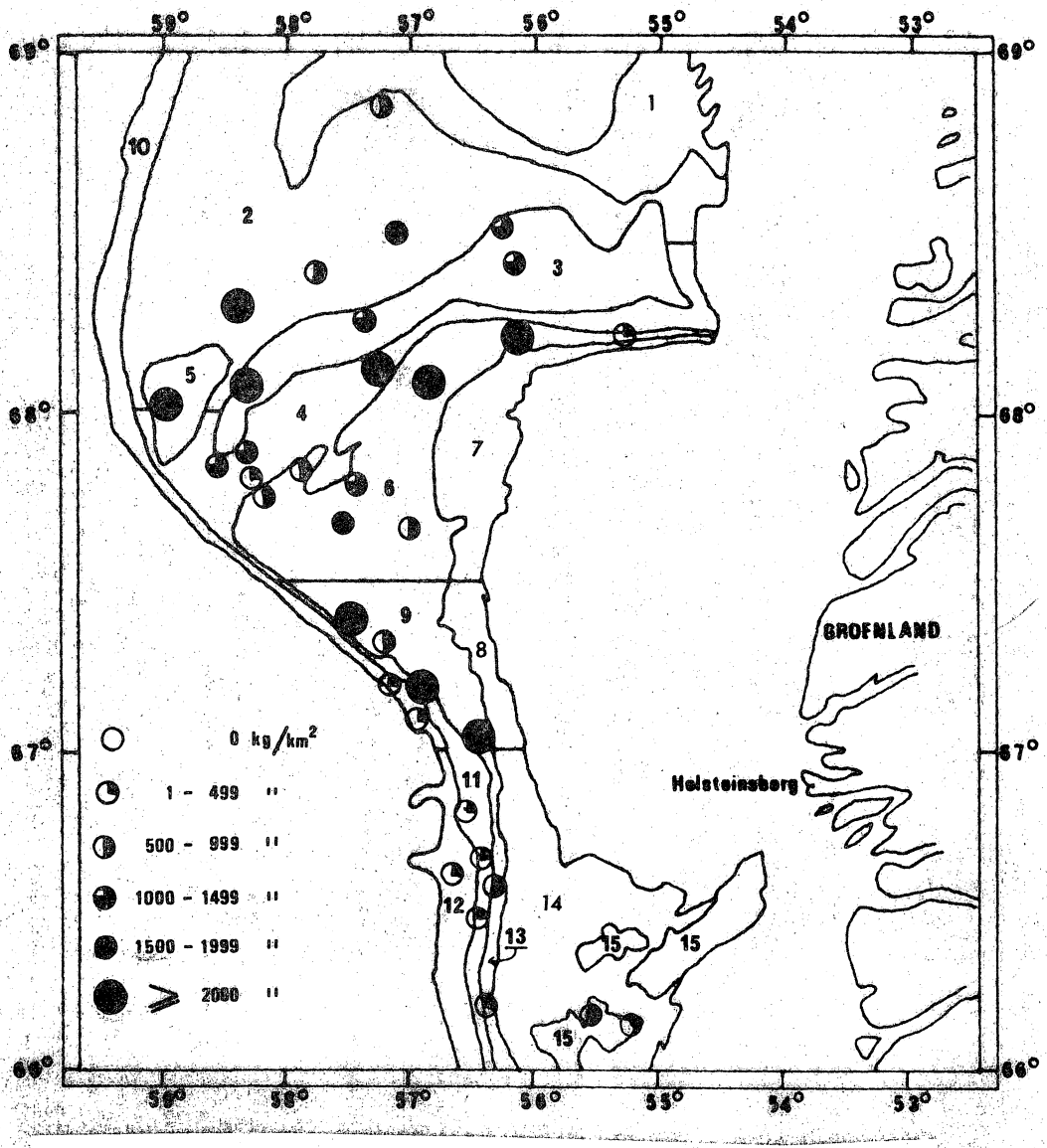

Figure 1. Positions of stations occupied by the Thalassa and adjusted catches of shrimps in Division 1B and adjacent areas (East of OA and South of 1A) - September-October 1979.

