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Observations on the New Canadian Fishery for Shrimp (*Pandalus borealis*) in NAFO Division 0B in 1988

by

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INTRODUCTION

The occurrence of northern shrimp off Cumberland Sound in NAFO Division 0B has been known for some time (Minet et al. 1978, Veitch et al. 1978, Jones and Parsons 1978, Dupouy et al. 1979) but, up to the fall of 1988, had not attracted the attention of the commercial fishery. It also was known from the exploratory work done in the late 1970's that the shrimp in this area attained substantially larger sizes than conspecifics farther north in the Davis Strait and in southern waters of the Labrador Sea, the large sizes encountered being similar to those found in the Denmark Strait (e.g. Smedstad 1988). Canadian licensed vessels began fishing the area (Fig. 1) in mid October and continued to late December with the total catch amounting to just over 2800 t. Initially, catch rates were low but effort was maintained likely because of the very large sizes being obtained. However, in early December, catch rates increased substantially and continued at higher levels until vessels were forced out of the area later in the month by advancing ice.

Data from this fishery were collected through logbooks and observer records, providing details of catch and effort, size composition of shrimp, by catches and discards. In addition, the observers provided some preserved samples for examination of biological detail. Although the new fishery is somewhat remote from the traditional shrimp grounds in the Davis Strait (over 100 n mi west of Div. 1C and south of Div. 0A), it was considered appropriate to examine the characteristics closely to determine how or if these resources might be related. A precautionary TAC of 3500 t has been set in this area for the 1989/90 season.

MATERIALS AND METHODS

Catch and effort data were compiled on a daily basis to detect any changes in fishing pattern that occurred over the relatively short season. These data, obtained from vessel logs, were then combined by time periods during which the areas and depths fished were similar. Size composition of the catches sampled by observers were summarized similarly. By-catch data were compiled as the percentages of the total observed catch in each month and estimates of the proportions of shrimp discards were also calculated.

Three samples of shrimp, collected by observers, were analyzed for biological detail. These were taken from depths between 410 and 460 m on November 11, 24 and December 15, 1988 in the area around 65° N, 59° 30' W. The samples were pooled because there were no major differences in the proportions and size distributions of the various sexual components. Carapace lengths were measured to the nearest 0.1 mm and subsequently combined to 0.5 mm intervals. Sex was determined by observation of the first pleopod and maturity by condition of the gonads. Condition of sternal spines was determined for non-ovigerous females to distinguish the primiparous and multiparous females. A modal analysis (Macdonald and Pitcher 1979) of the pooled length frequency distributions of male shrimp was performed in an attempt to separate age groups. Weight/length and total length/carapace length relationships were determined by regression analysis and compared, graphically, with relationships from the west Greenland area.

RESULTS

CPUE and Effort

Daily catch (kg) per unit effort (hr) values from mid October to late December are given in Figure 2. After very little success in the first few days, catch rates fluctuated between about 200 and 500 kg per hour up to November 1. This was followed by a slow decrease which levelled off at about 120 kg per hour towards the end of November. On December 4, catch rates increased by an order of magnitude over the previous day to 2.4 t per hour, declined rapidly over the next week and increased sharply again on the 13th to almost 3 t per hour. Similar to the previous increase, a rapid decline followed. Monthly catch rate values were 300, 180 and 1027 kg per hour from October to December, respectively.

Because of the unusual CPUE pattern, the distribution of fishing effort was examined on a daily basis in relation to area and depth fished. The data were subsequently grouped into six intervals which can be described as follows:

Date	Effort Pattern	Depth Fished (m)
Oct. 14-18	Scattered, searching	> 400 m
Oct. 19-25	Concentrated at 65°N, 59°30'-60°W	< 400 m
Oct. 26-Nov. 8	North of 65°N and farther east	400 - 430 m
Nov. 9- Dec. 1	Father north of 65°N	> 430 m
Dec. 2-12	Moving south of 65°N and west	about 400 m
Dec. 13-25	Concentrated at 64°40'N, 59°15'W	> 400

The locations of fishing for each of these periods and for the complete season are given in Figure 3. In summary, after a few days of searching in the area around 65°N, most effort was focused very close to this latitude in depths less than 400 m. Later in October and November, effort was shifted to progressively deeper water which translated into a northwards displacement of the fleet. The high catch rates of early December are associated with a complete shift in the fishing grounds to the southeast, then proceeding southwest. The second peak in December coincides with a final shift to the easternmost grounds, possibly reflecting the intrusion of ice into the area as well as the search for optimal catch rates.

