

DISTRIBUTION OF DEEP SEA SHRIMP (Pandalus borealis Krøyer) IN RELATION TO TEMPERATURE IN THE BARENTS SEA

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ABSTRACT

In the years 1980 to 1985 stratified random bottom trawl surveys were carried out on the shrimp fields in the Svalbard and Barents Sea regions. The objectives of the cruises were to study the structure of the shrimp stock and to estimate the abundance of shrimp. On each trawl station the bottom temperature was measured. Only the results from the surveys in the Barents Sea have thoroughly been analysed with regard to temperature. In the investigated area the deep sea shrimp was abundant in areas with temperature between -1°C and 7°C . The deep sea shrimp appear to avoid cold water fronts of bottom water. The highest shrimp densities were found on the warm water side of the front.

INTRODUCTION

The deep sea shrimp (Pandalus borealis, Krøyer) is widely distributed in the boreal waters. The distribution is discontinuous circumboreal. Factors influencing the distribution patterns are depth, temperature, salinity and substratum. The most common temperature range for P. borealis is between 0°C and 5°C (e.g. HJORT and RUUD 1938, BRYAZGIN 1967, RASMUSSEN 1967). The deep sea shrimp has been reported found in waters with temperatures of -1.6°C (GORBUNOW 1934, INGRAKAM 1981) and upwards to 12°C (BJØRK 1913). It has been reported that extended exposure to temperatures below -1°C is deleterious and may cause mass mortalities (HORSTED and SMIDT 1956, and INGRAKAM 1981). SMIDT (1978) observed that changes in the distribution of age classes in Disko Bay, West Greenland, were likely caused by intrusion of warm bottom water (7° - 8°C). ABERCROMBIE and JOHNSON (1941) describe the effects of temperature shock on shrimps. They (op.cit.) observed that thermal death at low temperatures was a slow process. At low lethal temperatures the period of depression may last for hours or days. The activity of shrimps increases as the temperature increases. At high lethal temperatures, between 10°C and 15°C , there may be no period of depression, and the shrimps may be subject to a sudden death.

MATERIAL AND METHODS

A stratified random sampling scheme was used on bottom trawl surveys with R/V "Michael Sars" in the years 1980 to 1985 in the Barents Sea. The main objective was to estimate the abundance and structure of the deep sea shrimp

populations. Similar investigations were conducted in the Spitsbergen waters in the years 1982 to 1985. The results from both these investigations are published as reports to the ICES Shellfish Committee (TAVARES and ØYNES 1980, TEIGSMARK and ØYNES 1981, TEIGSMARK and ØYNES 1982, TEIGSMARK and ØYNES 1983, HYLEN, TVERANGER and ØYNES 1984, TVERANGER and ØYNES 1985). In this instance, only the results from the Barents Sea are presented.

The bottom temperature was measured at each trawl station in this program. However, during 1983 very few temperatures were measured because of some administrative and technical problems. Also from 1984 there are few temperature registrations available in time for this meeting because of an error in the computer system.

In the Barents Sea there are bottom temperatures from 93 trawl stations in 1981, 106 in 1982 and 116 in 1985. During 1984 the bottom temperature was measured, but only 14 can be found in the computer system. However, we know that the bottom temperature was above 0°C at each station (Loeng pers. comm.).

The investigations took place in the same area and during the same period of the year each year, namely April/May.

RESULTS AND DISCUSSION

Table 1 shows the number of trawl stations in each half degree temperature interval and the mean amount by weight of shrimps per 3 nautical miles (1 hour trawled). In 1981 the highest density of deep sea shrimps were in waters of temperature between -0.9°C and -0.5°C (233 kg per 3 nautical miles). In 1982 there were small differences in catch per hour in the different temperature intervals, and the maximum catch (199 kg per hour) were taken in an area with temperature between 2.1°C and 2.5°C. In the years 1984 and 1985 the bottom water was warmer on the shrimp fields than the years before.

Table 1. Number of trawl stations in different temperature regimes, and the mean amount by weight of shrimp in each haul of one hour duration (kg/h).

