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Length and Weight at Age of Northern Shrimp (*Pandalus borealis* Kr.) at the Flemish Cap in 1996 from Icelandic samples.

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Abstract

In this paper there are the results of the age analysis carried out on the northern shrimp at the Flemish Cap.

The age analysis was carried out on all the Icelandic shrimp samples, compiled by months from January through July in 1996, using modal analysis. From the length at age of 5 year-classes a growth curve can be anticipated.

The relationship between length and weight is also being studied. Altogether 6 length weight relationships have been calculated.

Introduction

Aging has been carried out using the modal analysis on samples from the Flemish cap by several authors (Parsons and Weitch1995, Nicholajsen 1994 and Skuladottir 1994). All have been using the method of MacDonald and Pitcher (1979). In this paper this method is used onthe data of 1996.

Moreover the length weight relationships of groups of Pandalus borealis at the Flemish cap have been calculated earlier (Skuladottir, 1994). These were the groups with or without eggs. This is not very practical as especially the multiparous females group can be very variable.

Material and Methods

The measuring of shrimp is carried out using sliding calipers and measuring the carapace from the eye socket to the hind end of the carapace middorsally to the nearest half mm. After this every specimen in a length class is gouped by sexual character as done by Rasmussen (1953) as well as detecting the presence or absence of sternal spines (McCrary 1971). The sex groups detected are 9. Later the 9 sex groups are combined and grouped together in the three main groups males, primiparous females (with sternal spines) and multiparous females (without sternal spines). Included in the group primiparous females are also transitionals.

The age determination was carried out using the method of Macdonald and Pitcher (1979). the program is called Mix. For detecting the age groups, each of the three aforementioned length frequency distributions (lfd.) of males, primiparous females and multiparous females was run separately. The samples were combined by months in 1995. It was tried first to asign as many age-groups to the lfd. and then reduce the number to find the best fit. For the more difficult lfds a constraint had to be put on the coefficient of variation of the so-called sigma (standard deviation of the age-class) to be fixed at 0.05. Trial values for the mean length were used as starting values.

Several samples were used for the calculation of the length- weight relationsships. The shrimp which were deep frozen at sea were left to thaw slowly overnight at 0°C. First the shrimp were measured and sexed as usual. The specimens were then weighed individually to the accuracy of 0.1 g.

Length frequency distributions

The great majority of the samples in 1996 were measured and sexed by observers at sea. But some samples were measured at the Marine Research Instiute of Iceland (MRI). Altogether 582 609 shrimp were measured. After compiling the samples by months the length frequency distributions (lfd) can be studied (Fig. 1). The shrimp are in three categories, namely, males, primiparous females and multiparous females. The male peak is very prominent and shows a strong year-class. A smaller peak appears gradually in the male lfd to the left as time goes by. In July and August the new recruitment is quite obvious although not as prominent as the large peak of the presumed 1993 year-class.

The primiparous females are unimodal in January. Later the primiparous female lfd becomes bimodal and one suspects that there are 2 age groups in this lfd. The multiparous female lfd contains probably more age groups than are obvious. In January the peak of about 23 mm is very clear as well as the one about 27, but after January the 26-27 mm peak is the most prominent one of the mutiparous group.

Estimation of Age

Some results of the age analysis of the 1996 samples are presented in table 1. There are mean lengths (CL) at age for each sex group, male, primiparous female and multiparous female. Also there are the proportions of the overall lfd. The weight at age is also presented, being calculated from the various length weight relationsships, see below. The 3 group of males is always the most prominent group being from 48 to 69 % of all specimens in the various months. The mean length is at first 19.1 mm and drops later to 18.93 mm in February and 18.85 in March. This is not a big difference and could be due variation in the samples. In January there could also have been really 3 age groups in the male lfd in instead of the 2 here assumed. This would change the CL of the 3 group to 18.8 mm when run through the modal analysis. Then there would be a small proportion (4.2%) of 4 group males, with 22.26 mm Cl. (mean length). Some of the 4 group had become multiparous females already in July -August in 1995. These are now in January 8% of the population. Most of the 1992 year-class (4 group) appears however to have delayed the change of sex making up about 20% of the population in January 1996 and maybe there is this 4 group males, 4 %, in addition.

