On the Biology and Exploitation of Shrimp (*Pandalus borealis*) at the Flemish Cap in November and December 1995.

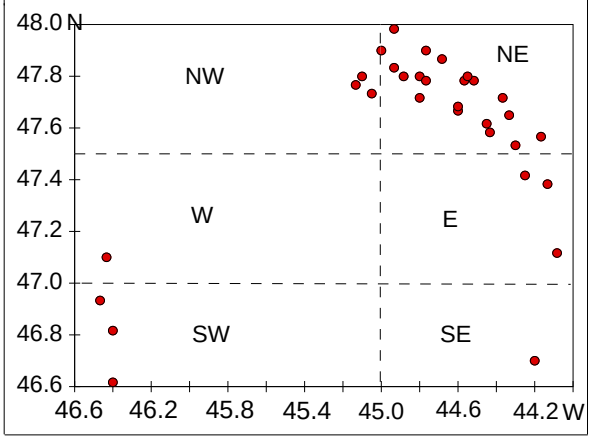
By
Jón Kristjánsson
August 1996

Authors adress:
Krosshamrar 7A
112 Reykjavík
Iceland
www.fiski.com

1. Introduction

Lack of Icelandic data on the shrimp stock at the Flemish Cap and a general discussion on the state of the stock led to a research trip to the Flemish Cap. It was was initiated and funded by some Icelandic trawler companies.The author has been responsible for the collection, analysis and interpretation of the data. Some of the results so far are presented in this paper.

Fig. 1. Location of sample sites in the Dalborg research trip 24/11-19/12 1995.



2. Materials and Methods

Samples were collected on board the commercial Icelandic shrimp trawler Dalborg during the period 24/11- 19/12 1995. Samples were taken from 31 hauls. Locations of the sample hauls are shown in Fig. 1.
The shrimps were measured to the nearest 0.1 mm, sorted into 0.5 mm length classes (OCL) and separated into sex categories, i.e. males, transitionals, and females.
Occasionally, samples were sorted by eye into age classes.
Length-Weight relationship was assumed to be:

$$\text{Weight} = K \times \text{Length}^3$$

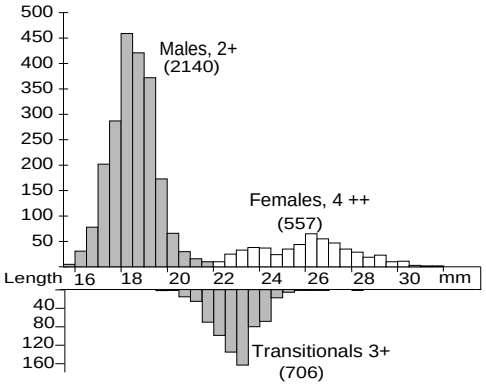
The mean weigth of individuals was found by counting and weighing separate length groups.
K was found to be = 0.58×10^{-3} for animals not bearing eggs and = 0.7×10^{-3} for egg bearing females. Mean individual weights of each age group were calculated from mean lengths of each age goup. Mean weights of age groups were used to compute catch rates (CR, in number of individuals per trawl hour)
Time is GMT, noon is at 15:00 h GMT at the Flemish Cap.
Depths are depths (in fathoms) at the start of each tow.
Information on catch, effort, location etc. in the period 7. July -20. December 1995, are from the Dalborg's log book
The trawl most frequently in use was a 4000 mesh "Bastard", 60-80 mm stretched mesh in the belly, 42 mm in the cod end, equipped with 22 mm sorting grid.
Sometimes, a reserve trawl, 2400 mesh "Angmagssalik" was used.
Age of length groups was assigned according to Parsons (Parsons et al. 1995).
Ages are years, i.e. a year class is 0+ in the birth year, becoming 1+ 1. of January the following year.

3. Results

3.1 Gender distribution, age and mean lengths of year classes

The shrimps could be divided into four age groups.
Two year classes of males, i. e. 1+ and 2+ (year classes 1994 and 1993) of average lengths 11.1 and 18.2 mm (OCL) respectively. Transitionals, 3+, showed a unimodal distribution, average length was 22.7 mm. Females had a relatively wide length distribution probably consisting of up to 3 year classes, 4+ and older. All females, except for one, were egg bearing.
Data on length distribution by genders is shown in Appendix 2.
Mean lengths and catch rates of each year class are shown in Table 1.
Relative distribution by number and by weight is also shown.

