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The Icelandic Shrimp (*Pandalus borealis*) Fishery at the Flemish Cap in 1993, with a Preliminary Analysis of the Age Structure

by

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ABSTRACT

Five Icelandic vessels have been fishing in the waters at the Flemish Cap in June July and August. A preliminary modal analysis on LFDs of three major sex categories has been carried out, revealing 5 cohorts of what is considered ages 2 - 7 year olds. This is much older than previously thought. The mean carapace lengths for each major sex-category were plotted against time, thus constructing a likely growth curve.

The catch and effort data from the fishery by Iceland are also presented for the months June through August.

INTRODUCTION

The fishery at the Flemish cap is relatively new. By 1993 many nations have fished in the area. In this paper there is listed the available data on catch and effort as well as the analysis of the few commercial samples obtained from one Icelandic vessel. Both Mena (1991 and 1992) and Sainza (1993) have tried to detect the age groups of P. borealis in the area. In this paper the sample data from the Icelandic vessels as well as from Sainzs are analysed using modal analysis.

MATERIALS AND METHODS

The few samples of shrimp used here were obtained from the commercial vessel Skutull. All specimens were measured to the nearest half mm carapace length middorsally. This is called an oblique carapace length (OCL). In all cases the samples were first frozen and then thawed. It was attempted to grade the specimens into the usual nine sexual categories, namely males (ma), transitionals (mi), and seven stages of females, using mostly the metod of Rasmussen (1953). The female stages are also divided into two major categories, with or without sternal spines (MacCrary 1971). The females with sternal spines would then be divided into two categories, with headroes, termed immature females green in head (gm) and without headroes (mg). The females without

sternal spines, hereafter also called mature females, were graded into 5 categories, i.e. females with headroes (ga) females with external eggs but no eyes visible in the eggs (ea), females with eyes visible in the eggs (em), females having headroes as well as external eyed eggs (eg) and females just without spines (ag). The transitionals if present are always included in the major category of immature females.

The method of MacDonald and Pitcher (1979) for age estimation was used on the length frequency distribution (LFD) of the three major categories, namely males, females with sternal spines and females without sternal spines (table 2). When the modal analysis was carried out on the females without sternal spines the standard deviations were always forced to be equal. For comparison the LFDs of shrimp from the spanish survey in 1992 were compared (Sainza 1993). As Sainza uses a different method from what is usual, the measurements need to be converted later, using the linear relationships from Teigsmark (1983) between lateral carapace length (LCL) and OCL.

$$OCL = 0.868 * LCL + 0.1$$

Also for comparison the oblique carapace measurements can be transformed into the lateral ones by using the following equation:

$$LCL = 1.149 * OCL - 0.05$$

In drawing the growth curve the birthday is assumed to be the 1st of May and the larvae have been found to be about 1 mm OCL when hatching (Ástthórsson and Gíslason, 1991).

The five vessels fishing in the area were from 414 - 793 tons (gross tonnage) using trawls ranging from 3000 - 3800 meshes (circumference of belly). The mesh size in the codend was about 37 -38 mm (open mesh). The catch and effort data were obtained from the logbooks of all the vessels fishing at the Flemish cap. Additional figures were obtained from the shipowners on landings both in Iceland and New Foundland. The total effort was calculated by dividing the nominal catch by the overall catch per unit effort (CPUE) from the shrimpers.

RESULTS

The samples were obtained from the last week in June and the first of July 1993. Only three categories were detected, i.e. males, immature females (with sternal spines) green in head (,mg in tables 1 and 2) and mature females (without sternal spines) also green in head (ga in tables 1 and 2). There were no transitionals.

The age analysis was carried out on the three samples combined, from Icelandic vessels using the LFDs of the three major sex categories as mentioned before (table 2 and Fig. 1). It was tried to asign as many components to each LFD as possible. Only three age cohorts could be detected from the male LFD, one from the LFD of females with sternal spines and two from the LFD of mature females (table. 3). Note that the socalled 6 year old mature females are just slightly larger than the immature 5 year old females. The seven year old females in 1993 are assessed to have the meen size 28.21 mm. For comparison the LFDs of the Spanish shrimp data in 1992 (Sainza, 1993, table 2) were also analysed for age cohorts. From these also three age cohorts of males could be detected (table 5), but these seemed to be considerably smaller than the males in 1993, see table 4 where the OCLs have been changed into LCLs for the Icelandic samples. More over in 1992 there seemed to be two components of immature females i.e. the socalled 4 and 5 years respectively. Also in 1992 there were 3 components of mature female , namely the socalled 4, 5 and 6 years. But the proportion of the four year old was only 3% of all the mature females. From the results of age analysis of both Icelandic and Spanish samples in

the years 1992 and 1993 using the OCLs (tables 3 and 6) the growth relationship (fig 2) was constructed.