Length Distributions

Length frequencies for catches sampled during the intervals mentioned above (Fig.4) show the large sizes of shrimp encountered in this area with average carapace lengths in the range of 25 to 27 mm. During the period from mid October to early November, catches were dominated by large (male) shrimp around 24 mm CL and females in the 27 - 28 mm range. The proportion of ovigerous females occurring in the catches increased later in November and it was this group that was responsible for the high catch rates obtained in December. Other than the obvious separation into ovigerous and non-ovigerous animals, modes in the length frequency data were severely overlapped. The shallower waters fished between October 19 - 25 is reflected in the smaller average size and the reduced proportion of berried females.

Biological Samples

The pooled samples (n = 957) consisted of 271 males (28.32 %), 9 transitionals (0.94 %), 142 non-ovigerous females (14.84 %) and 535 ovigerous females (55.90 %) (Fig. 5). All transitionals and non-ovigerous females had small ovaries and the latter lacked sternal spines, indicating that they had spawned previously. Only one male had large vasa deferentia and was classified as mature, the remainder being considered as maturing. The average length of the non-ovigerous, multiparous females was 27.74 mm CL compared to 27.42 for the ovigerous females.

Results of the modal analysis for male shrimp (Table 1) show that only two components could be estimated objectively from the severely overlapped data. The smallest mode had an estimated mean length of 21.5 mm and accounted for about 19 % of the sample. The larger, comprising 81 %, had a mean length of 24.3 mm CL.

Comparison of the weight/length relationship from Div. 0B (Fig. 6) with that from west Greenland (Carlsson pers. com.) shows, on average, greater weight at length in the former area, as well as the greater sizes attained. For example, a 26 mm shrimp would be expected to weigh 12.0 g in Div. 0B compared to only 10.3 g off west Greenland. The total length/carapace length relationships also show differences between the two areas (Fig. 7). Generally, for a given carapace length, total lengths were greater in Div. 0B. The differences were more pronounced at smaller sizes.

Shrimp Discards and By catches

Shrimp discards, as reported by observers, were estimated at 1.6 % of the total shrimp catch. This low level was consistent throughout the time period and reflects the large sizes and good quality of shrimp present in the area. The observer estimates were only slightly higher than the vessel log values (1.1 %), confirming the low discard levels. No length distributions of discarded shrimp were available to monitor the sizes but, with such low discard rates and large sizes occurring in the catches, any discarding was likely due to damage.

Main by-catch species were Greenland shark, Greenland halibut and redfish with lesser amounts of skates, Arctic cod and sculpins. In most instances, shrimp comprised over 90 % of the total catch of all species except when Greenland sharks were present. Catch rates of Greenland halibut and redfish increased in December to about 16 and 27 kg per hour, corresponding to total discards of 30 and 49 t, respectively for that month. No length distributions of discarded fin fish were obtained and, consequently, these data cannot be translated into numbers.

DISCUSSION

The daily CPUE figures tell a lot about the activities of the shrimp fleet but very little about the distribution and behaviour of the shrimp themselves. Generally, catch rates were low north of 65^{0}N and high south of this latitude but because the two areas were fished at different times it is not possible to say that the concentrations remained low to the north when fishing occurred in the south or were always high in the south when fishing occurred in the north. The dramatic increase in catch rates in December can only be related to a change in the fishing grounds and, although it might also be related to a concentration of berried females over a brief period, the data cannot substantiate this possibility. The effects of fishing might be reflected in the CPUE data in that there was a slow decline in catch rates in the northern areas from mid October to the end of November and rather sharp decreases from the high levels achieved in December. The latter periods suggest that dense concentrations might be highly sensitive to intensive fishing pressure.

The fact that the high densities encountered in December consisted primarily of ovigerous females might cause some concern for recruitment overfishing. However, the mechanisms of recruitment in this area are totally unknown and the effects of fishing the spawning stock biomass in 1988 on future recruitment will not be measurable for several years. The 1989 fishery should give some idea of the effects of the 1988 fishery on the spawning stock (i.e. decrease in average size, reduced proportions of females, lower catch rates) and provide some perspective for the 1988 catch level.

Biological sampling data show that the largest (oldest) males attain greater sizes than in either the traditional west Greenland area or off Labrador. The modal analysis revealed two components but it is quite probable that three exist within that range, in which case the first mean size is probably overestimated and the second, underestimated. In either instance, the estimated mean size of 24.3 mm CL is considerably larger than either 22.3 mm in the SA 0+1 fishing area or 20.9 mm in the Hopedale Channel (Div. 2H) (Parsons et al. 1988). Similarly, the mean size of females is larger in Division 0B. The non-ovigerous, multiparous female group averaged 27.7 mm compared to 26.1 mm and 24.8 mm for the other two areas, respectively. No comparison is possible for the primiparous females because, in the 0B samples, they were indistinguishable within the ovigerous group. Although the ageing of shrimp in Division 0B has not been resolved, these patent differences likely reflect the different rates of growth and maturation between the areas. It is known that temperatures in the area off Cumberland Sound are colder than in either the grounds off Store Hellefiske Banke or off Labrador (Dupouy et al. 1979).

