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The Icelandic Shrimp (*Pandalus borealis*) Fishery at the Flemish Cap in 1994

by

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ABSTRACT

Some 7 Icelandic vessels have been fishing in the waters at the Flemish Cap in 1994. The catch and effort data and catch per unit of effort (CPUE) from 5 vessels are presented here. The CPUE has been falling gradually from the average of 321 kg/hour in 1993 to 248 kg in 1994. Biological samples from three months give rise to several biological observations. Among those the loss of sternal spines among the primiparous females is followed in time as spawning gets near. Also weight length relationships are shown. Modal analysis on LFDs of three major sex categories has been carried out, revealing 5 age groups where the first 3 are male of about 17.3, 21.4 and 23.5 mm respectively (oblique carapace length). The 4th age group consists mainly of primiparous females of the size 25.3 and the 5th age group consists of multiparous females of the size 27.6 mm (age 6+ presumably). A change in the sex ratio was noted between the years 1993 and 1994 where the proportion of males increased from some 40% in 1993 to some 70% in 1994.

INTRODUCTION

The Spanish investigators have been measuring the biomass index of northern shrimp at the Flemish Cap since 1988 in their annual bottom trawl survey of the Flemish Cap (Vázquez 1993). In 1993, Canada and Faroe Islands started fishing at the Flemish Cap in April and May. In June 1993 Iceland started fishing at the Flemish cap as well. In this paper there are listed the available data on catch and effort from the Icelandic vessels, as well as the analysis of the few commercial samples obtained from two Icelandic vessels.

MATERIALS AND METHODS

The samples of shrimp used here were obtained from the commercial vessels Skutull and Jon Finnsson. All specimens were measured to the nearest half mm carapace length middorsally. This is called the oblique carapace length (OCL). In all cases the samples were first frozen and then thawed in air. 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 method of Rasmussen (1953). The female stages are also divided into two major categories, with or completely without sternal spines (MacCrory 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 weighing was not done on every specimen, but all specimens of the same length class in each sample were weighed together and then the mean weight per length class was fitted for all the samples together. The shrimp were divided into two groups according to presence of external eggs or not. Specimens with very few eggs were included in the ovigerous group.

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 (also transitionals) and females without sternal spine (tables 1-3). When the modal analysis was carried out on the females the coefficients of variation were kept the same for all components.

## RESULTS AND DISCUSSION

### Length distributions and weights

The shrimp samples in 1994 were obtained from June, July and the beginning of August (Fig. 1). In all these samples only one transitional was found in June (table 1). In June and July there were besides males, females with developing ovaries, so called green in head. The females were either with sternal spines, namely spawning for the first time or without sternal spines. The males were more prominent in 1994 as compared to 1993 (Skúladóttir and Einarsson), namely some 70 % against 40% in 1993. This could be due to the 2 and 3 year old males being strong year classes. Also the females with sternal spines do not seem to be as numerous as they were in 1993.

On Fig. 2 the length weight relationships are shown for both eggbearing (ovigerous) and not ovigerous shrimp. As each point is the mean weight per length class from each sample there are down to one specimen for each point at the extremities of the curves.

### The preparation for the spawning

According to McCrary (1971) the immature females that some investigators call primiparous females lose their sternal spines just prior to spawning. The samples obtained this year demonstrate this process very clearly. Thus the proportion of females without sternal spines of all females was found to be between 50 and 60 % at June 14th and was found to increase substantially in the last week of July and become 95% by the 2nd of August (Fig. 3). As to spawning there were no ovigerous females found in the sample from the 4th of July, but a few at the 21st of July. There were no samples between those two dates. By July 21st 16 % of the females preparing for spawning this year had already spawned and by August 2nd 38% had spawned. It would thus appear that the main time of spawning is in August. As in 1993 there seem to be no females without sternal spines that are neither preparing spawning (green in head) nor egg bearing so all females seem to spawn every year.