Temperature	YEAR							
	1981		1982		1984		1985	
	NO.	kg/h	NO.	kg/h	NO.	kg/h	NO.	kg/h
< - 1°C	3	27	2	63	0			
-0.9°C - -0.5°C	2	233	5	80	0			
-0.4°C - 0°C	9	142	5	117	0			
0.1°C - 0.5°C	14	137	9	141	3	289	9	166
0.6°C - 1.0°C	18	134	19	177	3	421	17	151
1.1°C - 1.5°C	18	157	30	116	2	149	26	148
1.6°C - 2.0°C	8	112	5	172	0		19	75
2.1°C - 2.5°C	5	87	8	199	4	197	20	42
2.6°C - 3.0°C	16	113	7	146	2	234	9	46
3.1°C - 3.5°C	0		13	93	0		5	42
3.6°C - 4.0°C	0		3	65	0		11	89

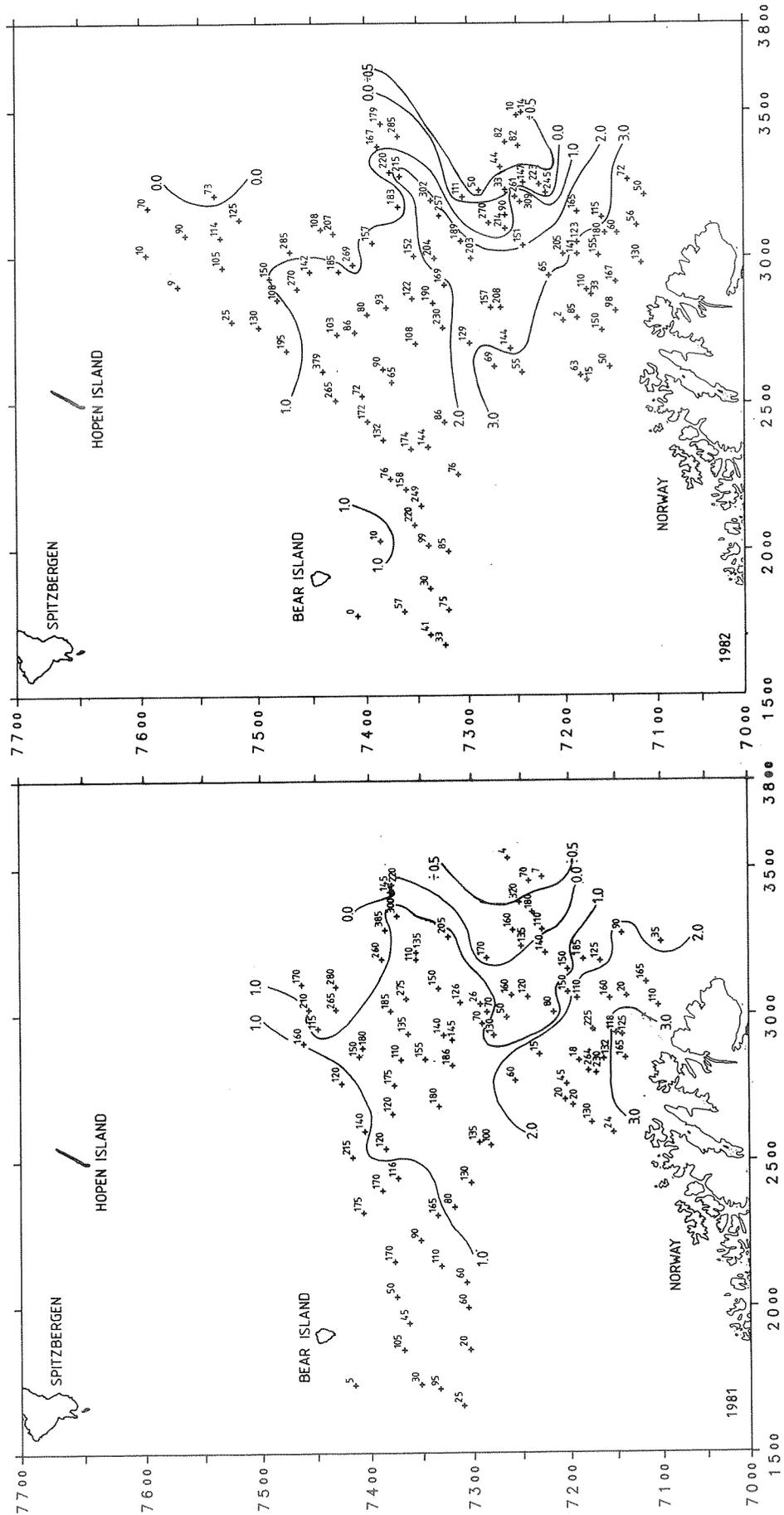


Fig. 1. Trawl stations with catch per 3 nautical miles and bottom isotherms ($^{\circ}\text{C}$) during the surveys in 1981 (left) and 1982 (right).