On the whole, there is considerable variation in the proportions of the primiparous females thus the proportion is between 6.3% and upto 24.4 % in the months January to July. August is the month when the primiparous females loose their sternal spines and spawn just after that. It is noticeable that there seem to be for the first time 3 year old shrimps changing sex. This is a small percentage compared to the rest of the age group but it is probably the largest component of the 1993 year-class that changes sex one year earlier than ever at the Flemish Cap. These are between 0.2 and 6.2 % of the population.

The multiparous group was as could be expected rather difficult and there were variable mean lengths at age even when still eggbearing in January through April when growth is not possible. August was particularily difficult. The mean lenghts of the 4 group diminshed from 23.1 mm to 22.8 in April. The 5 group was 26.7 mm in January and then fluctuated between that and 25.9 in this period. The 6 group would decrease from 28.8 mm to 28.4 in april. this could be explained by the removal always of the largest individuals so the lfd of the 6 group could become skewed. In the period April to July the mean length of the 4 group grows from 22.8 mm to 25.2. and even to 25.5 mm in August a growth of 2. 4 mm. The 5 group grows from 26. 2 mm in April to 27 in July, a growth of about 1 mm. The 5+ group in August contains a wee proportion of 6 year olds as well and therefore the mean CL of that is not valid. The 6 year olds seem to grow from 28.4 mm in April to 29 mm in July, a growth of 0.6 mm. As the shrimp spawns every year and spawns in August this could be considered a plausible picture of the slowing down of the growth by age. But due to the skewing of the oldest animals the growth of the 6 group could be an underestimate of the real growth.

It is a bit curious that there seems to be a tiny proportion of 3 year old multiparous females. These proportions were from 0.2- 1.3 % in the months May through August. The modal analysis was not sensible unless this component was included. Some of those were probably parasitised females.

The length at age data (table 2 and Fig. 2) show all the data available from Iceland or the 5 year-classes that are now in the fishery. Some of the data on the 1990-, 1991- and 1992 year-classes were carried out in 1994 (Skúladóttir, 1994). There is noticeable some drop in the growth rate of the 1993 year-class, namely by 1 mm as compared to that of the 1991-yearclass or by 1 mm in the months June through July (months 41-43, Table 2). The growth of the 1994 year-class appears even slower as there is a difference between the CL of the 1994 and that of the 1992 year-class, namely a differnce of 1.7 mm in August (month 31).

Length weight relationships

There are large changes in the weight at length for the multiparous female group as the females are not ovigerous the whole year. At times it is neccessary to have a length weight relationship per month for this group. There are however at present only 3 length weight relationships that have been fitted for the multiparous female group (table 3), namely May- June, July and August. For calculating the mean weight at age for the multiparous females in Table 1 the August relationship had to be used for the months January through April. It is evident that more effort is needed in weighing the multiparous females especially during the months when all are egg bearing.

The primiparous group could also be slightly variable. There could be an increase in the weight of headroes in the primiparous females when getting nearer to spawning. This would probably only be noticeable in the last couple of months before spawning takes place. In this investigation the data are not sufficent and more weighing of primiparous females should be carried out in July where there were only 9 specimens so far weighed.

In fitting the length weight relationship for males it was assumed that all months should be combined.

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Table 1. Some results of the modal analysis by sex and presumed age groups in 1996. Also shown rom the length-weight relationships.