The comparison of other biological characteristics (i.e. weight/length, total length/carapace length) also suggests some differences between the animals in the two areas. It is possible that the high proportion of ovigerous females in the sample from Division 0B contributes to some of the observed difference and a more rigorous analysis is recommended. Also, the total length/carapace length comparison should be performed over a broader size range. Nevertheless, it appears that this resource is separate from that found in the SA 0+1 fishery, both geographically and, in some ways, biologically. It is not certain if they are different stocks because there might be some connection through recruitment in either or both directions. It is likely, however, that adults constitute separate fishable units with no apparent mixing at that stage.

Other characteristics of the fishery create no immediate concerns. By catches of important fin fish species were generally low, the incidental occurrence of Greenland shark representing the only operational problem. Shrimp discards are minimal and should remain at low levels, provided the average size of animals in the catches continues to be substantially larger than those encountered in the other northern shrimp fisheries in the northwest Atlantic. Because the fishery is new, and because very little is known about the resource in this area, observer coverage should be maintained at high levels to closely monitor all aspects of the fishery in its formative stages.

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Table 1. Results of Macdonald and Pitcher (1979) analysis for male shrimp from Division 0B, November - December, 1988.

INTERVAL	EXPECTED COUNT	OBSERVED COUNT	RIGHT BOUNDARY
1	2.4680	2.0000	20.0000
2	4.3482	5.0000	20.5000
3	8.2666	9.0000	21.0000
4	12.4446	12.0000	21.5000
5	15.6612	14.0000	22.0000
6	18.0735	19.0000	22.5000
7	21.0295	22.0000	23.0000
8	25.1034	26.0000	23.5000
9	29.0046	27.0000	24.0000
10	30.6111	28.0000	24.5000
11	28.6812	32.0000	25.0000
12	23.6260	25.0000	25.5000
13	17.0653	16.0000	26.0000
14	10.8023	10.0000	26.5000
15	5.9916	4.0000	27.0000
16	2.9119	6.0000	27.5000
17	1.9110	1.0000	

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20.00 EEEOE
20.50 EEEEEEEEO
21.00 EEEEEEEEEEEEEEE O
21.50 EEEEEEEEEEEEEEEEEEEEEEX
22.00 EEEEEEEEEEEEEEEEEEEEEEEEEOEEE
22.50 EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE O
23.00 EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE O
23.50 EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE O
24.00 EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEOEEE
24.50 EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEOEEEE
25.00 EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE     O
25.50 EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE  O
26.00 EEEEEEEEEEEEEEEEEEEEEEEEEEEEEOEE
26.50 EEEEEEEEEEEEEEEEEEOE
27.00 EEEEEEEOEEE
27.50 EEEEE     O
      EOEE
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Proportions and their standard errors

0.18598	0.81402
0.13158	0.13158

Means and their standard errors

21.5470	24.2694
0.5863	0.3216

Sigmas and their standard errors

0.9265	1.3680
0.2944	0.1791

Degrees of freedom = 11

Chi-squared = 5.29803 (P = 0.9159)

