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The Icelandic Shrimp Fishery (*Pandalus borealis* Kr.) in the Denmark Strait in 1994 - 1995 and some reflection on age groups in the years 1991-1995.

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Abstract

In this paper there are logbook information on the Icelandic fishery for the years 1994-1995 as well as nominal catches.

The four shrimp samples taken on the eastern side of the midline in 1995 are combined. An attempt is again made to determine the age in the February samples from the year 1995 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 generally estimated to take place at age 6 so the the first spawning will take place at the age 7 for about a quarter of the year-class and the rest of the year-class will spawn at the age of 8 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. The ages may well be incorrect and a year should be subtracted.

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 of Macdonald and Pitcher (1979).

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. Wherupon 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 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, listed beside table 2. Later the 9 sex groups are combined and grouped together in the three main groups males, immature females (with sternal spines) and mature females (without sternal spines). In the group immature female 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 freqency distributions (lfd.) of males, immature females and mature females was run separately. The samples were combined by month in 1995. It was tried first to asign 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 socalled sigma (standard deviation of the age-class) to be constant. Trial values for the mean length were used as starting values.

Catch and effort data

In 1994 the fishery was carried out in the period February through November. But most of the catch was taken in March and May. The total annual catch was 1514 tons in 1994 (table 1) as compared to 2553 tons in 1993. Catch was less in 1995 than 1994, namely 1150 tons. Most of the catch was taken in the months February and March. After that ice covered the area for many 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 catch was however very occasional on the eastern side of the midline in 1994 and did not last long. The average size of gear was about 2134 meshes circumference in 1994 and 2260 meshes in 1995 as compared to the mean size of 2400 meshes of most previous years. So the mean gear size of 2700 meshes in the year 1993 was unusual and on the whole there is not an increasing trend in the size of trawl.

Commercial Samples

The samples were obtained from shrimpers in 1995. There were only 4 small samples obtained in February on the eastern side in the traditional north area (Table 2, Fig.1). The proportion of males was 30%, the percentage of immature females was 6.7% in 1995 as compared to 9% in March-April in 1994. The percentage of mature females was very high or 63.7% in 1995 as compared to 41% in the samples of 1994. Moreover of the mature females (without sternal spines) 39% were not carrying eggs, but 61% were carrying eggs. 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 1994 27% were not carrying eggs and are considered to be in the resting phase, but 73% of the mature females were carrying eggs most of which did not have eyespots.

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 using the modal analysis method of McDonald and Pitcher (1979) (Skúladóttir 1994). Here again the modal analysis is applied to the February samples (Table 3). The estimation of the length frequency distributions (lfds) did not go well and the coeficient of variation of sigma had to be fixed at 0.045. The immature females seemed only to have a single peak with mean length at 27.3 mm, there have been two peaks detected in the yeas 1991 through 1994. It was unusual that no constraint was neccessary for the mature females and the analysis ran freely without any constraints. 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 lenghts at age. Four modes can always 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 socalled 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 and may reflect a change in the size at sex change since 1991, but in 1995 the males are on the whole larger than in the years 1992 to 1994 and more in line with the 1991 results.

The immature females always seemed to be biomodal except for May 1992 and again in 1995. The proportions of the 5 year olds changing sex as judged by the proportion of immature females against males plus immature 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. It is interesting to note that the proportion of 6 year old mature females to both 6 and 7 year old mature females is about 11% on the average. In 1995 however, there does not seem to be any 5 year olds changing sex.

The mature 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 considerable slowing down of the growth. This does not seem to be the case if looking at the overall length by age (Table 6). The mix is unable to pick up more than 3 age groups at a time except for 1994 when there were 4 year classses. The 6 year olds (mature females) only represent small percentages, namely between 3% and 6% of the overall proportion so their mean size may not be very well determined. The occurence of the 5 year old mature females in 1994, which only makes up 2% of the total frequency is peculiar. At any rate there was no indication of an early sex change at the age of 4 in 1993.

When looking at proportions these seem generally to be highest of 5, 6 and 7 year olds (Table 7). The year-classes from 1986, 1987 and 1988 seem to have been quite strong. if the assumption on age is correct.

