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The Icelandic Shrimp Fishery (*Pandalus borealis* Kr.) in the Denmark Strait in  
1995-1996 and Some Reflection on Age Groups in the Years 1991-1996

by

U. Skúladóttir

Marine Research Institute, Skúlagata 4,  
P. O. Box 1390, 121-Reykjavik, Iceland

**Abstract**

In this paper there are logbook information on the Icelandic fishery for the years 1995-1996 as well as nominal catches.

Age determination of the shrimp samples taken on the eastern side of the midline in 1995 were and 1996 were assessed by using modal analysis. The growth of males from the assumed age 3 to 6 is found to be about 2.5 mm per year. The change of sex starts at the age of 5 but is estimated to take mostly place at age 6 so the first spawning will take place at the age 6 for about a quarter of the year-class and the rest of the year-class will spawn at the age of 7 for the first time as the birthday is assumed to be the 1st of June. The oldest shrimp detected were 8 years soon to become 9 years old.

**Introduction**

Logbook information is supposed to come in by the end of the month from each vessel. This is usually delayed by one or more months. This information is presented here as well as the nominal catch.

There has been a growing need to assess the age of shrimp in Denmark Strait. This is now done for the second time using the modal analysis.

**Material and Methods**

For most of the catch data there are logbook data which include catch and effort. Not all skippers send in the logbooks, but information on landings can be obtained elsewhere. Thus the equivalent to the nominal catch can be calculated for the effort. This is done by adding up all catch and effort by two periods of the year from the logbooks and calculating the CPUE. Whereupon the nominal catch for the same period is divided by the CPUE to get the corrected effort.

The measuring of the 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 grouped 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, listed beside table 2. 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). In the group primiparous females there 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. It was tried first to assign many age-groups to the lfd. and then reduce the number to find the best fit. For the more difficult lfd. 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. Moreover when assessing the age of the multiparous females the sigmas were kept equal.

**Catch and effort data**

In 1995 the fishery was carried out in the period February through September. But most of the catch was taken in February and March. The total annual catch was 1150 tons in 1995 (table 1) as compared to only 566 tons in 1996. Catch was less in 1995 than 1994, namely 1150 tons. Most of the catch was taken in the months February, March and April. After that ice covered the area for some months. The mean CPUE for the year 1995 was the

highest ever for Iceland, namely 309 kgs per trawling hour. In 1994 the mean CPUE was 284 kg, which was also higher than ever before. The CPUE lower in 1996 i.e. 229. The catch was however very occasional on the eastern side of the midline in 1996 and did not last long. The average size of gear was about 3120 meshes circumference in 1996 as compared to 2260 meshes in 1995 (2400 meshes of most previous years).

#### Commercial Samples

The samples were obtained from shrimpers in 1995 and 1996. There were only 8 small samples obtained in February 1995 on the eastern side in the traditional north area (Table 2, Fig.1). The proportion of males in 1996 was very high namely 70% as compared to 22% in 1995. The percentage of females was 30% in 1995 as compared to 88% in February 1995. As the Icelandic commercial samples have been quite few the last years it is not wise to draw any conclusions on the proportions of females in the catch.

Of the multiparous females 72% were carrying eggs, but 28% were not carrying eggs, and are considered to be in the resting phase. As pointed out before most of the females will spawn every second year as hinted by the percentage of mature females that were not carrying eggs. As a comparison in 1995 these proportions were 39% not carrying eggs.

#### Estimation of Age

An attempt was made to determine the age of the shrimp in the Denmark Strait of the Icelandic samples 1991, 1992, 1993 and 1994 (Skúladóttir 1994). Here again the February samples of 1995 (Table 2) were aged again with the addition of 4 more samples (Skúladóttir, 1995). The primiparous females seemed only to have a single peak with mean length at 27.3 mm, there have been two peaks detected in the years 1991 through 1994. The multiparous females were run through with a constraint on the deviations being equal. All samples of the year 1996 were taken in February through April. As the samples taken were rather few (1071 specimens), these were all combined before the age assessment was carried out. It is strange that the 6 year old males seem for the first time to be missing. This time there were two peaks in the primiparous females where the 5 year old presented a tiny proportion.