### Age composition

The age analysis was carried out on the samples combined for each month, using the LFDs of the three major sex categories as shown (tables 1-3 and Fig. 1). For the sake of comparison the results of the summer samples in 1993 are shown. As before it was tried to assign as many components to each LFD as possible. Only three age cohorts could be detected from the male LFD, and three from the LFD of females with sternal spines in June whereas the July LFD only allowed the fitting of one component (tables 5 and 6). As shown before by the gradual loss of sternal spines with time, in August the primiparous appeared to be multiparous and the LFD of females without sternal spines is probably comprised of at least two components, but only one could be fitted (table 7). In short the main results are that the 2 year old males (1992 -yearclass) are the same mean size as in 1993, (Skúladóttir and Einarsson, 1993) namely 17.1 mm in June 1994. There is some growth from June to August or to 17.5 mm. The 3 year old males (1991 year-class) are slightly bigger or 21.3 in June 1994 against 20.9 mm in 1993. There is also some growth in the mean size from June to August or to 21.45 mm in August. The 4 year old males are on the other hand slightly smaller in 1994 or 23.7 in June against 23.95 mm in June 1993. The females with sternal spines are a bit more complicated and judging by the SD of 1.59 in July it would seem likely that there are more components than just the one. The mean sizes (OCL) at age from the Icelandic data for year 1994 for the months June, July and August of 17.3, 21.4, and 23.5, 25.3 and 27.6 mm respectively for ages 2, 3, 4, 5, and 6+ agree quite well with the results of Parsons and Weitch (1994) for the same age groups but their samples cover the period from March to June and their mean sizes per age group for the males are also a bit smaller than here presented, as could be expected.

In the tables 4-7 are listed both the proportions within each sex group and the overall proportion for that month. It is noticeable that the strong 1988 year-class is still occurring in considerable proportions in all 3 months as 6 year olds, namely in the overall proportion of 19-24.5%. This is in accordance with the findings of Sainsa (1994) who shows the occurrence of the very strong apparently 2 year old year-class that appeared first in the Spanish bottom trawl survey in the year 1990. The 1992 year-class seems to be very big and growing in proportions from June to August. The 1991 year-class also appears to be rather big, whereas the 1989 and 1990 year-classes seem weak. The standard deviations are also shown in these tables. They are usually between 0.76 and 1.3.

### Catch, effort and CPUE

In table 8 are listed all the effort and catch data available from the Icelandic fishery in 1993. The overall CPUE is 321 kg/hour in 1993 and the total catch was 2243 tonnes. The CPUE was gradually increasing from 374 kg in June to 221 kg in December. Table 9 shows the same as table 8, but for 1994. The preliminary catch for 1994 is 1437 tonnes to this date. It is however known that 2 vessels have not reported yet. The CPUE was low, 216 kg/hour in January to rise in February to 325 kg. After this the CPUE gradually fell to about 218 kg in July to increase again to 312 kg in September. So on the whole there has not been a serious fall in CPUE during the year 1994.

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

Table 1.

June 1994				
OCL mm	♂	♂ ♀ Spines	♀ No Spines	Σ
14	0	0	0	0
14.5	1	0	0	1
15	3	0	0	3
15.5	7	0	0	7
16	20	0	0	20
16.5	27	0	0	27
17	33	0	0	33
17.5	26	0	0	26
18	23	0	0	23
18.5	13	0	0	13
19	6	0	0	6
19.5	8	0	0	8
20	19	0	0	19
20.5	39	1	0	40
21	73	0	1	74
21.5	69	0	0	69
22	49	1	0	50
22.5	31	4	1	36
23	27	3	2	32
23.5	23	2	1	26
24	26	10	0	36
24.5	16	17	0	33
25	7	16	2	25
25.5	2	17	7	26
26	0	15	20	35
26.5	0	12	21	33
27	0	6	25	31
27.5	0	6	44	50
28	0	5	38	43
28.5	0	6	22	28
29	0	4	22	26
29.5	0	2	7	9
30	0	0	2	2
30.5	0	1	3	4
31	0	0	0	0
31.5	0	0	1	1
32	0	0	0	0
32.5	0	0	0	0
33	0	0	0	0
33.5	0	0	0	0
34	548	128	219	895
Σ	ma	mi	mg	gm
mean OCL	548	1	0	127
%	20.53	25.50		25.70
	61.23	0.11		14.19
Σ	ag	ga	ea	em
mean OCL	0	219	0	0
%		27.50		
		24.47		
Σ	eg			
mean OCL	0			
%				

The legend used in tables 1-3:

- 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.