As the Icelandic commercial samples have been quite few the last two years it is not wise to draw any conclusions on the proportions of females in the catch.

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Table 1. The catch, effort and CPUE as reported by Icelandic logbooks. in the Denmark Strait in 1994 .
and 1995.

YEAR	MONTH	FROM LOGBOOKS		
		CPUE kg/hr	EFFORT Tr. hours	CATCH Tonnes
1994	February	357	14	5.120
	March	350	1533	536.192
	April	70	86	6.021
	May	265	2045	542.290
	June	149	263	39.244
logbooks	∑ Feb-Jun	286	3941	1128.867 -
Nominal catch	∑ Feb-Jun	286	5233	1498.876
	August	185	14	2.500
	September	56	56	3.148
	October	104	77	7.950
	November	90	20	1.750
logbooks	∑ Aug-Nov	93	165	15.348
Nominal catch	∑ Aug-Nov	93	165	15.348
Nominal catch	∑∑ 1994	284	5326	1514.2
1995*	February	383	1339	513.194
	March	209.	983	205.563
	May	10	4	0.043
logbooks	∑ Feb-May	309	2326	718.800
Nominal catch	∑ Feb-May	309	3722	1149.992
1995*	September	171	7	1.200
Nominal catch	∑ Sep-Oct	171	7	1.200
Nominal catch	∑∑ 1995	309	3729	1151.2

* Provisional

Table 2. 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 CL by the 9 sexual categories as explained below.

February 1995				
α mm	♂	♂♀ spines	♀ no spines	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	16	2	2	20
24	22		2	24
24.5	19	1	3	23
25	15		6	21
25.5	18		3	21
26	13	3	11	27
26.5	18	9	14	41
27	7	10	24	41
27.5	15	10	43	68
28	1	11	45	57
28.5	5	6	54	65
29		3	65	68
29.5			51	51
30			53	53
30.5			35	35
31			24	24
31.5			27	27
32			24	24
32.5			17	17
33			9	9
33.5			6	6
34			4	4
34.5				0
35				0
35.5				0
Σ	242	55	522	819
Σ mean CL %	ma 242 23.68 29.57	mi 0	mg 0	gm 55 27.25 6.72
Σ mean CL %	ag 5 29.30 0.61	ga 97 29.60 11.84	ea 391 29.22 47.74	em 29 28.86 3.54
Σ mean CL %	eg 0			

The legend used in table 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 3. The mean carapace length (Cl), standard deviation (SD) and proportion (PR) for each age class from the Icelandic samples in 1995.

February 1995

Age	Males			Immature females			Mature females			Overall CL and PR	
	CL	SD	PR	CL	SD	PR	CL	SD	PR	CL	PR
3	19.5	0.88	0.0366							19.5	0.0366
4	21.2	0.95	0.0575							21.2	0.0575
5	24.1	1.09	0.1109							24.1	0.1109
6	26.4	1.19	0.0905	27.30	1.19	0.0672	25.5	1.08	0.0250	26.6	0.1827
7							28.6	1.22	0.4274	28.6	0.4274
8							31.3	1.34	0.1849	31.3	0.1849

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

MALES							
Year/"Age groups"	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		19.5	21.2	24.1	26.4		
Mean	14.5	18.4	20.7	23.5	25.9		
IMMATURE FEMALES							
Year/"Age groups"	2	3	4	5	6	7	8
1991				25.6	28.6		
1992				25.1	27.9		
1993				24.2	27.6		
1994				23.9	27.0		
1995					27.3		
Mean				24.7	27.7		
MATURE FEMALES							
Year/"Age groups"	2	3	4	5	6	7	8
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					25.5	28.6	31.3
Mean					25.8	29.5	31.9

Table 5. Proportions by age of northern shrimp as estimated from Icelandic samples in the Denmark Strait in February-May in the years1991-1995.