In table 4 are listed the mean lengths at age for the 3 sex groups for the years 1991-1995. For the males there appears to be great consistency between years in the mean lengths at age. Four modes can usually be detected in the male lfd and some times five. As the left hand side of the male lfd is usually very deficient as regards the so-called 2 year olds, their mean size is therefore badly determined. At the age 3, 4 and 5, mean sizes of males are generally better estimated than in any other sex group. The 6 year old males in May 1991 were unusually large but as the proportion was very low the mean size was not so well determined.

The primiparous females always seemed to be bimodal except for May 1992 and again in 1995. The proportions of the 5 year olds changing sex as judged by the proportion of primiparous females against males plus primiparous females in the 5 group has been about 9% on the average in the years 1991 to 1994, but this could be an underestimate as more males may manage to change sex in time and still be able to spawn in August as females.

The multiparous females are a composite group and each year class is growing mostly when in the resting phase, i.e. when the females are not eggbearing (every second years) so there should be some slowing down of the growth as compared to that of the younger animals. This does not seem to be the case if looking at the overall length by age (table 4). The Mix is usually unable to pick up more than 3 age groups at a time except for 1994 and 1996 when there were 4 year classes. The youngest, i.e. the 5 year old multiparous females only represent a tiny proportion (below 2 % of all sex groups). The 6 year olds (mature females) also represent rather small percentages, namely between 3% and 10% of the overall proportion so their mean size may not always be very well determined.

When looking at proportions these seem generally to be highest of 5, 6 and 7 year olds (Table 6).

#### References

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Table 1. The catch, effort and CPUE as reported by Icelandic logbooks. in the Denmark Strait in 1995 and 1996.

YEAR	MONTH	FROM LOGBOOKS		
		CPUE kg/hr	EFFORT Tr. hours	CATCH Tonnes
1995*	February	383	1339	513.194
	March	209	983	205.563
	May	10	4	0.043
logbooks	Σ Feb-May	309	2326	718.800
Nominal catch	Σ Feb-May	309	3722	1149.992
1995*	September	171	7	1.200
Nominal catch	Σ Sep-Oct	171	7	1.200
Nominal catch	ΣΣ 1995	309	3729	1151.2
1996	February	198	1228	242.642
	March	229	359	82.316
	April	341	618	210.885
	May	2	5	0.012
logbooks	Σ Feb-May	242	2210	535.855
Nominal catch	Σ Feb-May	242	2305	558.988
	July	495	7	3.466
	September	94	34	3.183
logbooks	Σ July-Sept	162	41	6.649
Nominal catch	Σ July-Sept			
Nominal catch	ΣΣ 1996	229	2468	565.637

Table 2. The length distribution by 3 major categories by months. The legend at the bottom of the table is the same as before (Skúladóttir, 1995 a).

February 1995				
CL m m	Males	Primip. Females	Multip. Females	Σ
14				
14.5				
15				
15.5				
16				
16.5	1			1
17				0
17.5				0
18				0
18.5	5			5
19	6			6
19.5	8			8
20	14			14
20.5	10			10
21	8			8
21.5	14			14
22	10			10
22.5	8			8
23	9			9
23.5	17	2	2	21
24	22		2	24
24.5	19	1	3	23
25	15		6	21
25.5	19		4	23
26	15	4	12	31
26.5	21	10	17	48
27	8	12	28	48
27.5	18	12	61	91
28	1	11	63	75
28.5	6	9	84	99
29		4	107	111
29.5			92	92
30			92	92
30.5			62	62
31			44	44
31.5			49	49
32			43	43
32.5			31	31
33			18	18
33.5			10	10
34			7	7
34.5				
35				
35.5				
Σ	254	65	837	1156
Σ	ma	mi	mg	gm
mean CL	254	0	0	65
%	21.97	0.00	0.00	5.62
Σ	ag	ga	ea	em
mean CL	8	52	656	41
%	29.69	29.94	29.45	29.12
%	0.69	11.42	56.75	3.55
Σ	eg			
mean CL	0			
%	0.00			