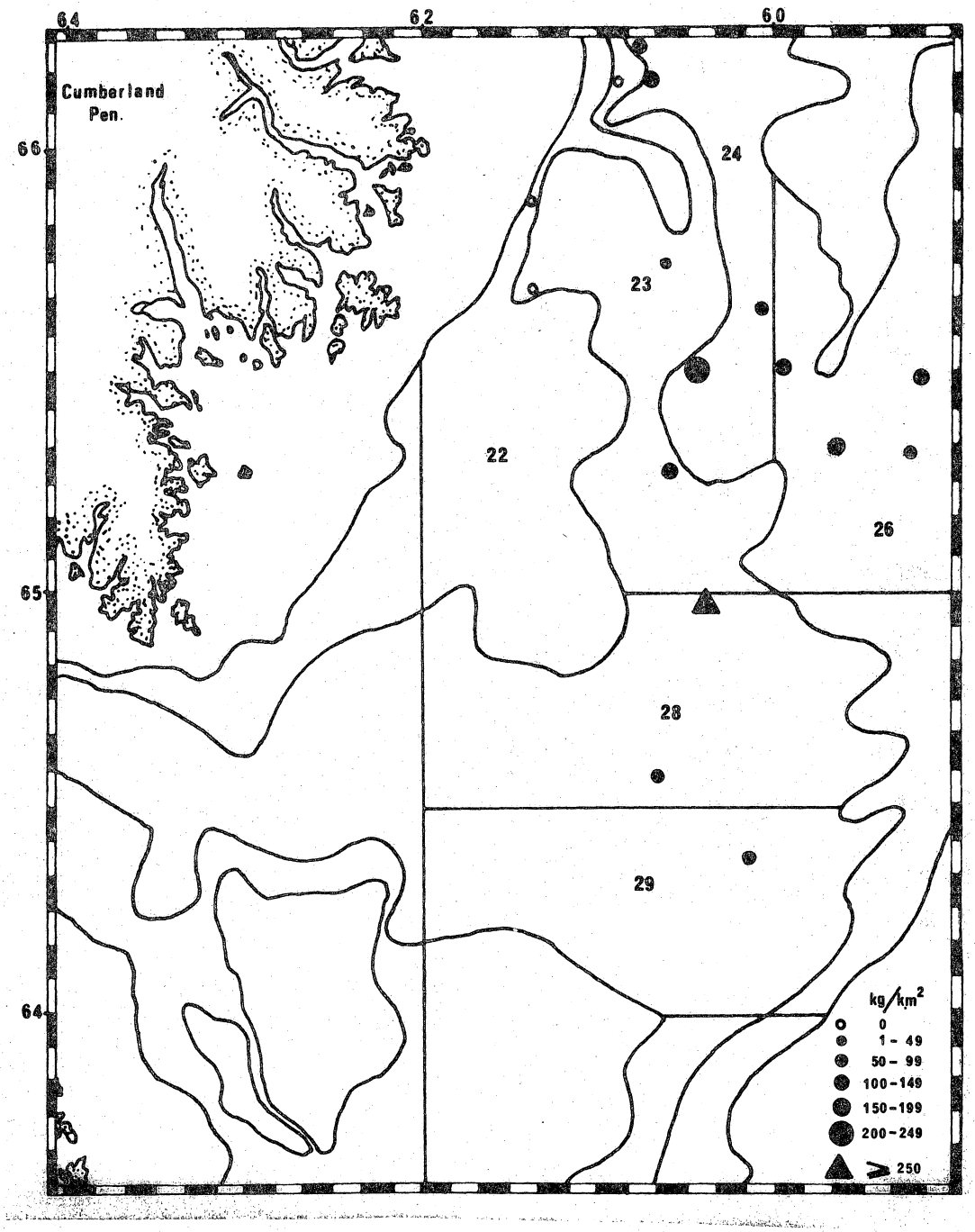

Figure 2. Positions of stations occupied by the Thalassa and adjusted catches of shrimp in Statistical Area 0B - September-October 1979.