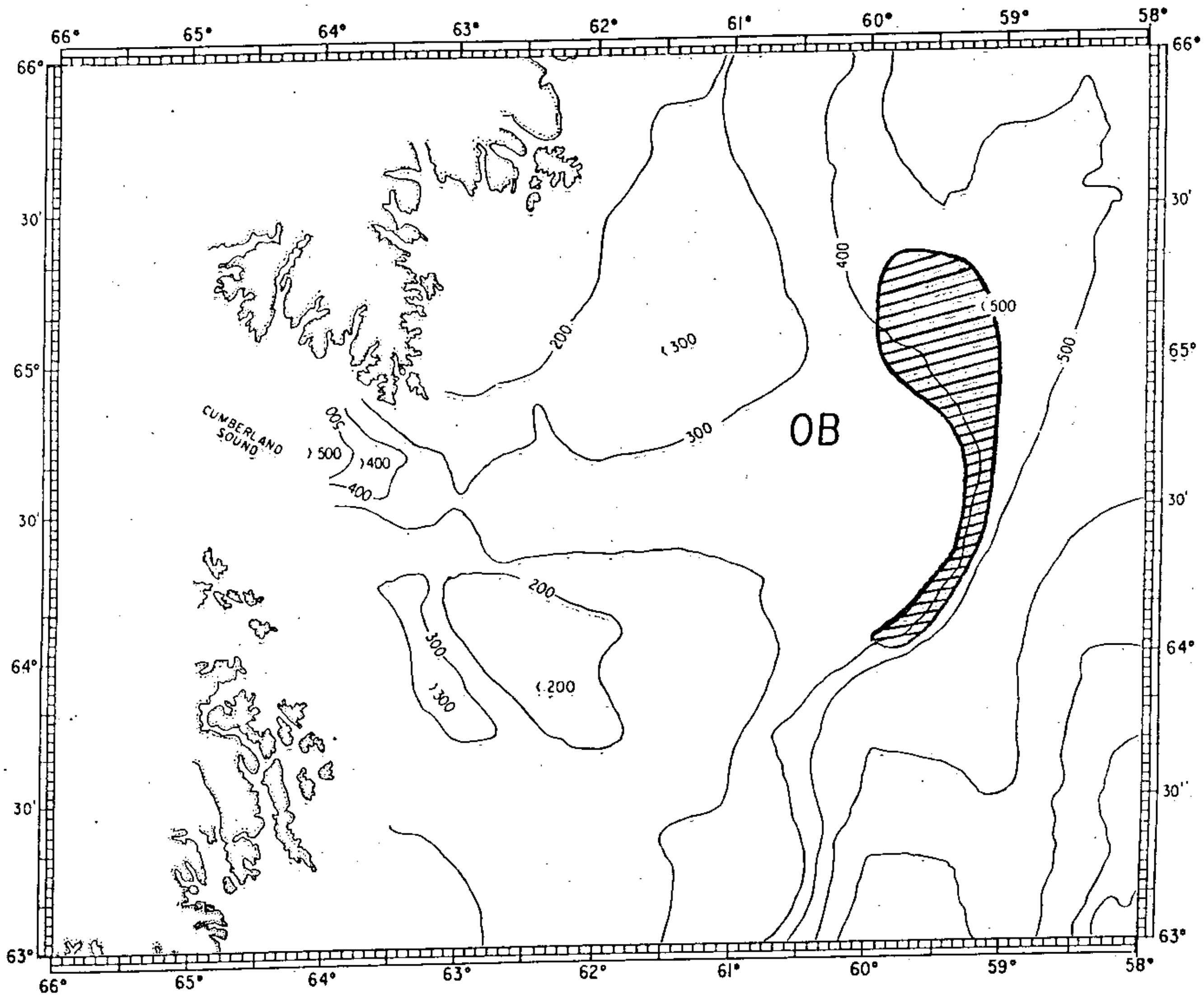

Fig. 1. Shrimp fishing area in Division OB, October-December, 1988.