February 1996				
CL m m	Males	Primip. Females	Multip. Females	Σ
14				
14.5				
15				
15.5				
16	1			1
16.5				0
17				0
17.5				0
18				0
18.5	1			1
19	1			1
19.5	1			1
20	2			2
20.5	6			6
21	6			6
21.5	9			9
22	7			7
22.5	3			3
23	6			6
23.5	5	1	1	7
24	5	1		6
24.5	7	1		8
25	3	1		4
25.5	1	1		2
26	4			4
26.5	1	1	6	8
27	1	3	4	8
27.5	1		6	7
28		1	2	3
28.5			2	2
29			5	5
29.5			2	2
30			5	5
30.5			3	3
31				0
31.5			2	2
32			1	1
32.5				0
33			1	1
33.5				0
34				0
34.5				
35				
35.5				
Σ	71	10	40	121
Σ	ma	mi	mg	gm
mean CL	71	2	0	8
%	22.67	25.20	0.00	25.94
%	58.68	1.65	0.00	6.61
Σ	ag	ga	ea	em
mean CL	1	3	7	29
%	28.00	29.33	28.57	28.48
%	0.83	2.48	5.79	23.97
Σ	eg			
mean CL	0			
%	0.00			

Table 2 continued.

March 1996				
CL m m	Males	Primip. Females	Multip. Females	Σ
14				
14.5				
15				
15.5	1			1
16				0
16.5				0
17				0
17.5	1			1
18	2			2
18.5	4			4
19	11			11
19.5	5			5
20	14			14
20.5	9			9
21	24			24
21.5	33			33
22	23			23
22.5	23			23
23	29	1		30
23.5	32	2		34
24	43	1	3	47
24.5	20	2	2	24
25	33	3		36
25.5	18	6	1	25
26	22	5	5	32
26.5	7	9	4	20
27	7	12	8	27
27.5	1	11	11	23
28		7	14	21
28.5		4	9	13
29		4	6	10
29.5		3	8	11
30		1	9	10
30.5		1	6	7
31			6	6
31.5			3	3
32			1	1
32.5				0
33			1	1
33.5				0
34				0
34.5				
35				
35.5				
Σ	362	72	97	531
Σ	ma	mi	mg	gm
Σ	362	13	1	58
mean CL	23.07	26.31	23.50	27.16
%	68.17	2.45	0.19	10.92
Σ	ag	ga	ea	em
Σ	1	24	0	72
mean CL	24.50	29.96	0.00	27.98
%	0.19	4.52	0.00	13.56
Σ	eg			
Σ	0			
mean CL	0.00			
%	0.00			

April 1996				
CL m m	Males	Primip. Females	Multip. Females	Σ
14				
14.5				
15				
15.5	1			1
16				0
16.5				0
17	1			1
17.5	1			1
18	1			1
18.5	4			4
19	3			3
19.5	8			8
20	5			5
20.5	19			19
21	10			10
21.5	17			17
22	26			26
22.5	27	1	2	30
23	31	1		32
23.5	24			24
24	37		1	38
24.5	21	2	1	24
25	14	2		16
25.5	9	1	2	12
26	10	3	6	19
26.5	8	6	7	21
27	1	2	10	13
27.5	3	6	11	20
28		3	10	13
28.5	1	9	4	14
29		1	12	13
29.5		1	8	9
30		1	7	8
30.5			8	8
31			2	2
31.5			4	4
32			2	2
32.5			1	1
33				0
33.5				0
34				0
34.5				
35				
35.5				
Σ	282	39	98	419
Σ	ma	mi	mg	gm
Σ	282	1	1	37
mean CL	22.94	25.00	26.50	27.12
%	67.30	0.24	0.24	8.83
Σ	ag	ga	ea	em
Σ	2	18	0	74
mean CL	28.75	28.81	0.00	28.12
%	0.48	4.30	0.00	17.66
Σ	eg			
Σ	4			
mean CL	29.50			
%	0.95			

Table 3. The mean carapace length (CL), proportion (PR) and standard deviation (SD) for each age class from the Icelandic samples in the years 1995 -1996 in the eastern part of the Denmark Strait area.