The standard deviations are listed in tables 3 and 5. They range from 0.57 to 1.15 mm . In general these seem to agree quite well with the findings of other authors although 0.57 mm is a bit small for 3 year old shrimps (Skuladottir et al 1989).

In table 7 are listed all the effort and catch data available from the Icelandic fishery. The sums (of all vessels combined) per month from table 7 were moved to table 8 along with the nominal catch. The overall CPUE is 526.5 kg/hour in 1993 and the total catch is at least 1336 tonnes. The CPUE was gradually increasing from 514 kg in June to 527 in August.

DISCUSSION

As noted by Sainza (1993) the mode of females with sternal spines is not very different from that of females without sternal spines in her data from 1992. According to our experience her opinion that the criterion of sternal spines or no sternal spines is not so useful at this time of the year,i.e. especially when spawning is oncoming. It is known that the primaparous females loose their sternal spines prior to spawning. But just how early prior to spawning is not known for certain. If the spawning takes place in late July it is possible that a considerable proportion of females without sternal spines is indeed primaparous in July at least. Therefore we find, using the word primaparous for females with sternal spines at this time of the year is misleading. Although using the expression immature females is not strictly true either. Females with or without sternal spines is maybe more accurate. However we think the females without sternal spines in the June samples in 1993 are truly multiparous females of age 6, whereas the main peak in 1992 of both females with and without sternal spines probably belongs to the same age group i.e. 5 year olds being 24.23 and 23.69 mm OCL respectively (table 6). The 1992 data were also colleceted several weeks later in the season than the Icelandic data of last week of June. In 1993 the 5 year old females are thus all primaparous females of the OCL 25.73 mm (table 3). There should be some 5 year old females without sternal spines in 1993 as there were some 4 year old females with sternal spines in 1992 ,i.e. about 14 % of the immature females (table 6). The analysis is not very accurate for the mature female LFD and there could be hidden some small proportion of 5 year olds. The other possibility is that the mode of 26.15 mm mature females in 1993 is actually 5 year olds and has thus grown from the immature females of 21.83 mm in 1992 and the males of 22.42 mm in 1992 (table 6). Here is need for more investigation.

By comparing the results of 1992 and 1993 provided the conversion equation is correct, there seems to be faster growth after 1992 than before. The males are consistently bigger in 1993 as compared to 1992. The difference is 1.1 mm for the 2 year olds, 0.68 mm for the 3 year olds and 1.53 mm for the 4 year olds. Also the females with sternal spines of 5 year olds are also 1.5 mm larger in 1993 as compared to 1992.

The age at sex change would seem to be mostly at the age of 5 which is similar to the results of Skuladottir et al (1991) for the offshore area Grimsey which is north of Iceland and in an area where the mean annual near-bottom temperaturee is 1.15° C. The OCL where 50% have changed sex is between 26.5 and 27 mm at the Flemish cap in 1993, which is much larger than that of the afore mentioned area Grimsey where the corresponding size is about 22 mm OCL but almost as large as that of the Denmark Strait shrimp (Skuladottir 1993) where the 50% size is generally between 27.3 and 28.5 mm OCL. The oldest age detected is 7 years of 28.2 mm OCL .

As all females are ovigerous , spawning of females must be annual.

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Table 1. The length distribution by 3 major categories, namely males, immature females with sternal spines, and females with no sternal spines. At the bottom there are sums and mean OCL by the 9 sexual categories as explained below.

JUNE 23rd 1993 48°14' N - 45°22' W				
OCL mm	♂	♀ Spines	♀ no spines	Σ
14	0	0	0	0
14.5	0	0	0	0
15	0	0	0	0
15.5	0	0	0	0
16	1	0	0	1
16.5	0	0	0	0
17	0	0	0	0
17.5	0	0	0	0
18	0	0	0	0
18.5	0	0	0	0
19	0	0	0	0
19.5	0	0	0	0
20	0	0	0	0
20.5	1	0	0	1
21	2	0	0	2
21.5	3	0	0	3
22	1	0	0	1
22.5	2	0	0	2
23	2	0	0	2
23.5	7	0	0	7
24	6	1	0	7
24.5	12	1	0	13
25	4	2	1	7
25.5	8	3	2	13
26	2	4	6	12
26.5	2	11	6	19
27	0	8	8	16
27.5	0	7	5	12
28	0	1	3	4
28.5	0	1	4	5
29	0	0	3	3
29.5	0	0	0	0
30	0	0	1	1
30.5	0	0	0	0
31	0	0	0	0
31.5	0	0	0	0
32	0	0	0	0
32.5	0	0	0	0
33	0	0	0	0
33.5	0	0	0	0
34	0	0	0	0
34.5	0	0	0	0
35	0	0	0	0
35.5	0	0	0	0
Σ	53	39	39	131
Σ	ma 53	mi 0	mg 0	gm 39
mean OCL	23.90			26.55
%	40.50			29.77
Σ	ag 0	ga 39	ea 0	em 0
mean OCL		27.17		
%		29.77		
Σ	eg 0			
mean OCL				
%				