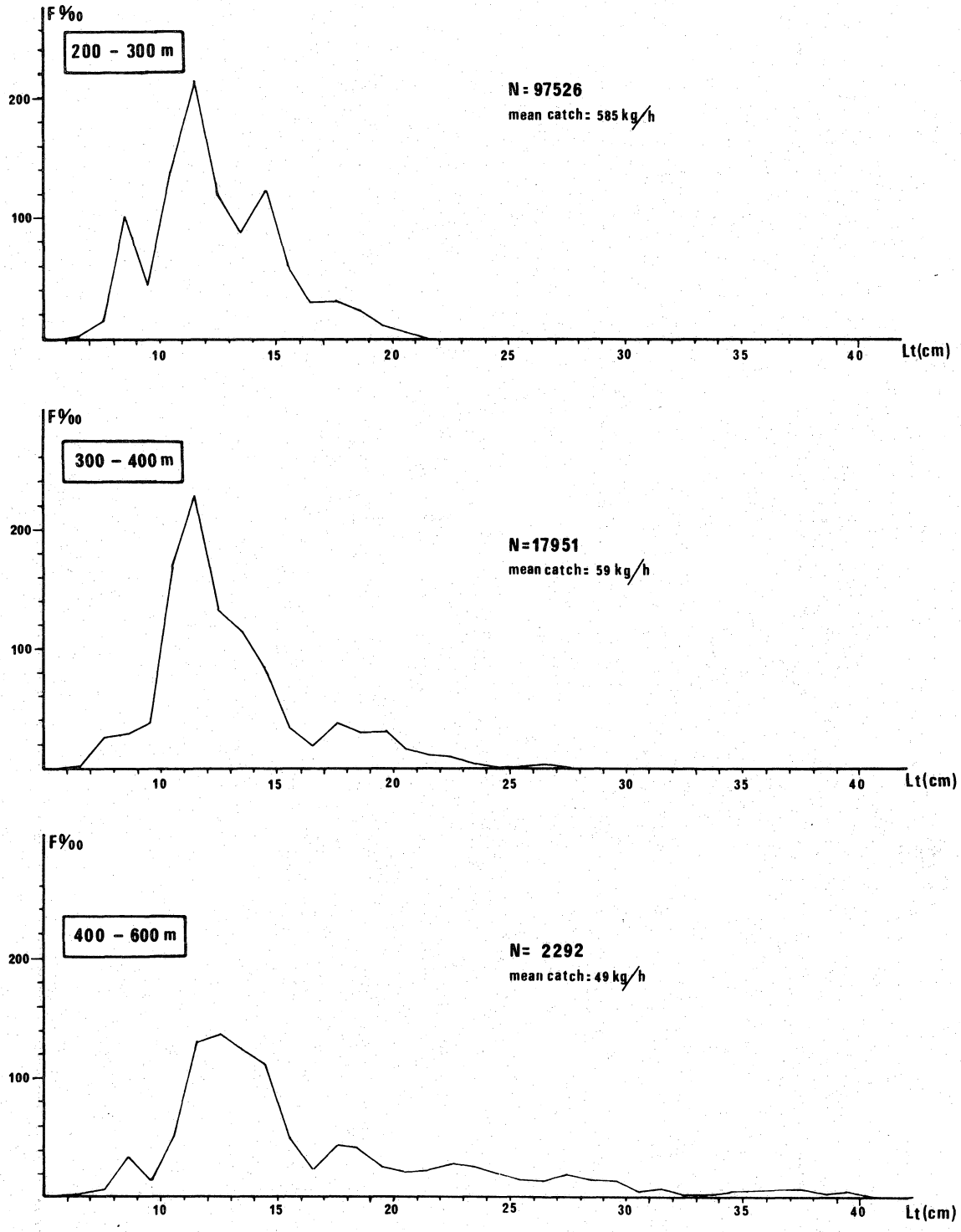

Figure 3. Length frequencies of redfish and abundance index by depth, in Division 1B - Thalassa survey September-October 1979.