Fig. 2. Length, gender and age distribution og 3403 shrimps (stations 1-27).



Differences in mean lengths of 2+ and 3 + shrimps between sample sites were small, SD. for 2+ was 1.37 and 1.67 for 3+, indicating a single stock of shrimps at the Flemish Cap.

Table 1. Age and gender distribution of the shrimps.

Age	1	2	3	4	5	6
Year Class	1994	1993	1992	1991	1990	1989
Gender	Males	Males	Trans.	Females.	Females	Females
Mean Length, mm	11.1	18.2	22.7	23.5	26	(28)
% Number	-	72	16	12		
% Weight	-	50	22	29		
Mean Catch Rate, no/hour	-	44.508	5.998	5.105		

3.2 Gender distribution by depth

Figs. 3-5 show CR's of genders plotted against depth. Catch Rates for males decrease with depth while catch rates for both transititonals and females increase with depth. Older shrimps tend to be distributed in deeper waters than younger ones.
The average CR for males was 44.509 ind./h, 5.998 for transitionals and 5.105 for females. Earlier in the season the corresponding catch rates were 30.562, 13.160 og 12.010 (Table 5).
It therefore appears that CR's for 2+ shrimps have increased by 50% while it has decreased for older animals. The possible effect of season and type of trawl is not known.

Fig. 3. CR (ln no./h.) of males by depth (ftm).

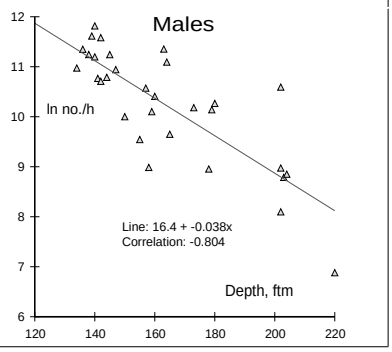


Fig. 4. CR (ln no./h) of transitionals (3+) by depth.

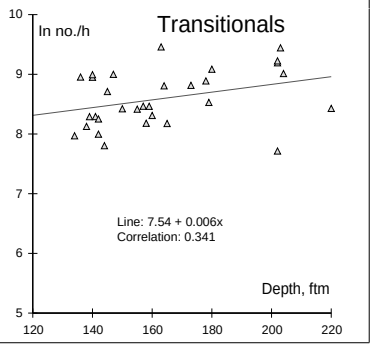


Fig. 5. CR (ln no./h) of females by depth.

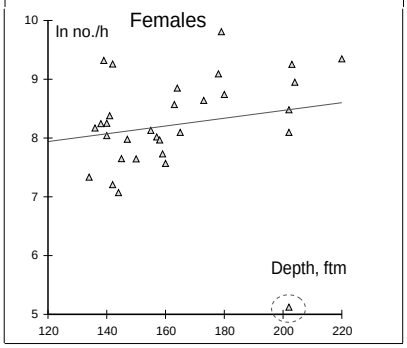


Fig. 6. Mean weight (g) of males by depth (ftm).

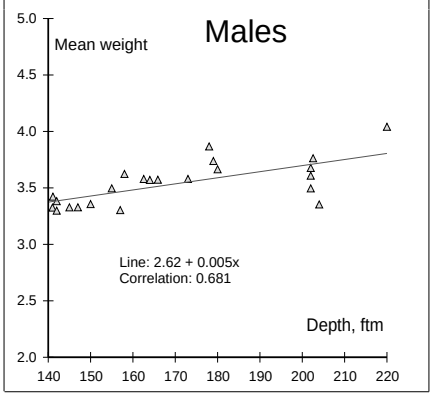


Fig. 7. Mean weight (g) of transitionals by dept.