JUNE 27th 1993 47°35' N - 44°08' W				
OCL mm	♂	♀ Spines	♀ no spines	Σ
14	0	0	0	0
14.5	0	0	0	0
15	0	0	0	0
15.5	1	0	0	1
16	0	0	0	0
16.5	0	0	0	0
17	1	0	0	1
17.5	0	0	0	0
18	1	0	0	1
18.5	1	0	0	1
19	0	0	0	0
19.5	0	0	0	0
20	1	0	0	1
20.5	0	0	0	0
21	8	0	0	8
21.5	6	0	0	6
22	5	0	0	5
22.5	2	0	0	2
23	2	0	0	2
23.5	3	0	0	3
24	6	2	0	8
24.5	10	3	0	13
25	6	4	2	12
25.5	3	3	1	7
26	3	8	9	20
26.5	1	8	6	15
27	0	3	12	15
27.5	0	2	5	7
28	0	2	3	5
28.5	0	2	3	5
29	0	0	2	2
29.5	0	0	2	2
30	0	0	1	1
30.5	0	0	0	0
31	0	0	1	1
31.5	0	0	0	0
32	0	0	0	0
32.5	0	0	0	0
33	0	0	0	0
33.5	0	0	0	0
34	0	0	0	0
34.5	0	0	0	0
35	0	0	0	0
35.5	0	0	0	0
Σ	60	37	47	144
Σ	ma 60	mi 0	mg 0	gm 37
mean OCL	22.96			26.55
%	41.67			25.69
Σ	ag 0	ga 47	ea 0	em 0
mean OCL		27.18		
%		32.64		
Σ	eg 0			
mean OCL				
%				

The legend used in tables 1-2:

m a	Males.
m i	Transitionals.
m g	Females with sternal spines, no headroes.
g m	Females with sternal spines, with headroes.
a g	Females without sternal spines, no headroes, not berried but at times with egghairs.
g a	Females without sternal spines, with headroes, not berried.
e a	Females with green eggs, no eyespots.
e m	Females with eggs with eyespots.
e g	Females with eggs with eyespots and also with headroes.

Table 2. The same legend as in table 1

JULY 1st 1993 47°46' N - 44°20' W				
cal mm	♂	♀ Spines	♀ no spines	Σ
14	0	0	0	0
14.5	0	0	0	0
15	0	0	0	0
15.5	0	0	0	0
16	0	0	0	0
16.5	4	0	0	4
17	4	0	0	4
17.5	4	0	0	4
18	4	0	0	4
18.5	0	0	0	0
19	5	0	0	5
19.5	1	0	0	1
20	0	0	0	0
20.5	5	0	0	5
21	9	0	0	9
21.5	5	0	0	5
22	6	0	0	6
22.5	3	1	0	4
23	2	0	0	2
23.5	2	0	0	2
24	5	1	0	6
24.5	4	2	1	7
25	1	4	2	7
25.5	2	6	7	15
26	0	5	10	15
26.5	1	6	10	17
27	0	1	14	15
27.5	0	4	7	11
28	0	1	4	5
28.5	0	0	0	0
29	0	0	0	0
29.5	0	0	0	0
30	0	0	0	0
30.5	0	0	0	0
31	0	0	0	0
31.5	0	0	0	0
32	0	0	0	0
32.5	0	0	0	0
33	0	0	0	0
33.5	0	0	0	0
34	0	0	0	0
34.5	0	0	0	0
35	0	0	0	0
35.5	0	0	0	0
Σ	67	31	55	153
Σ mean OCL %	ma 67 20.90 43.80	mi 0	mg 0	gm 31 25.16 20.26
Σ mean OCL %	ag 0	ga 55 26.11 35.95	ea 0	em 0
Σ mean OCL %	eg 0			