A *January 1996*

Age	2	3	3	4	4	5	6
Sex	Male	Male	Primi. Fe.	Primi. Fe.	Multi. fe.	Multi. fe.	Multi. fe.
CL (mm)	12.13	19.10	20.21	23.09	23.11	26.72	28.77
Weight (g)	1.07	4.16	4.92	7.31	7.83	12.10	15.08
Per cent	0.18	58.14	0.23	19.75	8.04	10.31	3.35

B *February 1996*

Age	2	3	3	4	4	5	6
Sex	Male	Male	Primi. Fe.	Primi. Fe.	Multi. fe.	Multi. fe.	Multi. fe.
CL (mm)	12.71	18.93	20.86	23.83	23.03	25.91	28.53
Weight (g)	1.24	4.05	5.41	8.04	7.76	11.04	14.71
Per cent	0.38	48.12	2.96	16.88	6.64	16.59	8.44

C *March 1996*

Age	2	3	3	4	4	5	6
Sex	Male	Male	Primi. Fe.	Primi. Fe.	Multi. fe.	Multi. fe.	Multi. fe.
CL (mm)	12.95	18.85	20.58	23.80	22.85	26.16	28.39
Weight (g)	1.31	4.00	5.19	8.01	7.58	11.35	14.50
Per cent	0.54	68.57	4.86	6.28	5.93	8.81	5.01

D *April 1996*

Age	2	3	3	4	4	5	6
Sex	Male	Male	Primi. Fe.	Primi. Fe.	Multi. fe.	Multi. fe.	Multi. fe.
CL (mm)	13.28	19.61	21.07	24.56	22.82	26.22	28.42
Weight(g)	1.41	4.50	5.57	8.80	7.55	11.43	14.55
Per cent	3.78	61.92	6.21	15.13	3.76	5.61	3.60

E *May 1996*

Age	2	3	3	4	3	4	5	6
Sex	Male	Male	Primi. Fe.	Primi. Fe.	Multi. fe.	Multi. fe.	Multi. fe.	Multi. fe.
CL (mm)	14.35	19.88	21.23	24.80	18.38	23.23	25.95	28.51
Weight (g)	1.78	4.68	5.77	8.89	4.15	7.76	10.44	13.43
Per cent	1.95	52.50	5.04	27.99	0.17	3.24	5.59	3.53

F *June 1996*

Age	2	3	3	4	3	4	5	6
Sex	Male	Male	Primi. Fe.	Primi. Fe.	Multi. fe.	Multi. fe.	Multi. fe.	Multi. fe.
CL (mm)	14.74	20.29	20.58	23.80	19.03	24.33	26.92	29.08
Weight (g)	1.92	4.98	5.29	7.93	4.55	8.79	11.51	14.16
Per cent	3.39	56.12	3.86	24.35	0.12	1.82	7.11	3.23

G *July 1996*

Age	2	3	3	4	3	4	5	6
Sex	Male	Male	Primi. Fe.	Primi. Fe.	Multi. fe.	Multi. fe.	Multi. fe.	Multi. fe.
CL (mm)	15.60	20.39	21.62	25.05	20.87	25.21	27.04	29.04
Weight (g)	2.27	5.05	6.37	9.72	5.04	9.80	12.54	16.11
Per cent	6.15	63.50	2.64	13.35	0.40	7.30	3.83	2.82

H *August 1996*

Age	2	3	3	4	3	4	5+
Sex	Male	Male	Primi. Fe.	Primi. Fe.	Multi. fe.	Multi. fe.	Multi. fe.
CL (mm)	15.79	20.51	21.29	26.34	21.56	25.46	28.80
Weight (g)	2.36	5.14	6.09	11.23	6.37	10.46	15.14
Per cent	9.30	63.93	1.55	1.23	1.34	19.50	3.15

Table 2. Mean carapace length by months of 5 year-classes as assessed from Icelandic data.