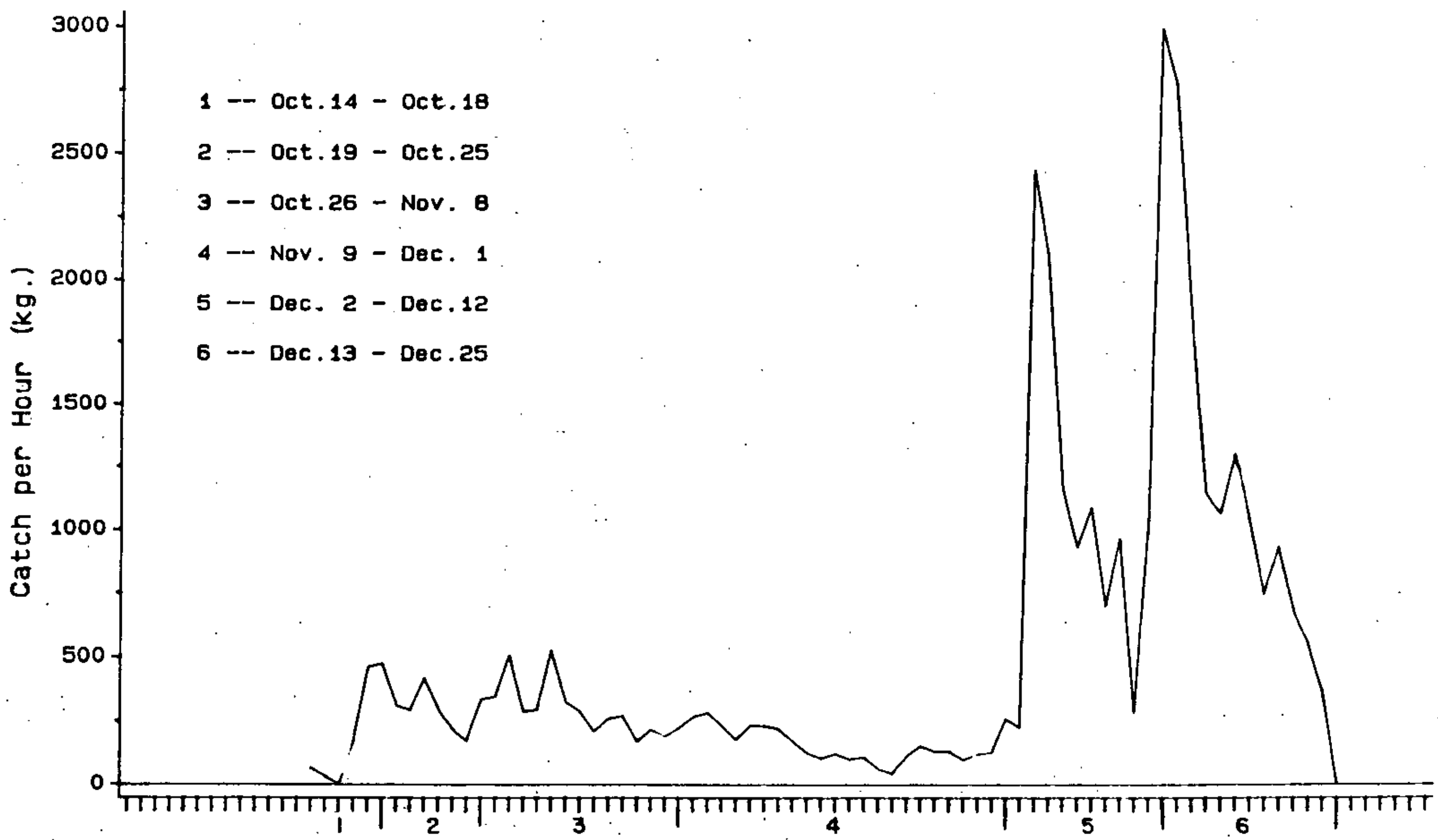

Fig.2 Daily catch (kg) per unit effort from mid-October to late December. Div.OB, 1988.

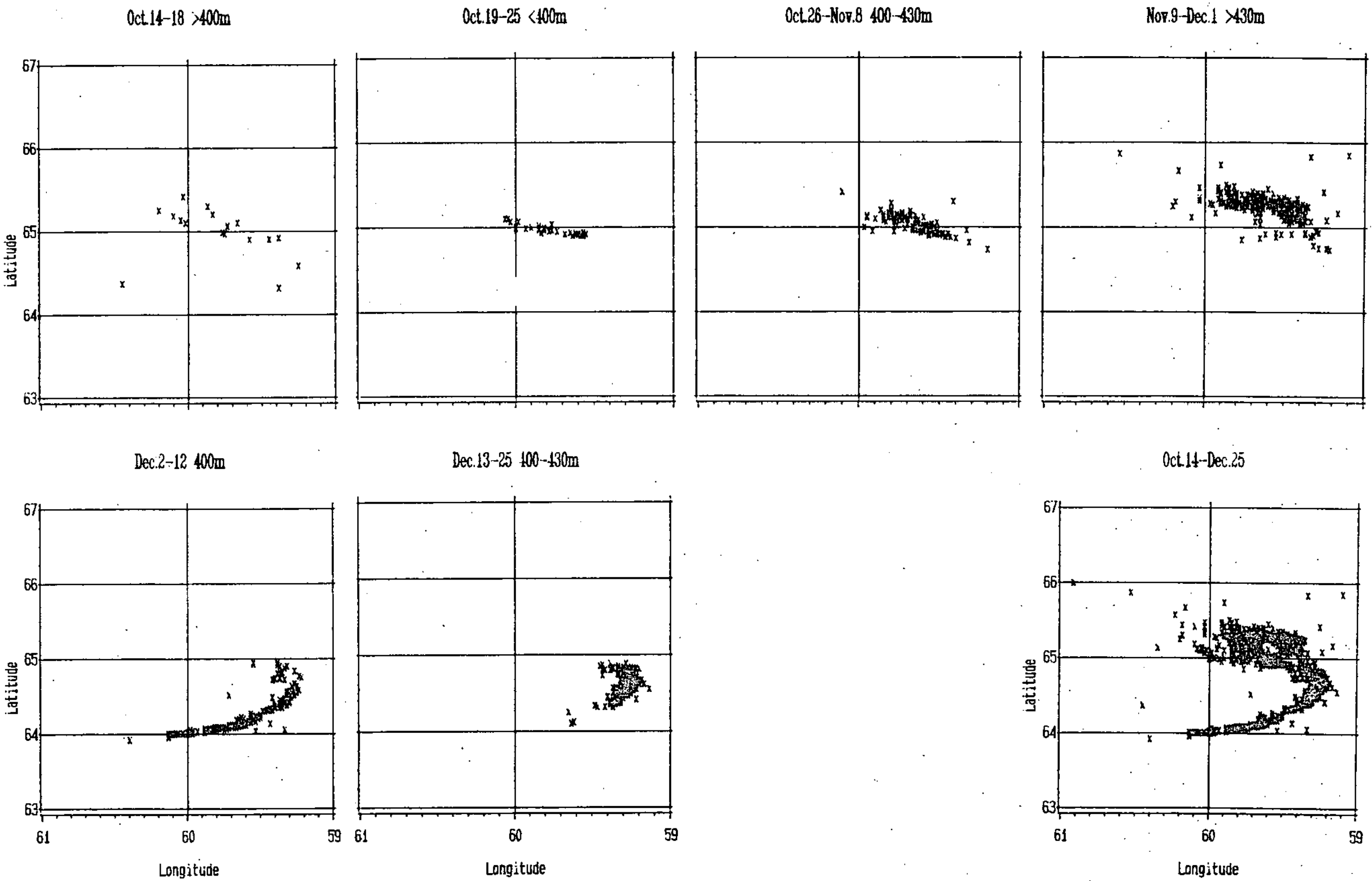

Fig. 3. Distribution of fishing effort for shrimp in Div. OB, 1988.