All samples 1993				
cal mm	♂	♀ Spines	♀ no spines	Σ
14	0	0	0	0
14.5	0	0	0	0
15	0	0	0	0
15.5	1	0	0	1
16	1	0	0	1
16.5	4	0	0	4
17	5	0	0	5
17.5	4	0	0	4
18	5	0	0	5
18.5	1	0	0	1
19	5	0	0	5
19.5	1	0	0	1
20	1	0	0	1
20.5	6	0	0	6
21	19	0	0	19
21.5	14	0	0	14
22	12	0	0	12
22.5	7	1	0	8
23	6	0	0	6
23.5	12	0	0	12
24	17	4	0	21
24.5	26	6	1	33
25	11	10	5	26
25.5	13	12	10	35
26	5	17	25	47
26.5	4	25	22	51
27	0	12	34	46
27.5	0	13	17	30
28	0	4	10	14
28.5	0	3	7	10
29	0	0	5	5
29.5	0	0	2	2
30	0	0	2	2
30.5	0	0	0	0
31	0	0	0	0
31.5	0	0	0	0
32	0	0	0	0
32.5	0	0	0	0
33	0	0	0	0
33.5	0	0	0	0
34	0	0	0	0
34.5	0	0	0	0
35	0	0	0	0
35.5	0	0	0	0
Σ	180	107	140	427
Σ mean OCL %	ma 180 22.50 42.20	mi 0	mg 0	gm 107 26.21 25.06
Σ mean OCL %	ag 0	ga 140 26.90 32.79	ea 0	em 0
Σ mean OCL %	eg 0			

Table 3. The mean obligue carapace length OCl proportion (PR) and standard deviation SD for each age class from the Icelandic samples in 1993 .

Age	Males			Immature females			Mature females		
	OCL	PR	SD	OCL	PR	SD	OCL	PR	SD
2	17.15	0.1525	1.1						
3	20.87	0.3006	0.57						
4	23.95	0.5469	0.99						
5				25.73	1.0000	1.12			
6							26.15	0.8751	0.82
7							28.21	0.1249	0.82

Table 4. The lateral carapace length LCl calculated from the OCL in table 3 from the Icelandic samples in 1993.

Age	Males			Immature females			Mature females		
	LCL	PR	SD	LCL	PR	SD	LCL	PR	SD
2	19.66	0.1525							
3	23.93	0.3006							
4	27.469	0.5469							
5				29.51	1.0000				
6							30.00	0.8751	
7							32.36	0.1249	

Table 5. The mean lateral carapace length LCl proportion (PR) and standard deviation SD for each age class from the Spanish samples in 1992.

Age	Males			Immature females			Mature females		
	LCL	PR	SD	LCL	PR	SD	LCL	PR	SD
2	18.38	0.153	1.04						
3	23.15	0.3323	0.77						
4	25.71	0.5147	1.15	25.04	0.1439	0.77	23.95	0.0304	1.11
5				27.8	0.8561	1.06	27.18	0.7961	1.11
6							30.23	0.1736	1.11

Table 6. The mean *obligue carapace length OCl in 1992 calculated* from the LCL of the Spanish samples in table 4.

Age	Males			Immature females			Mature females		
	OCL	PR	SD	OCL	PR	SD	OCL	PR	SD
2	16.05	0.153							
3	20.19	0.3323							
4	22.42	0.5147		21.83	0.1439		20.89	0.0304	
5				24.23	0.8561		23.69	0.7961	
6							26.34	0.1736	

Table 7. The catch and the effort from the logbooks of five Icelandic vessels fishing at the Flemish cap in 1993, on one hand and provisional nominal catch on other.

Tonnage	Trawl size No of meshes	Vessel/month	Effort Tr.hours	Catch Tonnes	CPUE kg/hr	Nominal catch Tonnes
		June				
414	3300	Hákon ÞH 25	355.17	160,100	450.8	167,000
714	3600	Jón Finnsson RE 506	355.69	123,065	346.0	130,214
446	3800/3000	Pétur Jónsson RE 69	370.75	133,760	360.8	133,760
793	3600	Skutull ÍS 180	231.8	81,646	352.2	86,012
620	3000	Sunna SI 67	237.28	176,433	743.6	176,433
		June Σ	1313.41	675,004	513.9	693,419
		July				
414	3300	Hákon ÞH 25				158,000
714	3600	Jón Finnsson RE 506	17.33	6,860	395.8	7,259
446	3800/3000	Pétur Jónsson RE 69	76.5	27,400	358.2	27,278
793	3600	Skutull ÍS 180	77.73	31,594	406.5	33,284
620	3000	Sunna SI 67	344.75	201,028	583.1	217,000
		July Σ	516.31	266,882	516.9	442,821
		August				
620	3000	Sunna SI 67	329.75	195,063	591.5	200,000
		August Σ	329.75	195,063	591.5	200,000
		Total 1993	**2159.47**	**1136,949**	**526.5**	**1336,240**

Table 8. The catch, effort and kg/hr as reported by Icelandic logbooks and the nominal catch by month and year at the Flemish cap.

