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GROWTH, RECRUITMENT AND MORTALITY OF *PANDALUS BOREALIS* (KRØYER), IN BALSFJORD, NORTHERN NORWAY

by

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ABSTRACT.

A population study of the deep sea prawn started in autumn 1975. Eight months were sampled until July 1976. The von Bertalanffy growth parameters were estimated from mean carapace length of certain yearclasses, excluding the oldest. Values for L_∞ and K show faster growth but smaller asymtotic length compared to Barents Sea values. The maternal generation did not moult until 1.5 months after the eggs had hatched. Recruitment to the utilized stock was estimated to take place at age 1.2 years. From then instantaneous rate of mortality Z, were found to increase throughout the prawns life. This can partly be explained by an increasing ratio of predation by cod.

INTRODUCTION.

In 1975 the Institute of Biology and Geology at the University of Tromsø, started a study of the biological productivity of Balsfjord, a North-Norwegian fjord. Part of this project is a population study of the deep sea prawn (Pandalus borealis). This species undergoes exploitation both from a small prawn fishery and from a cod (Gadus callarias) population in the fjord (KLEMETSEN, in prep.).

RASMUSSEN(1953) has described the growth of the deep sea prawn at several localities on the Norwegian coast, including Balsfjord. FONTAIN (1975) has given a report on the von Bertalanffy growth parameters from different offshore areas sampled in May - June. The present study was undertaken to determine growth, recruitment and mortality of the prawn stock in Balsfjord.

MATERIAL AND METHODS.

Balsfjord is situated a short distance south of Tromsø, and the fjord penetrates some forty kilometers south-east into mountainous country. It has a sill at the entrance (69°33'N.lat 18°54'E.long.), with a threshold depth of 35 meters. The fjord is further divided into three basins, the middle one being the main prawn field. The depth here is 180 - 190 meters.

On account of the sill, little replacement of the watermass occurs. As a result the deeper parts of the fjord are almost arctic. SCHEI (1975) reported that only late in the year (Sept.-Dec.), will the temperature at the bottom exceed 3° C.

The prawn investigations started in October 1975. Sampling took place every month, exept for November and December when it was interrupted because of the polar night.

An ordinary small prawn trawl (head line 14 m) was used. Internal mesh size was 30 mm (10 mm in the cod end).

The catches of P. borealis were counted, sexed and measured (carapace length) to nearest mm below. The length- and year class- distributions of the catch was assumed to be idential to those of the prawn population.

Yearclasses were usually easy to separate by their length frequency distributions. When not, the probability - paper method (HARDING, 1949) was used to establish means and standard deviations of the yearclasses involved. The assumption that the length distribution of a yearclass fitts the normal distribution, was taken.

The von Bertalanffy growth parameters: L_{∞} , K and t_0 were calculated following RICKER (1975). Only data from well defined yearclasses were used; the oldest was excluded and so was the youngest until it became fully recruited. To make a comparison with earlier results, data form two separate months were used for the same estimates.

An estimation was made when a yearclass would recruit to the stock by comparing the yearclass frequency distributions throughout the period sampled.

Instantaneous rate of total mortality (Z) was estimated throughout the sampling period by comparing the relative strength of the different yearclasses.

Stomach contents of cod from Balsfjord were examined from February 1975 to January 1976. All prawns found in the stomachs were measured and assigned their respective yearclasses. The ratio between yearclass frequency distributions in the cod stomachs and in the prawn stock(i.e. catches), were calculated on the assumption that monthly yearclass frequency distributions of the prawn stock do not change significanty from year to year. This should show how the degree of predation by cod changes throughout the lifetime of a prawn yearclass.

RESULTS.

Growth.

Table 1 give the mean carapace lengths ($\bar{L}$) and the standard deviations (Sd) of the yearclasses present in Balsfjord through October 1975 - July 1976. It also shows that the 1972 yearclass consisted merely of ovigerous females from October to March, hatching is completed by April 27. However, even in April and May this yearclass is easily recognized by the presence of setae on the pleopods. If one assumes that April 1 is the date of birth, it is evident that the maternal generation did not moult until 1.5 month after the eggs had hatched. This can also be seen from the mean lengths in April and May.