	Year-classes				
Months	1990	1991	1992	1993	1994
24					12.13
25					12.70
26					12.95
27					13.28
28					14.35
29		17.15	17.12		14.74
30			17.38		15.60
31			17.49		15.79
36				19.10	
37				19.83	
38				18.85	
39				19.61	
40				19.88	
41	20.87	21.30		20.29	
42		21.37		20.39	
43		21.45		20.51	
48			23.08		
49			23.83		
50			23.80		
51			24.56		
52			24.80		
53	23.70		23.80		
54	23.86		25.05		
55	22.80		25.46		
60		26.72			
61		25.91			
62		26.16			
63		26.22			
64		25.95			
65		26.92			
66		27.04			
67		25.47			
72	28.77				
73	28.53				
74	28.39				
75	28.42				
76	28.51				
77	29.08				
78	29.04				

Table 3. Length-weight relationships for different sex groups of northern shrimp, where y is the weight and x is the carapace length.

Month	Sex group	No. of specimens	Equation	r squared
May-August	Male	564	ln y = 2.980*ln x - 7.365	0.939
May-June	primip. fem.	101	ln y = 2.786*ln x - 6.760	0.905
July-August	primip. fem.	9	ln y = 2.872*ln x - 6.976	0.952
May-June	multip. fem	53	ln y = 2.676*ln x - 6.368	0.931
July	multip. fem	26	ln y = 3.517*ln x - 9.068	0.851
August	multip. fem	33	ln y = 2.991*ln x - 7.334	0.902