February 1995

Age	Males			Primip. females			Multip. females		
	CL	PR	SD	CL	PR	SD	CL	PR	SD
3	19.7	0.0275	0.99						
4	21.0	0.0353	1.05						
5	24.0	0.0733	1.20						
6	26.2	0.0836	1.31	27.3	0.0562	1.20	25.6	0.0264	1.19
7							28.9	0.5042	1.19
8							31.6	0.1936	1.19

February-April 1996

Age	Males			Primip. females			Multip. females		
	CL	PR	SD	CL	PR	SD	CL	PR	SD
2	16.3	0.004	0.81						
3	19.4	0.0535	0.97						
4	21.9	0.2907	1.10						
5	24.5	0.3475	1.22	24.1	0.0083	1.21	24.0	0.0098	0.93
6				27.1	0.0867	1.36	27.2	0.1010	0.93
7							29.5	0.0814	0.93
8							31.3	0.0171	0.93

Table 4. Mean carapace length mm of northern shrimp as estimated from Icelandic samples in the Denmark Strait in February-May. The birthday here is 1st of June.

MALES							
Year/"Agegroups"	2	3	4	5	6	7	8
1991	15.0	18.5	21.0	24.0	27.0		
1992		18.0	21.1	23.8	25.6		
1993		17.8	20.1	22.7	25.1		
1994	14.0	18.1	20.3	23.0	25.6		
1995		19.7	21.0	24.0	26.2		
1996	16.3	19.4	21.9	24.5			
Mean	15.1	18.6	20.9	23.7	25.9		
Primiparous females							
1991				25.6	28.6		
1992				25.1	27.9		
1993				24.2	27.6		
1994				23.9	27.0		
1995					27.3		
1996				24.1	27.1		
Mean				24.6	27.6		
Multiparous females							
1991					26.1	30.2	32.0
1992					26.0	30.1	32.7
1993					25.2	29.7	
1994				22.9	26.3	28.8	31.4
1995					25.6	28.9	31.6
1996				24.0	27.2	29.5	31.3
Mean				23.5	26.1	29.5	31.8

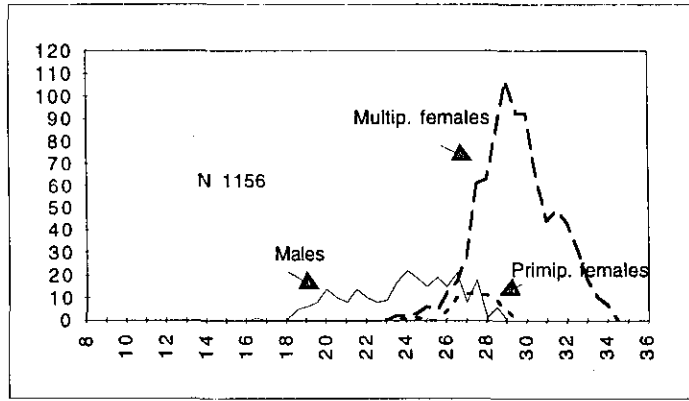
Table 5. Proportions by age groups of northern shrimp as estimated from Icelandic samples in the Denmark Strait in the years 1991-1996.

MALES							
Year/"Agegroups"	2	3	4	5	6	7	8
1991	0.0195	0.0672	0.2789	0.2512	0.0389		
1992		0.0231	0.1589	0.2122	0.1709		
1993		0.0244	0.1450	0.2655	0.2215		
1994	0.0049	0.0513	0.1370	0.1917	0.1112		
1995		0.0275	0.0353	0.0733	0.0836		
1996	0.0040	0.0535	0.2907	0.3475			
Mean	0.0095	0.0412	0.1743	0.2236	0.1252		
Primiparous females							
1991				0.0238	0.0902		
1992				0.0103	0.0603		
1993				0.0246	0.0638		
1994				0.0260	0.0620		
1995					0.0562		
1996				0.0083	0.0867		
Mean				0.0186	0.0699		
Multiparous females							
1991					0.0305	0.1732	0.0250
1992					0.0498	0.2821	0.0328
1993					0.0327	0.2225	
1994				0.0191	0.0383	0.2438	0.1149
1995					0.0264	0.5042	0.1936
1996				0.0098	0.1010	0.0814	0.0171
Mean				0.0145	0.0465	0.2512	0.0767