The means within the stippled line in Table 1 were used to calculate L_∞ , K and t_o, given in Table 2. The same parameters were also calculated on the basis of the data from May and June, in order to make a comparison with values form the Barents Sea. The results for these two months show considerable deviations for all three parameters, but the results from June agree well with those calculated from the whole sampling period. Growth in the Barents Sea is slower than in Balsfjord, but the L_∞ value is greater.

Recruitment.

The yearclass distributions (per cent) are listed in Table 3. From May and well into the summer the youngest yearclass is the most abundant one. It is assumed that recruitment to the utilized stock takes place at an age of 1.2 years old.

Mortality.

The instantaneous rates of total mortality (Z) were estimated by comparing the abundance of the different yearclasses throughout all the samples (Table 4).

It is evident that Z increases with age while total mortality through all yearclasses ($\bar{Z}$), seems to be fairly constant during the year.

The yearclass frequency distribution of prawns eaten by cod, is given in Table 5. By changing the yearclasses into agegroups, and taking the ratio between data in Tables 5 and 3, one ends up with Table 6. It shows that the degree of predation by cod on the prawn stock steadily increases from the I-group upwards. During the first year of life, no predation by cod was observed, and during the second year (I-group) the ration grew to one in the end of the year.

DISCUSSION.

In ageing the Balsfjord prawn stock, the oldest yearclass might be mixed up with some older individuals in the autumn (Table 1). However, due to the high mortality rate it does not seem likely that such individuals should live long enough to contribute to a second spawning. It is therefore concluded that a spawning group consist of one yearclass only.

Because of the doubt in ageing and the long ovigerous period, where no length growth takes place, data on the 1972 yearclass was not used in the calculations of the von Bertalanffy growth parameters.

In spite of the confined data underlaying the calculations of the growth parameters, the model fitted seem to describe growth in older yearclasses fairly good. Estimated $\bar{L}$ values for the 1973 yearclass in June and July, are 20.2 and 20.6, and the corresponding values for the 1972 yearclass are: 22.6 and 22.9.

Comparisons with the Barents Sea values for L_∞, K and t_o, reveal significant differences in all three parameters. (Table 2). According to BEVERTON AND HOLT (1959) food and temperature account for most of growth variation between different areas in a given species. while food modifies the L_∞, temperature will affect both L_∞ and K. An increase in temperature will increase K, and decrease L_∞. The differences in L_∞ and K, between the Barents Sea and Balsfjord, supports this argument. However, the difference in K seems surprisingly great.

Estimating the instantaneous rate of total mortality (Z) directly from the ratio of the catch instead of abundance of a yearclass in two successive years, might introduce an error if there has been any change in fishing mortality (BEVERTON AND HOLT, 1957). The legal mesh-seiz in the North-Norwegian prawn fishery is 35 mm (internal stretched) in the cod-end, which corresponds to a fifty per cent retention length of 15 mm carapace length (THOMASSEN AND ULLTANG, 1975). According to Table 1, the exploited phase of P. borealis in Balsfjord, starts at age 1.8 years. Consequently the first year of estimated Z, i.e. until April 1973/1974, should be biased due to fishing mortality in one of the yearclasses involved in the calculations.

The increasing Z throughout the prawns life can partly be explained by the greater share eaten by cod (Table 6).

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Table 1. Pandalus borealis. Mean lengths (in mm carapace), $\bar{L}$, and standard deviation (Sd) of the yearclasses present in Balsfjord from October 1975 to July 1976.