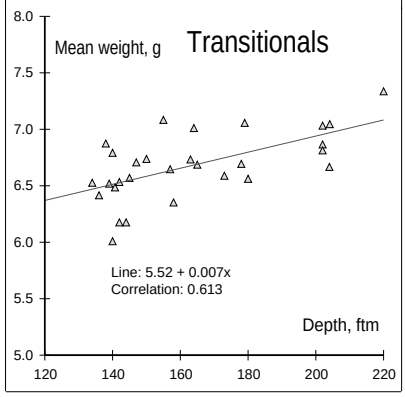
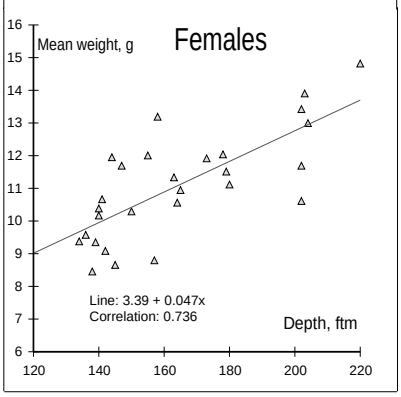


Fig.8. Mean weigth (g) of females by depth.



3.3 Mean weights of genders according to depth

Mean weigth of each gender class increase with depth (Figs. 6-8), indicating that the large individuals of each class stay deeper than the smaller ones.

3.4 The Dalborg's fishery July-December 1995.

The locations of all Dalborg's hauls on the Flemish Cap in 1995 is shown in Fig. 9.

The catch, effort, no. hauls and CPUE's of her fishing in each month of 1995 are shown in Table 2.

Table 2. Dalborg 1995. Catch, effort and no. hauls.

	Effort	Catch	CPUE	No. hauls
Month	Trawl hrs.	tons	kg/h	
July	389	103.435	266	63
August	366	77.820	213	53
September	448	82.380	184	69
October	501	115.690	231	75
November	341	72.920	214	51
December	399	85.690	215	51
Sums:	2444	537.935	220	362

Fig. 9. Location of Dalborg's hauls in 1995.

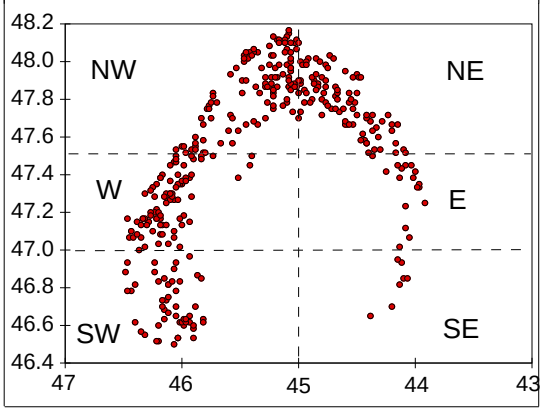


Table 3 shows the geographical pattern of her fishing. Time spent in each area is varying but the CPUE's are similar in the different areas. (The captain's choice of area is probably governed by other factors)

The average size of the shrimps increases with depth (Fig.10).

Geographical distribution for all hauls in each month are plotted in Appendix 1. Distributions of CPUE's for each month are also shown in Appendix 1.

Table 3. Dalborg 7. july - 24. december 1995. Effort, catch, CPUE and no. tows different sub areas of the Flemish Cap. Se fig. 9 for area definition.

	Effort	Catch	Kg/h	No. hauls
Area	Hrs.	Tons		
NW	731	165.6	227	111
W	534	108.0	202	84
SW	370	82.5	223	54
NE	645	149.1	231	89
E	115	22.8	198	17
SE	49	9.9	202	7

4. Discussion

4.1 Age and growth.

If the distribution pattern of shrimps on the Flemish Cap according to size and sex is generally as that found in this study, the methods used for assessing the stock have to be revised. Results from CR/ gender- analysis have to be integrated over depth areas. Then the "new" results have to be compared over a period of time. Looking at gender composition in the total catch is of limited value.
Length at age for the years 1993-1995 is compared in Table 4.
In 1995 the length at age is lower for all classes than in previous years, especially for the 2+ shrimps, possibly because of the great abundance of the 1993 year class.
By December 1995, the 2+ shrimps are 3.1 mm longer and 3+ are 2.5 mm longer than earlier in the season.