July 1994				
OCL	♂	♂ ♀	♀	Σ
mm		Spines	No Spines	
14	0	0	0	0
14.5	0	0	0	0
15	1	0	0	1
15.5	10	0	0	10
16	15	0	0	15
16.5	33	0	0	33
17	62	0	0	62
17.5	67	0	0	67
18	57	0	0	57
18.5	31	0	0	31
19	7	0	0	7
19.5	5	0	0	5
20	17	0	0	17
20.5	31	0	0	31
21	64	0	0	64
21.5	63	0	0	63
22	45	0	0	45
22.5	25	3	0	28
23	8	1	0	9
23.5	7	3	1	11
24	7	2	1	10
24.5	3	9	5	17
25	0	10	6	16
25.5	0	14	11	25
26	0	9	16	25
26.5	0	7	21	28
27	0	7	21	28
27.5	0	1	32	33
28	0	6	41	47
28.5	0	0	22	22
29	0	2	11	13
29.5	0	2	5	7
30	0	0	2	2
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	1	1
33	0	0	0	0
33.5	0	0	0	0
34	558	76	197	831
Σ	ma	ml	mg	gm
mean OCL	558	0	1	75
%	19.40		26.00	25.75
	67.15		0.12	9.03
Σ	ag	ga	ea	em
mean OCL	2	168	27	0
%	26.50	27.51	26.28	
	0.24	20.22	3.25	
Σ	eg			
mean OCL	0			
%				

Table 3.

August 1994				
OCL	♂	♂ ♀	♀	Σ
mm		Spines	No Spines	
14	0	0	0	0
14.5	0	0	0	0
15	0	0	0	0
15.5	3	0	0	3
16	4	0	0	4
16.5	10	0	0	10
17	18	0	0	18
17.5	17	0	0	17
18	21	0	0	21
18.5	11	0	0	11
19	5	0	0	5
19.5	1	0	0	1
20	3	0	0	3
20.5	9	0	0	9
21	11	0	0	11
21.5	9	0	0	9
22	12	0	0	12
22.5	5	0	0	5
23	6	0	0	6
23.5	4	0	0	4
24	2	0	0	2
24.5	1	0	0	1
25	0	2	2	4
25.5	0	0	4	4
26	0	0	1	1
26.5	0	0	5	5
27	0	0	9	9
27.5	0	0	5	5
28	0	0	4	4
28.5	0	0	2	2
29	0	0	2	2
29.5	0	0	1	1
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	1	1
32.5	0	0	0	0
33	0	0	0	0
33.5	0	0	0	0
34	152	2	36	190
Σ	ma	ml	mg	gm
mean OCL	152	0	0	2
%	19.24			25.00
	80.00			1.05
Σ	ag	ga	ea	em
mean OCL	0	23	13	0
%		27.61	26.50	
		12.11	6.84	
Σ	eg			
mean OCL	0			
%				

Table 4. The mean oblique carapace length (OCL) proportion (PR) within the sex group, overall proportion (OPR) and standard deviation (SD) for each age class from the Icelandic samples in 1993, from June and July 1st.

Age	Males				Females with st. sp.				Females without st. sp.			
	OCL	PR	OPR	SD	OCL	PR	OPR	SD	OCL	PR	OPR	SD
2	17,15	0,1525	0,0644	1,10								
3	20,87	0,3006	0,1269	0,57								
4	23,95	0,5469	0,2308	0,99								
5					25,73	1,0000	0,2506	1,12				
6									26,15	0,8751	0,2869	0,82
7									28,21	0,1249	0,0410	0,82

Table 5. The same as table 4 but from June 1994.

Age	Males				Females with st. sp.				Females without st. sp.			
	OCL	PR	OPR	SD	OCL	PR	OPR	SD	OCL	PR	OPR	SD
2	17,12	0,2926	0,1792	0,97								
3	21,30	0,5198	0,3183	0,78								
4	23,70	0,1876	0,1149	0,77	22,43	0,0590	0,0084	0,87				
5					25,25	0,7169	0,1025	0,98				
6					28,03	0,2241	0,0320	1,09	27,50	1,0000	0,2447	1,37

Table 6. The same as table 4 but from July 1994.