Date of sampling		1975 $\bar{L}$	1975 Sd	1974 $\bar{L}$	1974 Sd	1973 $\bar{L}$	1973 Sd	1972 $\bar{L}$	1972 Sd
1975	Oct. 15			12.1	1.0	17.3	0.8	21.4	1.9*
1976	Jan. 28	7.0	0	14.5	0.9	18.8	0.8	21.2	0.9*
"	Feb. 13	8.1	0.6	15.0	0.9	19.1	0.9	21.2	1.3*
"	Mar. 10	8.5	0.8	15.3	0.7	19.3	1.0	21.6	1.5*
"	Apr. 27	9.3	0.9	16.6	0.9	19.9	0.8	21.2	1.2
"	May 18	9.8	1.0	15.9	0.9	20.1	1.1	21.4	1.2
"	Jun. 15	10.7	0.8	16.6	0.9	20.2	1.1	23.0	1.0
"	Jul. 27	12.7	1.0	17.7	0.8	22.0	0.9	22.9	0.7

*Whole yearclass consist of ovigerous females.

Table 2. Pandalus borealis. Von Bertalanffy growth parameters from areas in the north east Atlantic.

A r e a	L_∞ (mm carapace)	K	t_o	Years fitted
	P a r a m e t e r s			
Barents Sea (FONTAINE, 1975)	31.39	0.192	-1.18	2 - 6
Balsfjord (this paper) (all data within stippled line, Table 1)	27.2	0.43	0.03	1 - 3
Balsfjord (all data from May, Table 1)	24.1	0.61	0.26	1 - 4
Balsfjord (all data from June, Table 1)	28.2	0.40	0.05	1 - 4

Table 3. Pandalus borealis. Yearclass frequency distributions (per cent) in all catches throughout the period October 1975 - July 1976.

Year	Month	Yearclass 1975	1974	1973	1972
1975	X	-	63	30	7
1976	I	1	77	19	3
"	II	7	77	14	2
"	III	20	59	16	5
"	IV	40	50	8	2
"	V	69	26	4	1
"	VI	64	30	5	1
"	VII	79	19	2	-

Table 4. <u>Pandalus</u> <u>borealis</u>. Estimates of instantaneous rate of total mortality (Z), in the period October 1975 - July 1976, by comparing strength of different yearclasses.

			Between successive yearclasses						Total	
Year	Month	No. of Samples	-75/-74		-74/-73		-73/-72			
			Z	Sd	Z	Sd	Z	Sd	$\bar{Z}$	Sd
1975	X	2			0.7-0.7		2.3-2.1		1.45	
1976	I	1			1.4		1.8		1.6	
"	II	1			1.7		2.0		1.85	
"	III	3			1.4	0.21	1.0	0.30	1.2	0.10
"	IV	1			1.8		1.4		1.6	
"	V	4	0.9	0.44	1.8	0.55	1.9	0.45	1.53	0.19
"	VI	2	0.2-0.8		1.6-2.1		1.9-2.6		1.53	
"	VII	1	1.4		2.2				1.8	
			0.93	0.45	1.59	0.44	1.81	0.44	1.57	0.20

Table 5. *Pandalus borealis.* Yearclass frequency distributions (per cent) eaten by cod (*Gadus callarias*) in Balsfjord during the period February 1975 - January 1976.

Year	Month	Yearclass 1974	1973	1972	1971
1975	II	--	61	35	4
"	III	1	74	20	5
"	IV	6	69	24	1
"	V	40	45	10	5
"	VI	13	64	21	2
"	VIII	42	42	16	-
"	IX	54	34	12	-
"	XI	67	18	14	-
1976	I	50	37	13	-

Table 6. Ratio of age-group distributions of *Pandalus borealis* eaten by cod (*Gadus callaris*), compared with age-group distributions of the natural *P. borealis* stock (i.e. catches).

Month	Age - group 0	I	II	III	IV
IV	-	.15	1.38	3.00	.50
V	-	.58	1.73	2.50	5.00
VI	-	.20	2.13	4.20	2.00
VII-VIII	-	.53	2.21	8.00	-
IX - XI	-	.95	.87	1.86	-
I	-	.65	1.95	4.33	-
II	-	.79	2.50	2.00	-
III	0.05	1.25	1.25	1.00	-