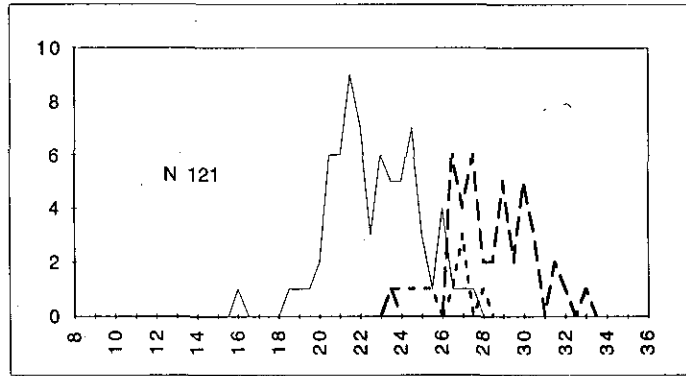
Table 6. Overall proportions by age of northern shrimp as estimated from Icelandic samples in the Denmark Strait.

Year/"Agegroups"	2	3	4	5	6	7	8
1991	0.0195	0.0672	0.2789	0.2750	0.1596	0.1732	0.0250
1992		0.0231	0.1589	0.2225	0.2810	0.2821	0.0328
1993		0.0244	0.1450	0.2901	0.3180	0.2225	
1994	0.0049	0.0513	0.1370	0.2368	0.2115	0.2438	0.1149
1995		0.0275	0.0353	0.0733	0.1661	0.5042	0.1936
1996	0.0040	0.0535	0.2907	0.3656	0.1877	0.0814	0.0171
Mean	0.0095	0.0412	0.1743	0.2439	0.2207	0.2512	0.0767

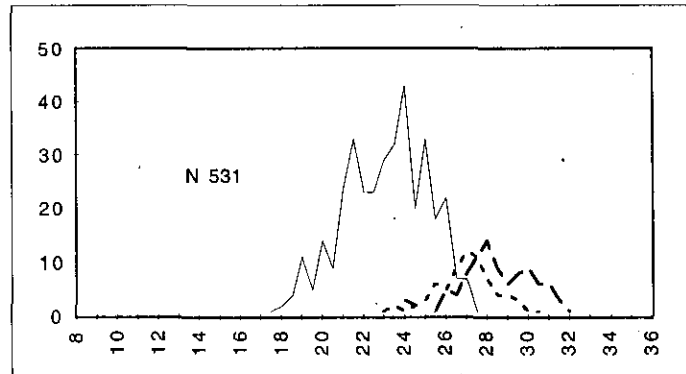
FEBRUARY 1995



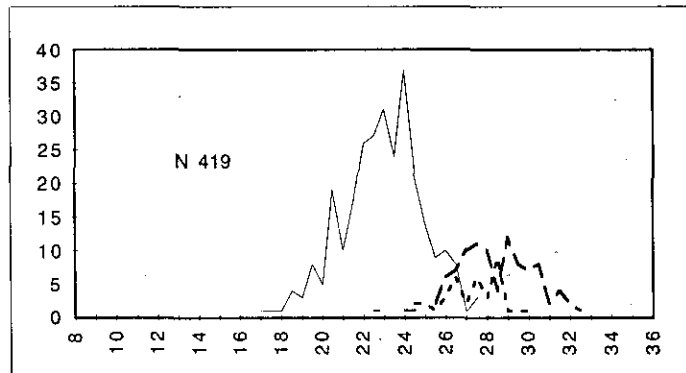
FEBRUARY 1996



MARCH 1996



APRIL 1996



Carapace length mm

Fig. 1. The Icelandic samples in 1995 and 1996.