Age	Males				Females with st. sp.				Females without st. sp.			
	OCL	PR	OPR	SD	OCL	PR	OPR	SD	OCL	PR	OPR	SD
2	17,38	0,5114	0,3434	0,82								
3	21,37	0,4591	0,3083	0,76								
4	23,86	0,0296	0,0199	0,43								
5					25,75	1,0000	0,0915	1,59	25,54	0,1303	0,0309	1,03
6									27,60	0,8697	0,2062	1,12

Table 7. The same as table 4 but from August 2nd 1994.

Age	Males				* Females with st. sp.				Females without st. sp.			
	OCL	PR	OPR	SD	OCL	PR	OPR	SD	OCL	PR	OPR	SD
2	17,49	0,5843	0,4664	0,84								
3	21,45	0,3333	0,2666	1,03								
4	22,80	0,0825	0,0660	1,09								
5					25,00	1,0000	0,0105					
6									27,21	1,0000	0,1895	1,30

\* Only 2 specimens.

Table 8. The catch and the effort from the logbooks of five Icelandic vessels fishing at the Flemish cap in 1993.

Tonnage	Trawl size No of meshes	Vessel/month	Effort Tr. hours	Catch kg	CPUE kg/hr
<b>June</b>					
414	3300	Hákon ÞH 25	355	159100	448.6
714	3600	Jón Finnsson RE 506	356	123065	346.0
446	3800/3000	Pétur Jónsson RE 69	426	151510	355.9
793	3600	Skutull ÍS 180	227	80592	355.3
620	2x3000	*Sunna SI 67	243	88215	363.4
		*Sunna SI 67	243	88215	363.4
		<b>June Σ</b>	<b>1848</b>	<b>690697</b>	<b>373.7</b>
<b>July</b>					
414	3300	Hákon ÞH 25	203	72970	359.9
714	3600	Jón Finnsson RE 506	17	6860	395.8
446	3800/3000	Pétur Jónsson RE 69	165	63140	383.2
793	3600	Skutull ÍS 180	78	31594	406.5
620	2x3000	*Sunna SI 67	348	100529	288.8
		*Sunna SI 67	348	100529	288.8
		<b>July Σ</b>	<b>1159</b>	<b>375622</b>	<b>324.2</b>
<b>August</b>					
414	3300	Hákon ÞH 25	332	105400	317.6
714	3600	Jón Finnsson RE 506	372	122280	328.6
620	2x3000	*Sunna SI 67	329	97963	298.0
		*Sunna SI 67	329	97963	298.0
		<b>August Σ</b>	<b>1361</b>	<b>423606</b>	<b>311.1</b>
<b>September</b>					
414	3300	Hákon ÞH 25	385	131400	341.7
620	2x3000	*Sunna SI 67	341	116538	341.8
		*Sunna SI 67	341	116538	341.8
		<b>September Σ</b>	<b>1066</b>	<b>364476</b>	<b>341.8</b>
<b>October</b>					
620	2x3000	*Sunna SI 67	187	40170	215.4
		*Sunna SI 67	187	40170	215.4
		<b>October Σ</b>	<b>373</b>	<b>80340</b>	<b>215.4</b>
<b>November</b>					
620	2x3000	*Sunna SI 67	303	89982	297.3
		*Sunna SI 67	303	89982	297.3
		<b>November Σ</b>	<b>605</b>	<b>179964</b>	<b>297.3</b>
<b>December</b>					
620	2x3000	*Sunna SI 67	290	64086	220.7
		*Sunna SI 67	290	64086	220.7
		<b>December Σ</b>	<b>581</b>	<b>128172</b>	<b>220.7</b>
		<b>Total 1993</b>	<b>6994</b>	<b>2242877</b>	<b>320.7</b>

\* The vessel Sunna operates two trawls at the same time. The effort is therefore shown double and the catch is divided by 2.