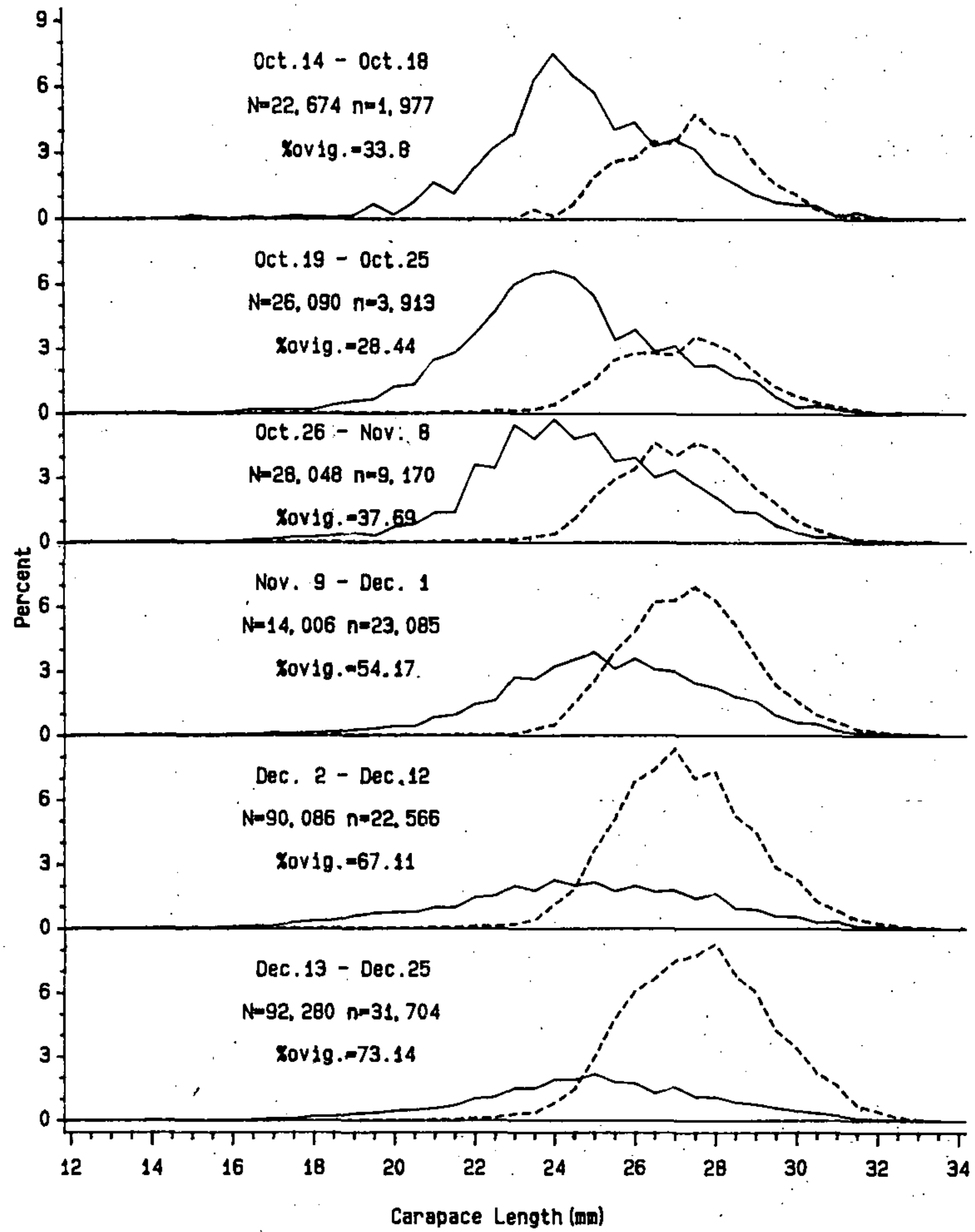

Fig.4 Length distributions of shrimp caught during the six time periods previously defined. (Broken line=ovigerous, N=number per hour, n=number measured).