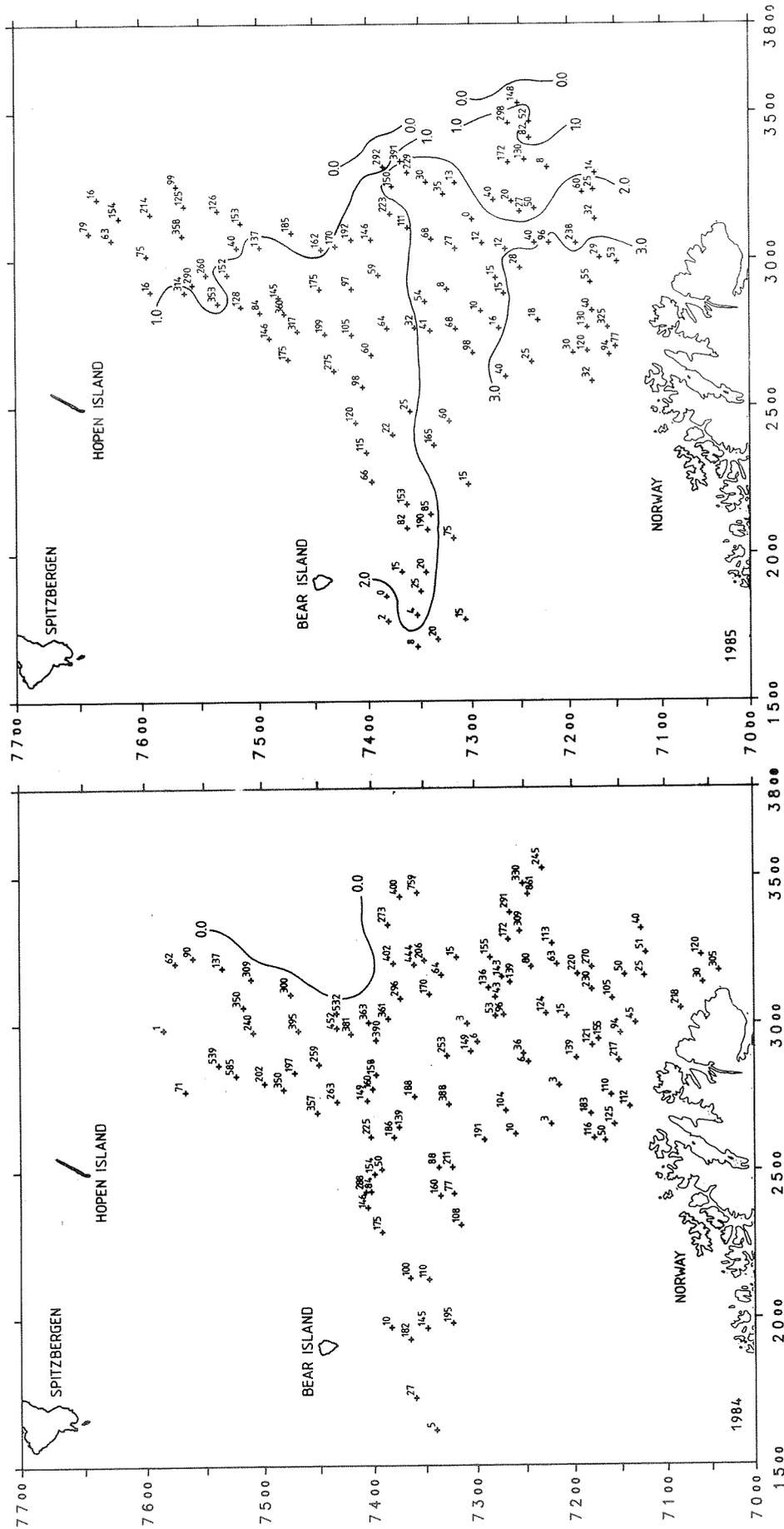


Fig. 2. Trawl stations with catch per 3 nautical miles and bottom isotherms ($^{\circ}\text{C}$) during the surveys in 1983 (left) and 1984 (right).

During these two years there were no temperatures below 0°C on the shrimp fields. The highest density of shrimps were found in the coldest water between 0 and 1°C. Figs 1 and 2 show the position of trawl stations and the catch per 3 nautical miles on each station. The bottom isotherms are indicated based on the temperature measurements taken at each station. In 1981 the eastern part of the shrimp fields was overflowed by cold water (Fig. 1). The highest density of shrimps was at the border between the cold and warm bottom water. The same situation occurred during 1982 on the shrimp field at the Tiddly Bank between N72°00' to N73°00' and E32°00' to 36°00' (Fig. 1). During the years 1984 and 1985 there were no temperatures below 0°C. But for 1984 and 1985 the cold front was close to the eastern shrimp fields (Fig. 2).