Table 9. The catch and effort from logbooks of five Icelandic vessels fishing at the Flemish Cap in 1994.

Tonnage	Trawl size No of meshes	Vessel/month	Effort Tr. hours	Catch kg	CPUE kg/hr
<b>January</b>					
620	2x 3000	*Sunna SI 67	76	16432	216.4
		*Sunna SI 67	76	16432	216.4
		<b>January <math>\Sigma</math></b>	<b>152</b>	<b>32864</b>	<b>216.4</b>
<b>February</b>					
620	2x 3000	*Sunna SI 67	343	111251	324.7
		*Sunna SI 67	343	111251	324.7
		<b>February <math>\Sigma</math></b>	<b>685</b>	<b>222502</b>	<b>324.7</b>
<b>March</b>					
620	2x 3000	*Sunna SI 67	280	78394	280.5
		*Sunna SI 67	280	78394	280.5
		<b>March <math>\Sigma</math></b>	<b>559</b>	<b>156788</b>	<b>280.5</b>
<b>June</b>					
305	2700	Andvari VE 100	335	65770	196.1
714	3600	Jón Finnsson RE 506	353	78856	223.6
793	3600	Skutull ÍS 180	109	35544	326.1
620	3000/3400	Otto Wathne NS 90	166	42149	254.2
620	2x 3000	*Sunna SI 67	178	55289	310.0
		*Sunna SI 67	178	55289	310.0
		<b>June <math>\Sigma</math></b>	<b>1320</b>	<b>332897</b>	<b>252.3</b>
<b>July</b>					
305	2700	Andvari VE 100	442	78250	177.1
714	3600	Jón Finnsson RE 506	9	2681	287.4
793	3600	Skutull ÍS 180	492	110382	224.4
620	3000/3400	Otto Wathne NS 90	514	106961	208.1
620	2x 3000	*Sunna SI 67	299	74788	250.5
		*Sunna SI 67	299	74788	250.5
		<b>July <math>\Sigma</math></b>	<b>2054</b>	<b>447850</b>	<b>218.0</b>
<b>August</b>					
305	2700	Andvari VE 100	258	68422	265.0
1018	3450	Pétur Jónsson RE 69	230	61050	265.4
793	3600	Skutull ÍS 180	34	8699	255.3
620	2x 3000	*Sunna SI 67	199	36584	183.5
		*Sunna SI 67	199	36584	183.5
		<b>August <math>\Sigma</math></b>	<b>921</b>	<b>211339</b>	<b>229.5</b>
<b>September</b>					
305	2700	Andvari VE 100	104	32415	312.4
		<b>September <math>\Sigma</math></b>	<b>104</b>	<b>32415</b>	<b>312.4</b>
		<b>Total 1994:</b>	<b>5795</b>	<b>1436655</b>	<b>247.9</b>

\* The vessel Sunna operates two trawls at the same time. The effort is therefore shown double and the catch is divided by 2.