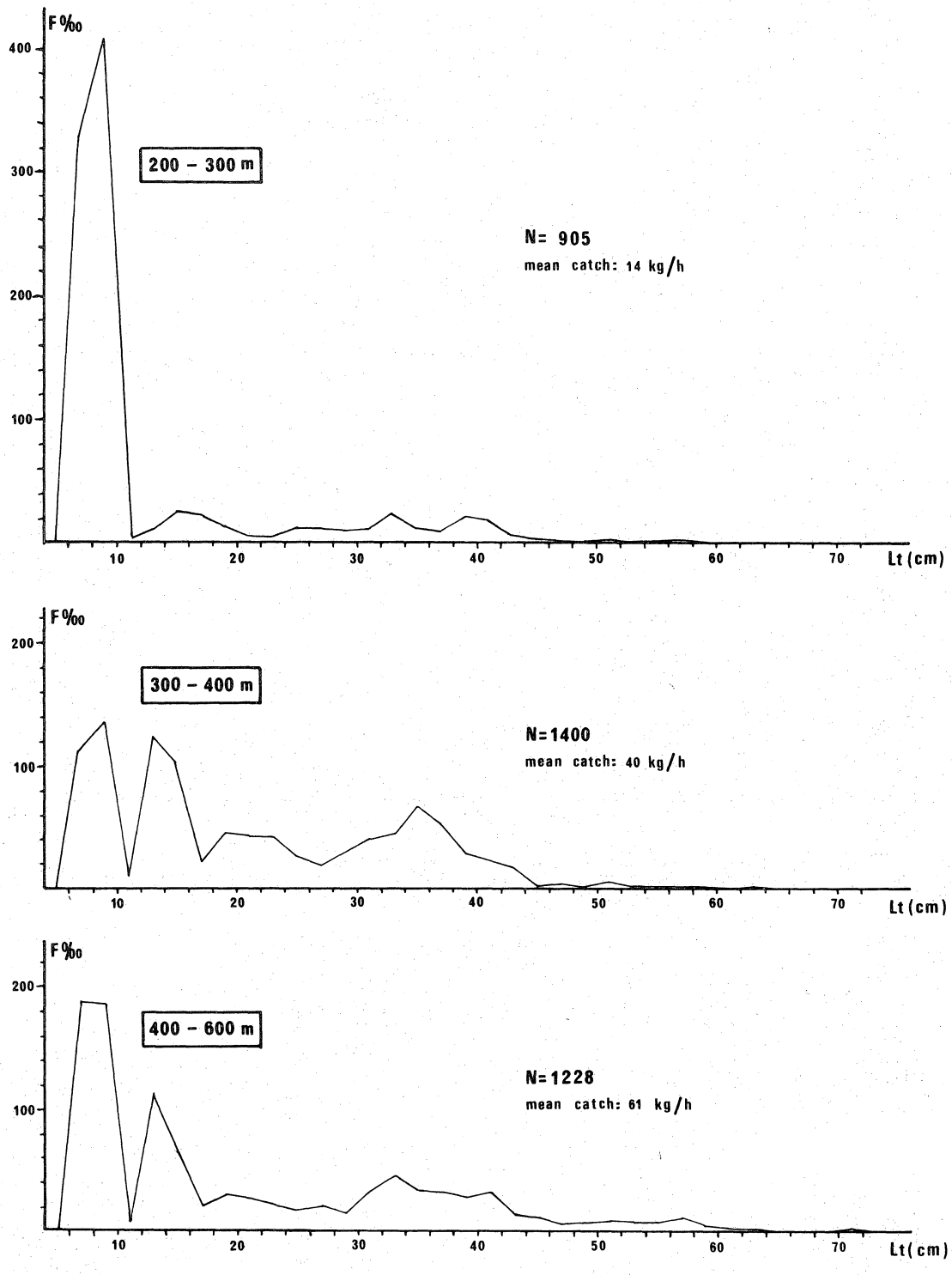

Figure 4. Length frequencies of Greenland halibut and abundance index by depth, in Statistical Area 0B - Thalassa survey September-October 1979.