	FROM LOGBOOKS			NOMINAL
YEAR,MONTH	EFFORT Tr. hours	CATCH Tonnes	CPUE kg/hr	CATCH Tonnes
1993				
June	1313.41	675,004	513.9	693,419
July	516.31	266,882	516.9	442,821
August	329.75	195,063	591.5	200,000
Subtotal	2159.47	1,136,949	526.5	
Total	2537.97	1,336,240	526.5	1,336,240

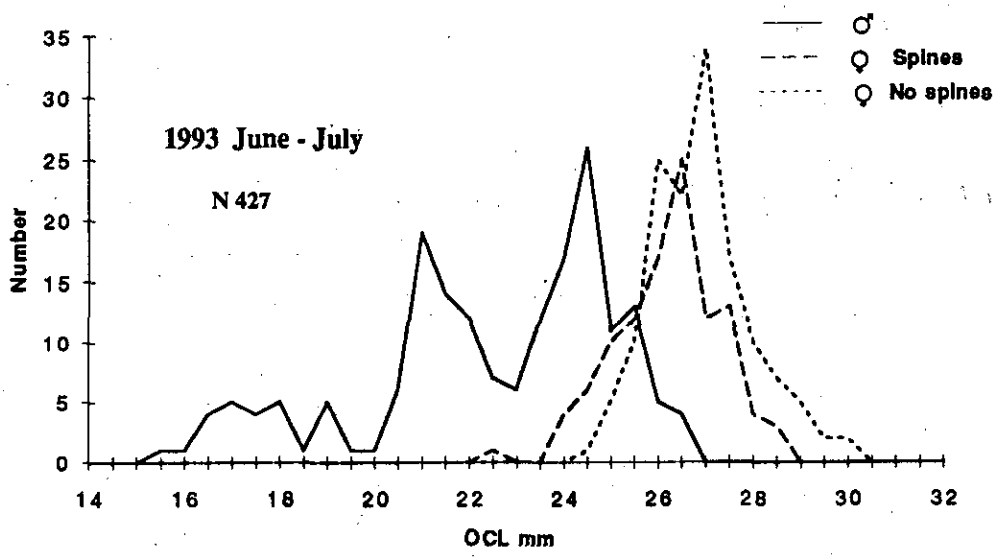

Fig. 1 . The length frequency distributions of P. borealis at the Flemish Cap in 1993 by sex groups.

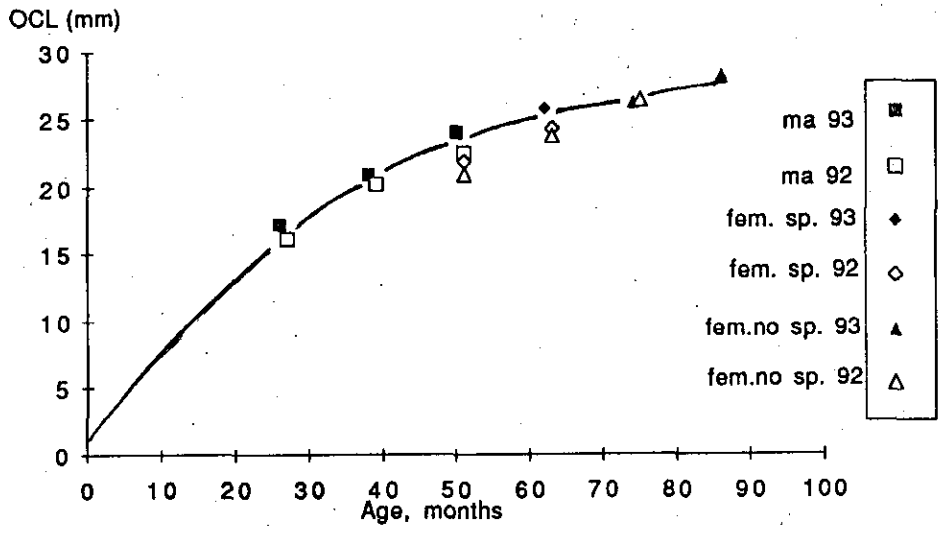

Fig. 2. The oblique carapace length by age from Icelandic and Spanish data in 1993 and 1992 respectively. The growth curve is drawn by eye.