CONCLUSIONS

It looks like the shrimp do not prefer any specific temperature interval between -0.5°C and 4°C but the deep sea shrimp seem to avoid fronts of cold bottom water. At temperatures below -0.5°C, the catches of shrimps decreased sharply. Other factors like depth, currents, and predation from fish are probably more decisive factors for the density of shrimps.

REFERENCES

- ABERCROMBIE, M. and JOHNSON, M.L. 1941. The effect of temperature on the respiratory movements and viability of a cold-water prawn, Pandalus borealis. Proc. Zool. Soc. Lond, Ser. A. III: 87-99.
- BJØRK, W. 1913. Bidrag til k nneheten om nordhafskr kens (Pandalus borealis Kr.) utbredning och biologi i Kattegat och Skagerrak. Svenska hydrogr. - biol. Komma Skr. No. 4: 1-11.
- BRYAZGIN, V.F. 1967. On the biology and distribution of Pandalus borealis in the offshore waters of the Barents Sea. Ann. Biol. 24: 204.
- GORBUNOW, G. 1934. Die Decapoden Crustaceen der nordischen Halfe des Karischen Meeres. Trans. Arctic. Inst. Vol IX. 1934.
- HJORT, J. and RUUD, J.T. 1938. Deep-sea prawn fisheries and their problems. Hvalr. Skr. 17: 1-44.
- HORSTED, S.A. and SMIDT, E. 1956. The deep sea prawn (Pandalus borealis Kr.) in Greenland waters. Medd. Dan. Fish. Havunders. N.S. 1(11), 118 p.
- HYLEN, A., TVERANGER, B. and ØYNES, P. 1984. Norwegian investigations on the deep sea shrimp (Pandalus borealis) in the Barents Sea in April-May and in the Spitsbergen area in July-August 1984. Coun. Meet. int. Coun. Explor. Sea 1984 (K-21): 1-7. (Mimeo).
- INGRAKAM, W.J. Jr. 1981. Environment of pink shrimp in the western Gulf of Alaska. In T. Frady (editor). Proceeding of the International Pandalid Shrimp Symposium, Kodiak, Alaska 1979, p. 361-375. Univ. Alaska Sea Gram Rep 81-3

- RASMUSSEN, B. 1967. Temperaturforhold og rekefiske i Skagerak 1962-66. Fiskets Gang Nr 47: 842-847.
- SMIDT, E. 1978. Diurnal variation in shrimp catches on the offshore grounds in ICNAF divisions 1B and 1C. ICNAF Sel. Pap. 4: 45-46.
- TAVARES, A.M. and ØYNES, P. Results of a stratified trawl survey for shrimps (Pandalus borealis) in the Barents Sea and the Spitsbergen area in May-June 1980. Coun. Meet. int. Coun. Explor. Sea, 1980 (K:22): 1-6. 3 tabs, 1 Fig. (Mimeo.)
- TEIGSMARK, G. and ØYNES, P. 1981. Results of a stratified trawl survey for shrimp (Pandalus borealis) in the Barents Sea in May-June 1981. Coun. Meet. int. Coun. Explor. Sea, 1981 (K:21): 1-9, 5 tabs, 4 Figs. (Mimeo.)
- TEIGSMARK, G. and ØYNES, P. 1982. Norwegian investigations on the deep Sea shrimp (Pandalus borealis) in the Barents Sea in 1982. Coun. Meet. int. Coun. Explor. Sea, 1982 (K:12): 1-8, 6 tabs, 6 Figs. (Mimeo.)
- TEIGSMARK, G. and ØYNES, P. 1983. Norwegian investigations on the deep Sea Shrimp (Pandalus borealis) in the Barents Sea in April-May 1983 and in the Spitsbergen area in July 1983. Coun. Meet. int. Coun. Explor. Sea, 1983 (K:46): 1-6, 10 tabs, 2 Figs. (Mimeo.)
- TVERANGER, B. and ØYNES, P. 1985. Results of stratified surveys for shrimps (Pandalus borealis) in the Barents Sea in May and in the Svalbard region in July-August 1985. Coun. Meet. int. Coun. Explor. Sea, 1985 (K:56): 1-25.