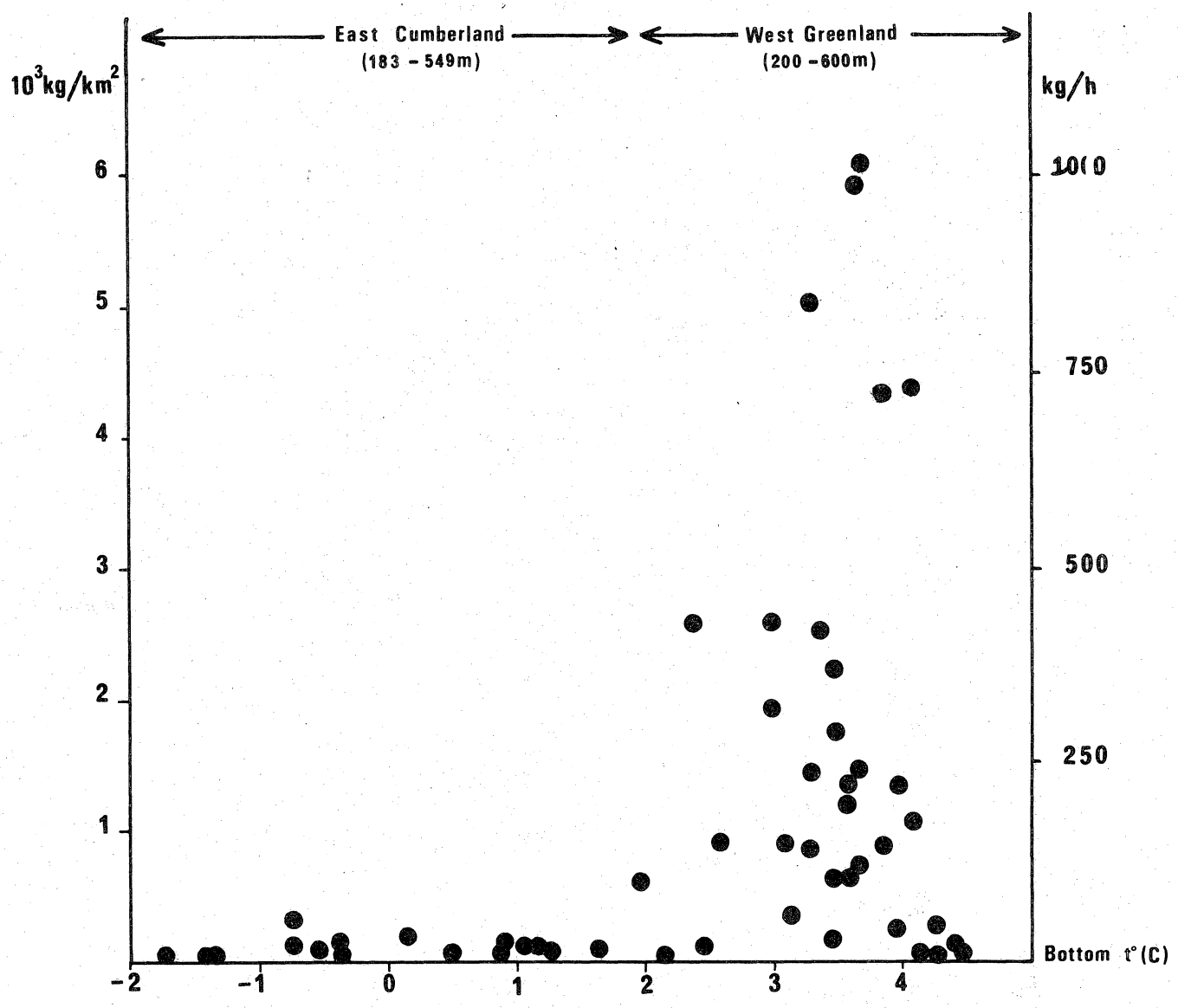

Figure 5. Shrimp adjusted catches expressed in kg/km^2 (left abscisse) or in kg/hour (right abscisse) versus bottom temperature - Thalassa survey in Davis Strait, September-October 1979 (t° ranged from -1.7° C to +1.7° C East of Cumberland and from +2° C to +4.5° C West of Greenland).