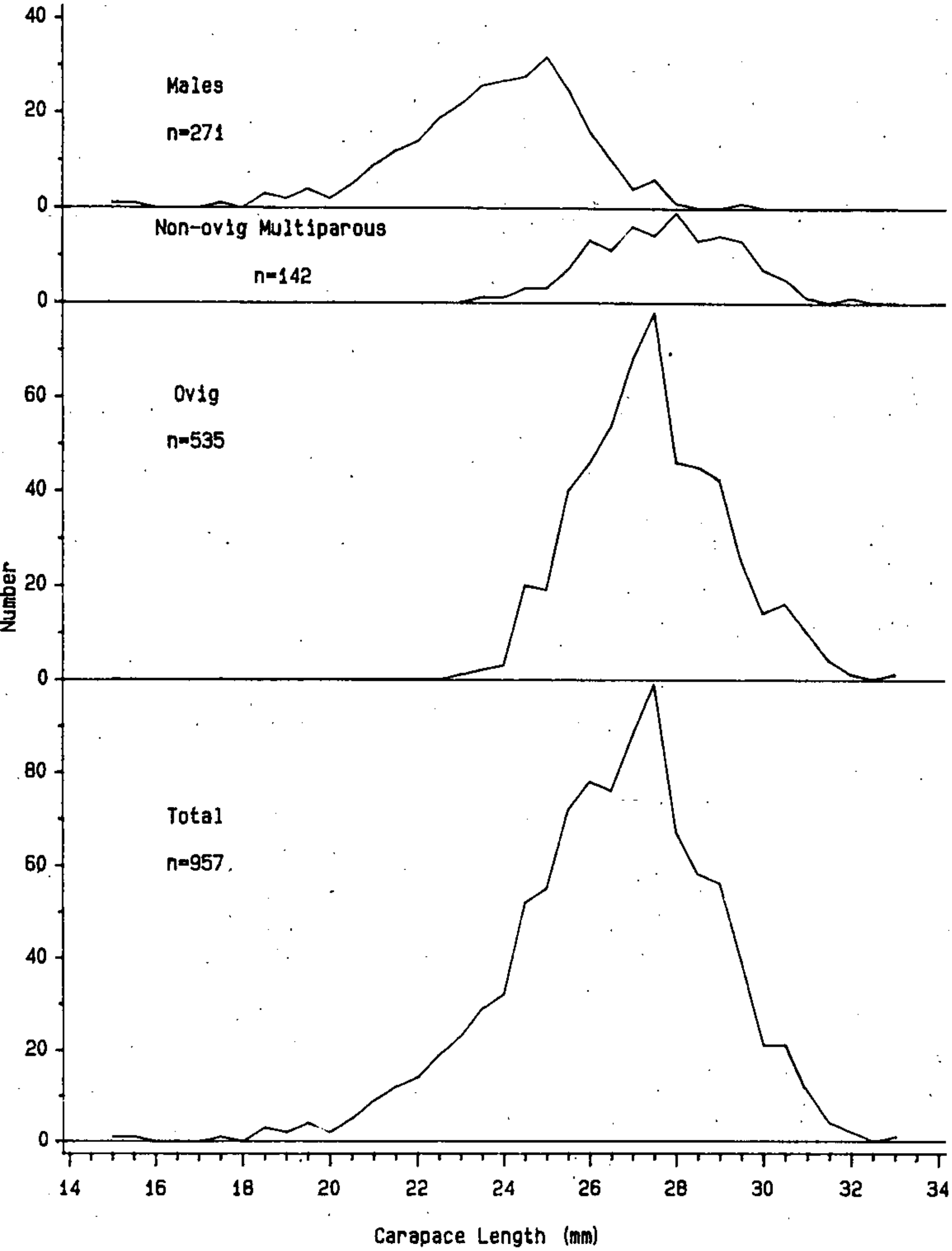

Fig.5 Pooled length distributions of males, multiparous and ovigerous females, and total sample from three samples in Div.0B, 1988.