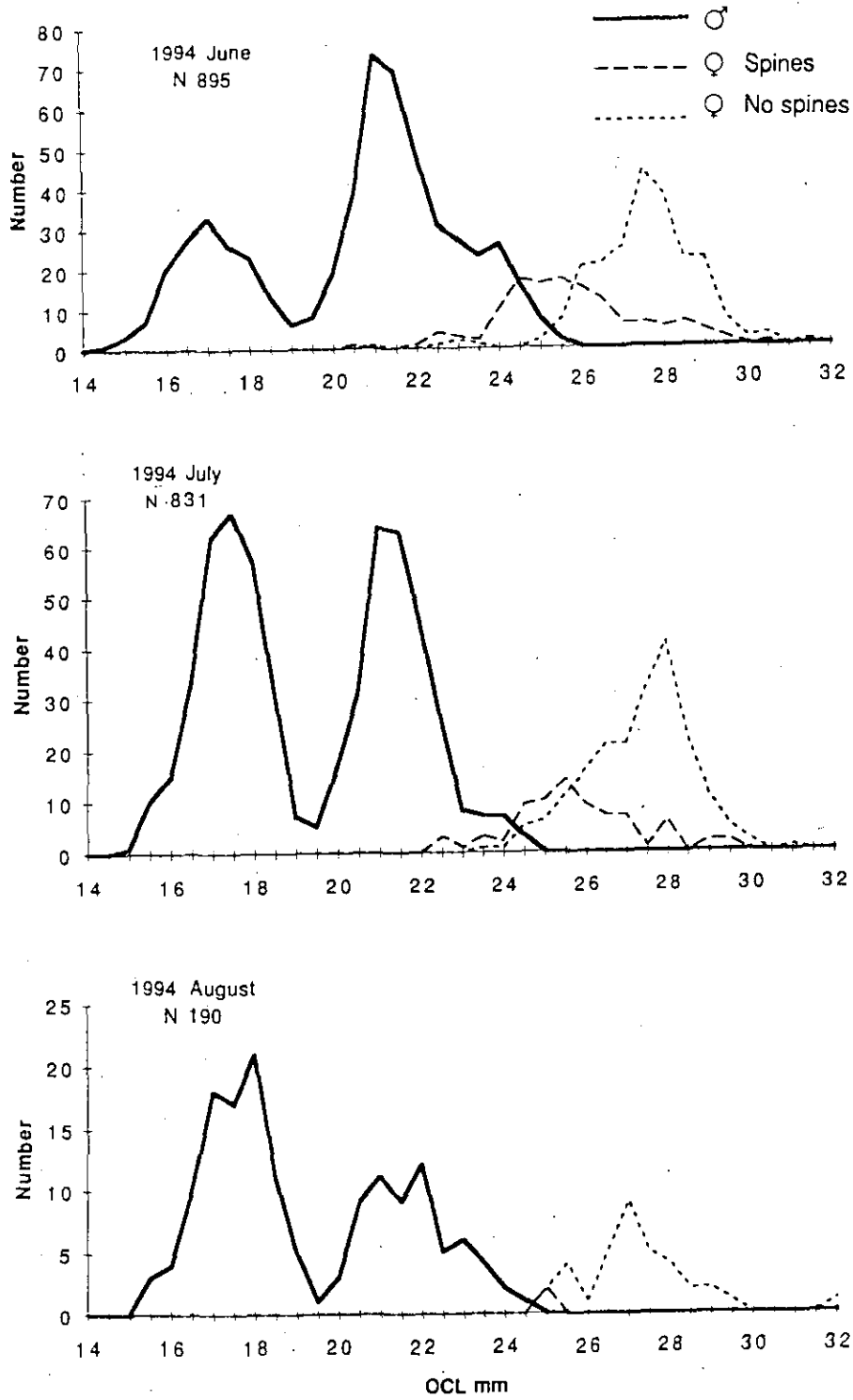


Fig. 1. The length frequency distributions of *P. borealis* at the Flemish Cap in June, July and one sample from the 2nd of August. In June and July a few samples are combined for each month.