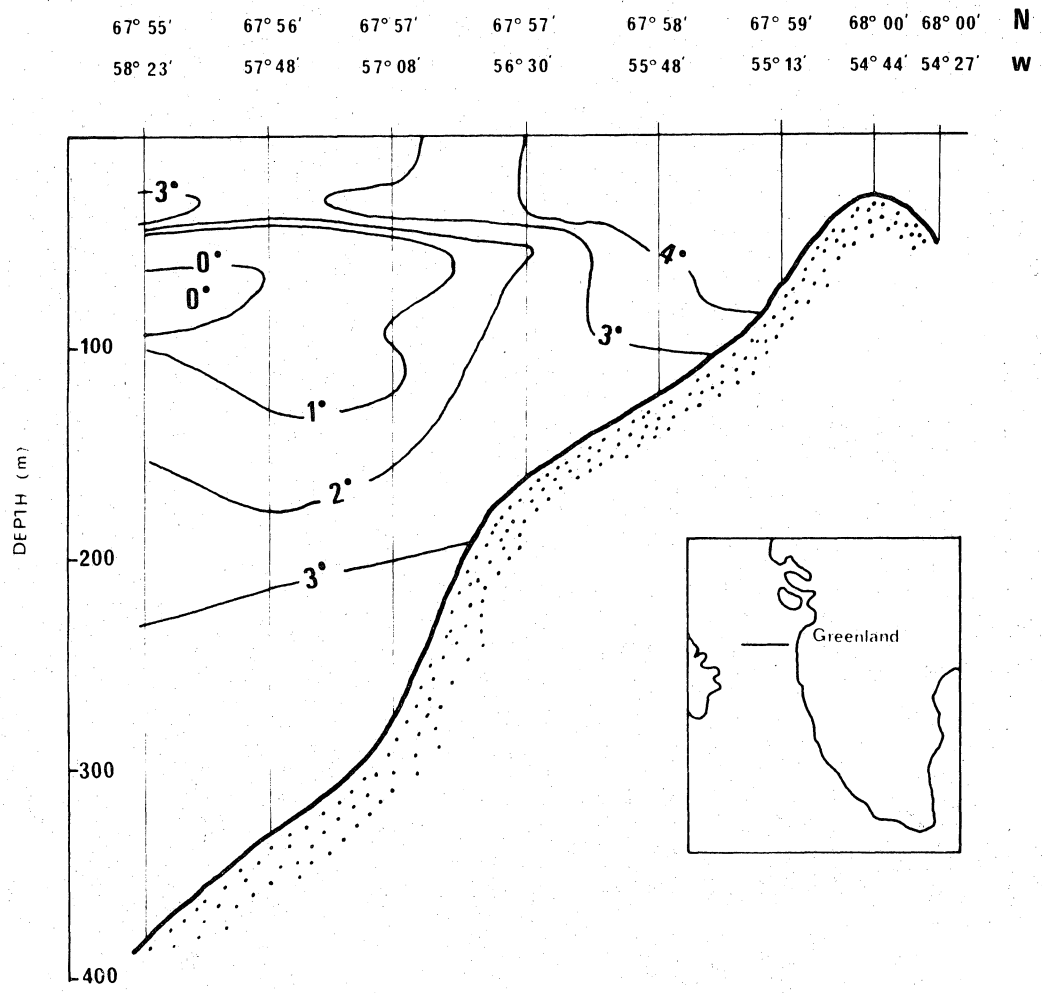

Figure 6. Vertical distribution temperature in the north of Division 1B - Thalassa survey, september-October 1979.