Fig. 10. Count (no./kg) related to depth in july

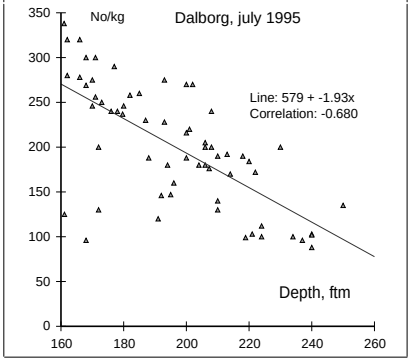


Table 4. Mean length (mm OCL) of shrimps at the Flemish Cap 1993-1995.

Year	Age:	1	2	3	4
1993	1)	9.9	17.0	20.7	24.0
1994	1)		16.6	20.5	22.7
1995	1)		15.1	20.3	21.9
1995 December	2)	11.5	18.2	22.7	23.5
	1) Parsons D.G. et al. 1995. 2) This study				

4.2 CR's of year classes

Catch rates of individual year classes 1993-1995 are shown in Table 5. Catch rates can be regarded as indicators of stock size and are as such a much better measure than simple CPUE's.
Catch rate for 2+ shrimps in late 1995 is the highest on record. It is 5-6 times higher than in 1994 and 10 times higher than in 1993 for the same age group. It seems that the 1993 year class is strong.
This is further supported by the decreased growth rates observed (Table 4). The catch rate increases by a factor of 2-3 from age 2+ to 3+ (Table 5).
The data here presented from the last month of the 1995 season have the same trend, CR for 2+ shrimps is increasing. If the same trend holds as in previous years, CR's for 3+ shrimps in 1996 should be good. It is however likely that retarded growth rates could lead to increased natural mortality. This might justify increased fishing pressure on the 1993 year class.

Table 5. Catch Rate (CR) of different year classes in the years 1993- 1995.

	Age:	2	3	4 - 6+
Year				
1993 1)	No./hour:	2.986	6.535	26.706
1994 1)	"	5.371	10.999	16.859
1995 1)	"	30.562	13.160	12.010
1995 autumn 2)		44.508	5.998	5.105
1) From Parsons et al. 1995 2) This surway				

4.3 The depth related distribution of shrimps at the Flemish Cap: A life history hypothesis.

It has been pointed out earlier that the ocean currents at the Flemish Cap are such that pelagic fish eggs remain within the area (Kudlo and Boytsov 1979, Kudlo et al. 1984)
"Clockwise water circulation can directly affect the movement of pelagic eggs and larvae from the spawning grounds toward the central part of the bank and the concentration of plankton in the area" (Kudlo and Boytsov 1979) .
With that in mind and the findings presented here, the following hypothesis of the life history for the shrimps at the Flemish Cap is put forward:

> *The females are distributed around the approximately circular "Cap", the density and average weight being highest in the deeper peripheral parts. The larvae, being pelagic, are transported by the currents towards the shallower central area. There they are for the first part of their life, pelagic. Later, they seek bottom in the central part of the Cap. As they grow and become females, they migrate deeper, into the peripheral area, closing the circle.*

In the system of sea currents around the Flemish Cap, it is interesting to observe how the shrimps are able to maintain their depth position after they have settled on the bottom. The currents at the bottom are most likely faster than the relative long term displacement of shrimps to deeper water; Therfore the movement of shrimps is unlikely to be passive. Also, being semi- pelagic, shrimps must be transported by currents over considerable distances. Therefore they must be able to orientate and migrate actively when they are back on the bottom after their night trips.

References:

Kudlo, B.P., and V.D. Boytsov, 1979. The effect of water dynamics on year class strength of cod on Flemish Cap. ICNAF Sel. Papers, 5: 7-9.

Kudlo, B.P., V.A. Borovkov and N.G. Sapronetskaya, 1984. Water Circulation Patterns on the Flemish Cap from Observations in 1977-82. NAFO Sci Coun. Studies, 7:27-37.

Parsons, D.G. and P.J. Veitch. 1995. The Canadian fishery for northern shrimp (*Pandalus borealis*) on Flemish Cap (NAFO Division 3M), 1993 to 1995. NAFO SCR Doc., No. 103, Serial No. N2626, 10p.