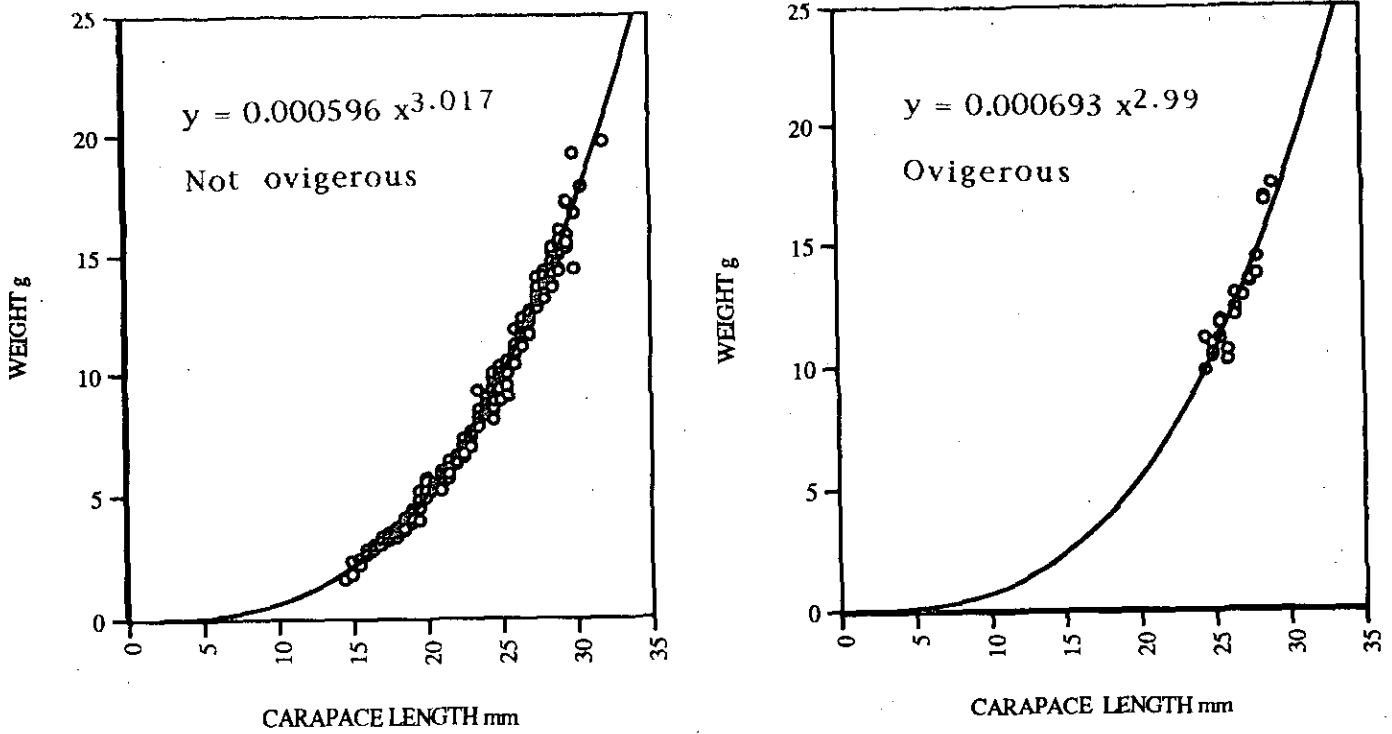


Fig. 2. The length (OCL) weight relationship from the 1994 Icelandic data.

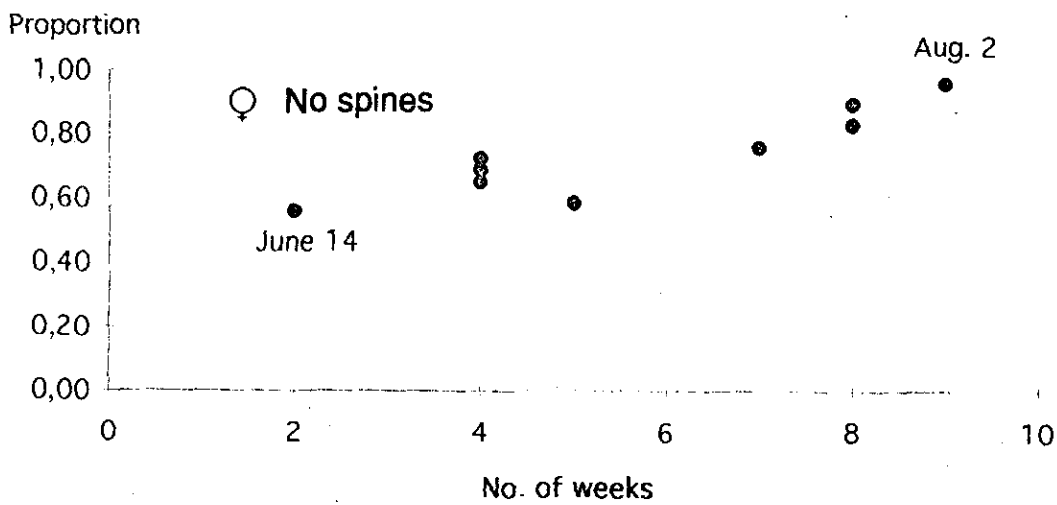


Fig. 3. The progressive change of proportion of females without sternal spines against all females from June 14th to August 2nd in 1994.