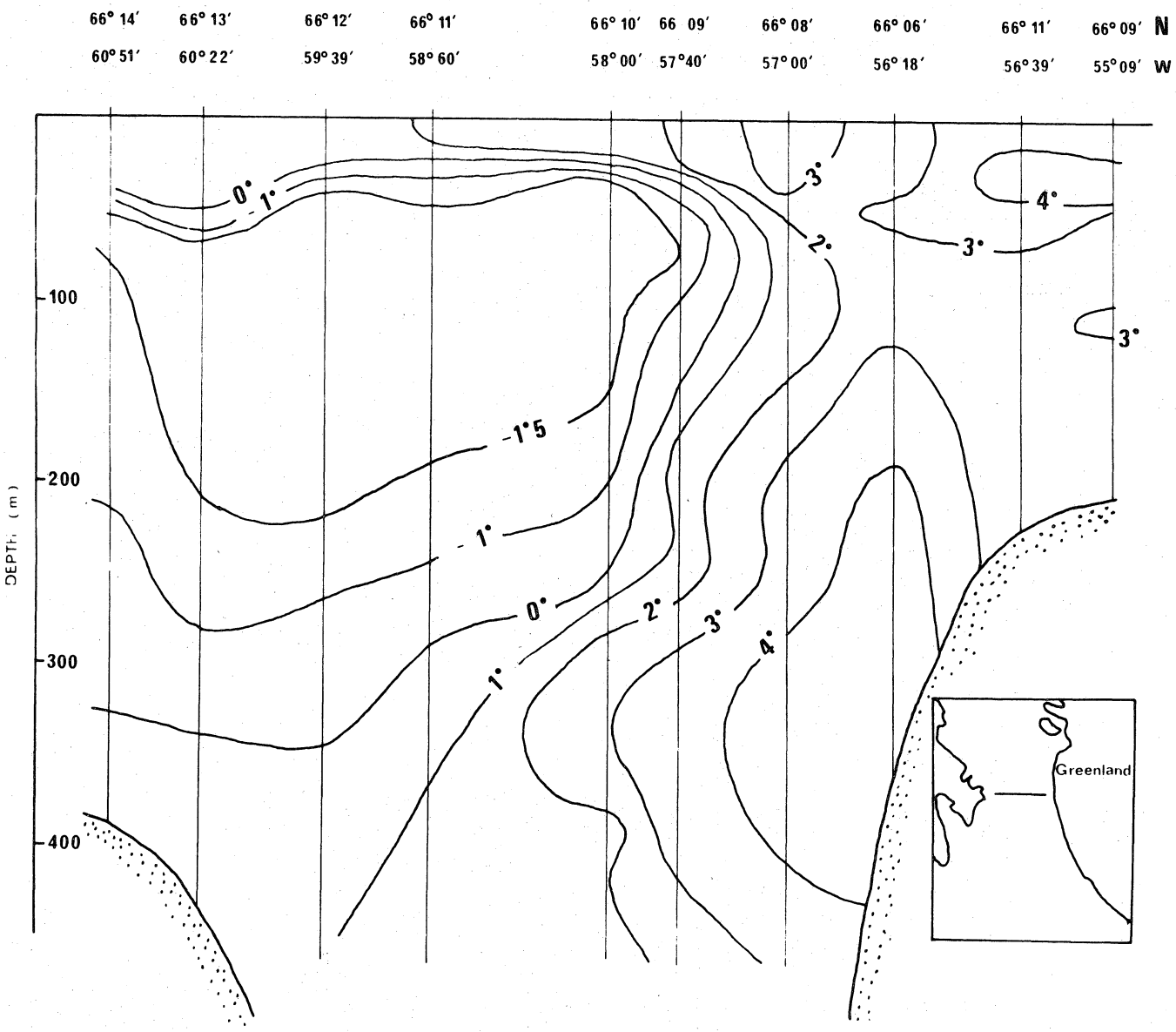

Figure 7. Vertical distribution temperature accross the Davis Strait, close to latitude 66° W - Thalassa survey, September-October 1979.