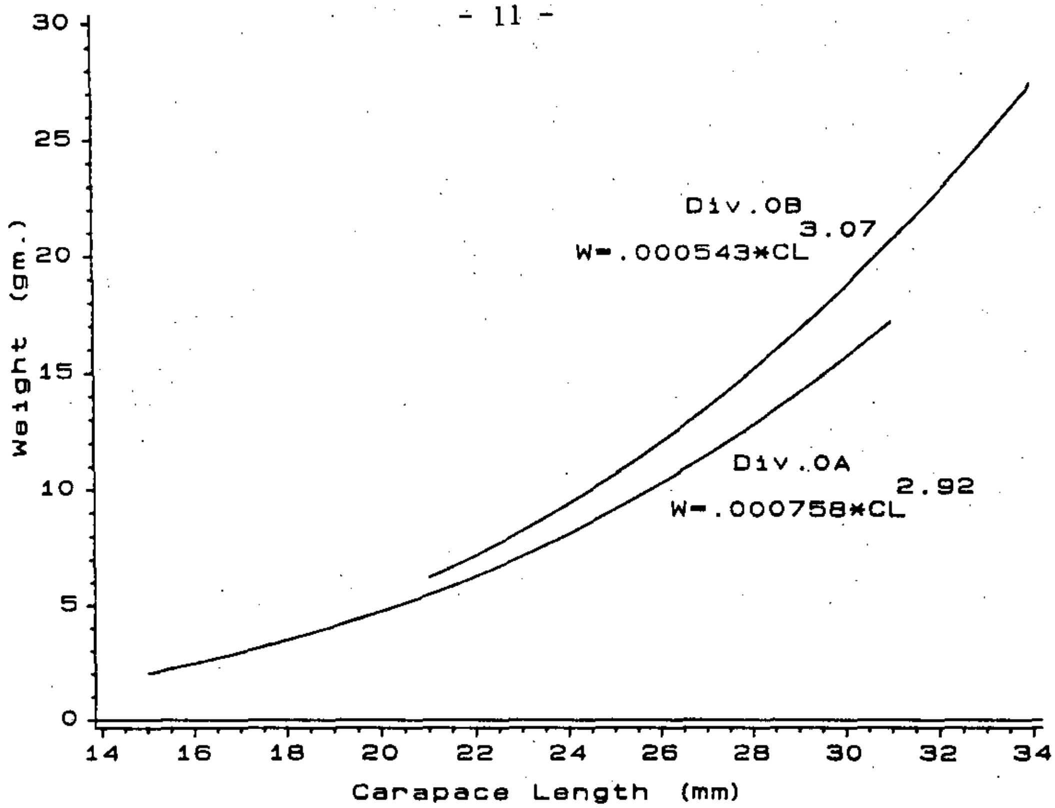

Fig.6 Weight/carapace length relationships for shrimp in Div.OB and West Greenland.

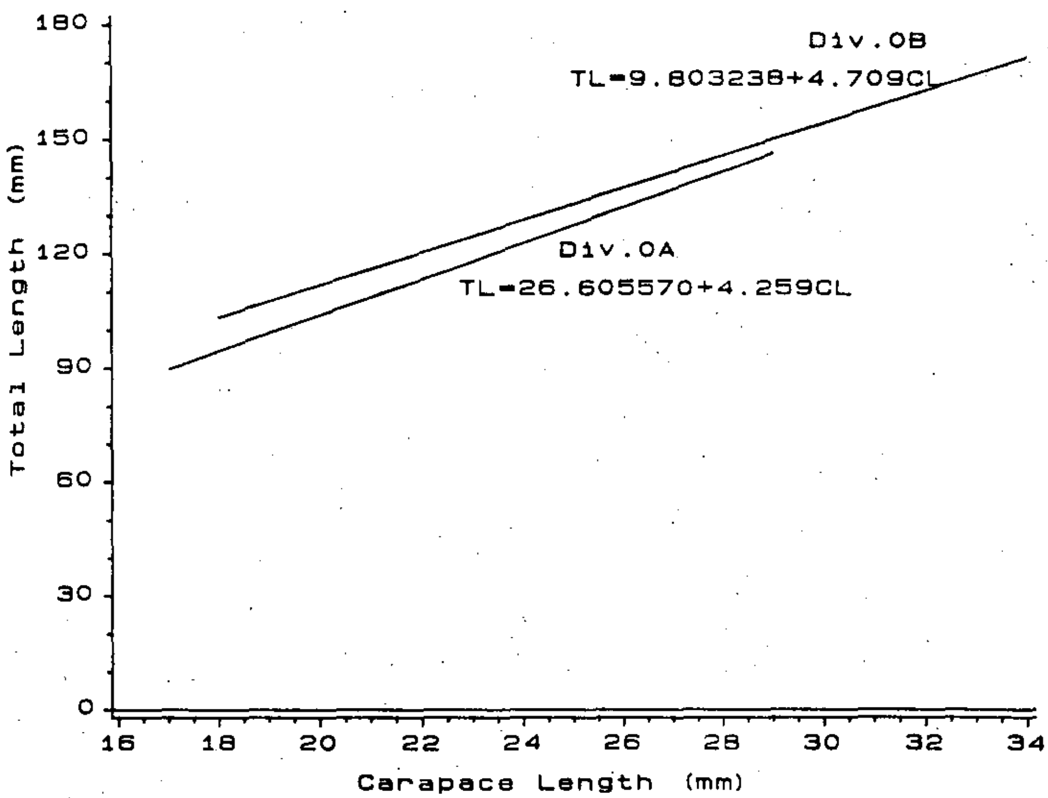

Fig.7 Total length/carapace length relationships for shrimp in Div.OB and West Greenland.