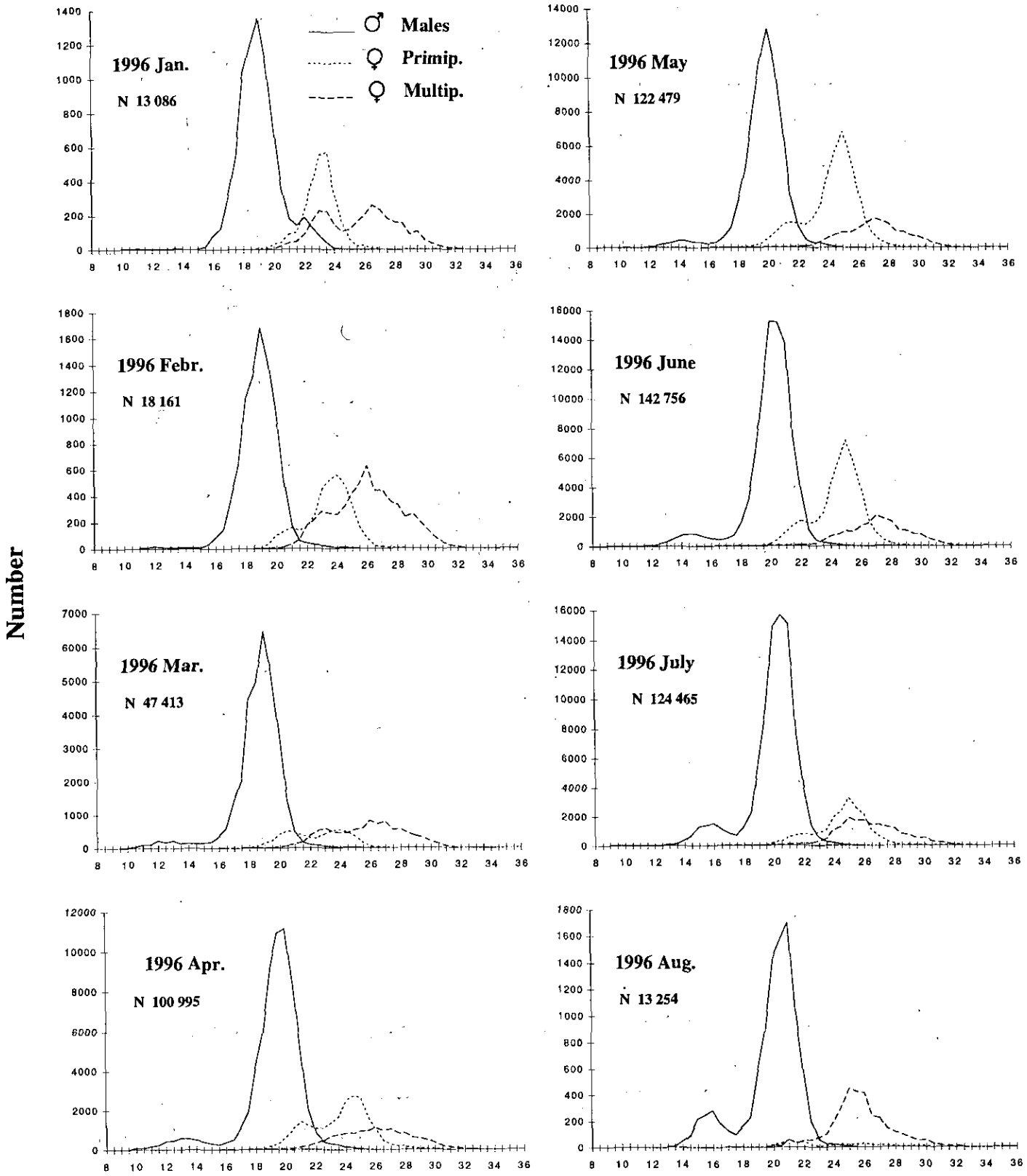

Fig. 1. The length frequency distributions of northern shrimp at the Flemish cap by months in 1996.

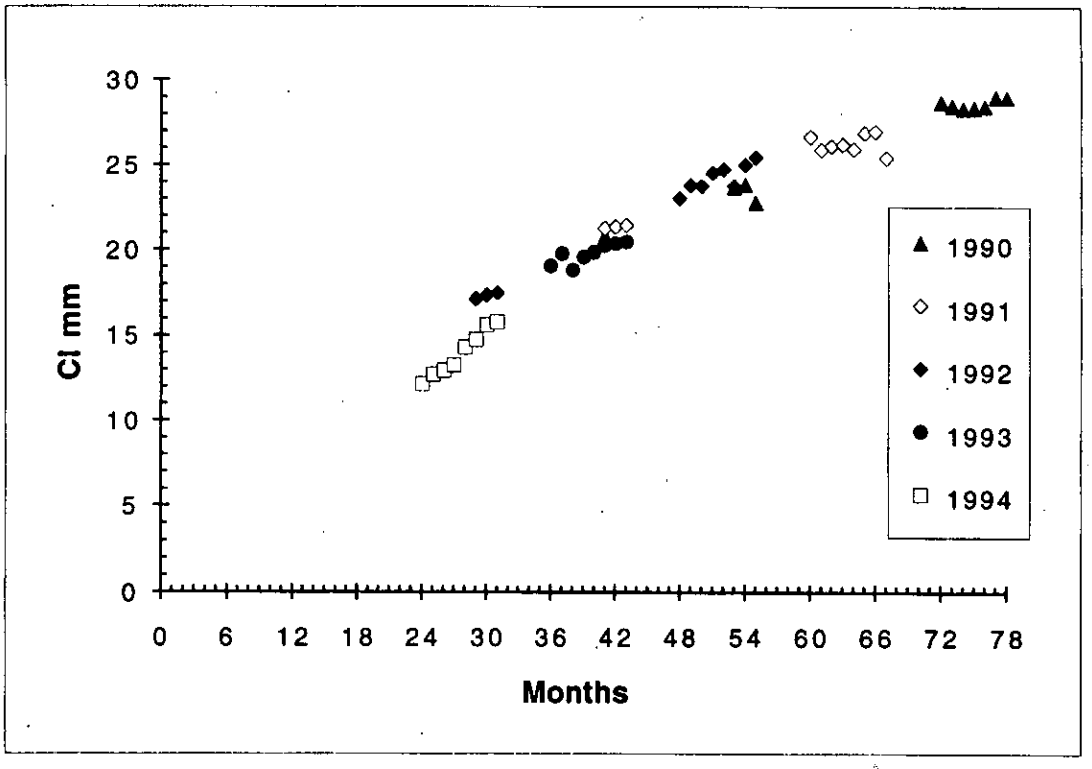

Fig. 2. The growth of 5 year-classes. The age is assumed from January before hatching. Hatching probably takes place in april.