Year/"Age gr."	2	3	4	5	6	7	8
MALES							
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		0.0366	0.0575	0.1109	0.0905		
Mean	0.0122	0.0405	0.1555	0.2063	0.1266		
IMMATURE FEMALES							
1991				0.0238	0.0902		
1992				0.0103	0.0603		
1993				0.0246	0.0638		
1994				0.0260	0.0620		
1995				0.0000	0.0672		
Mean				0.0169	0.0687		
MATURE FEMALES							
1991					0.0305	0.1732	0.0250
1992					0.0498	0.2821	0.0328
1993					0.0327	0.2225	0.0000
1994				0.0191	0.0383	0.2438	0.1149
1995					0.0250	0.4274	0.1849
Mean					0.0353	0.2698	0.0715

Table 6. Mean carapace length mm by age of northern shrimp as estimated from Icelandic samples in the Denmark Strait in February-May in the years 1991-1995. The mean CL is calculated by weighing the sex groups together with their respective proportions.

Year/"Age gr."	2	3	4	5	6	7	8
1991	15.0	18.5	21.0	24.1	27.7	30.2	32.0
1992		18.0	21.1	23.9	26.2	30.1	32.7
1993		17.8	20.1	22.8	25.6	29.7	
1994	14.0	18.1	20.3	23.1	26.1	28.8	31.4
1995		19.5	21.2	24.1	26.6	28.6	31.3
Mean	14.5	18.4	20.7	23.6	26.4	29.5	31.9

Table 7. Overall proportions by age of northern shrimp as estimated from Icelandic samples in the Denmark Strait in February-May in the years1991-1995.

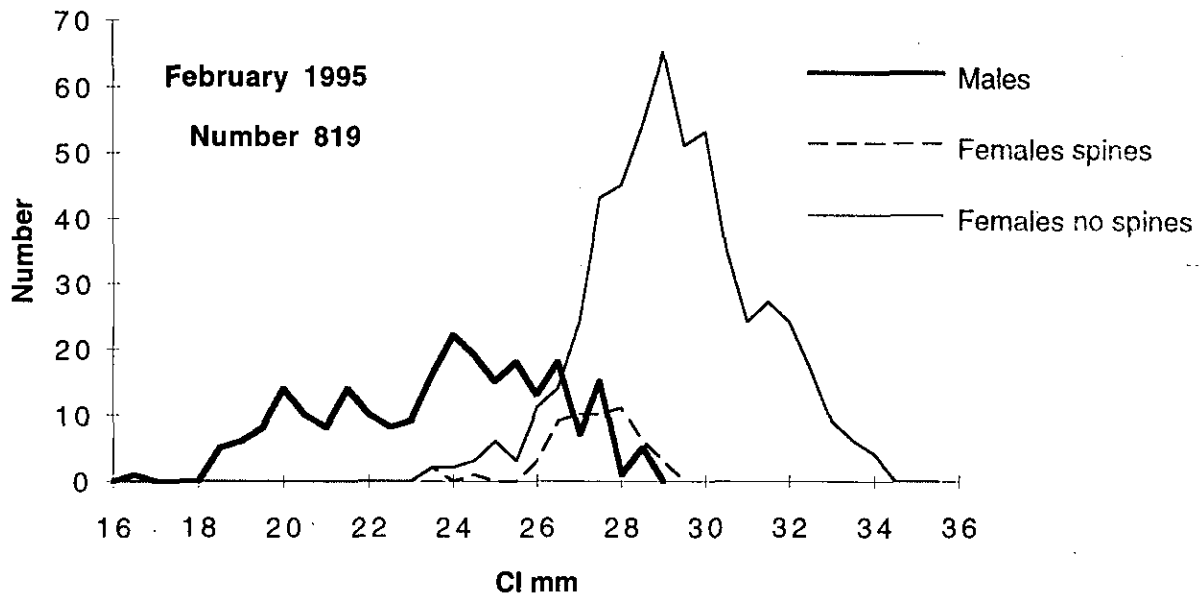| Year/"Age gr."	2	3	4	5	6	7	8
1991	0.0195	0.0672	0.2789	0.2750	0.1596	0.1732	0.0250
1992	0.0000	0.0231	0.1589	0.2225	0.2810	0.2821	0.0328
1993	0.0000	0.0244	0.1450	0.2901	0.3180	0.2225	0.0000
1994	0.0049	0.0513	0.1370	0.2368	0.2115	0.2438	0.1149
1995	0.0000	0.0366	0.0575	0.1109	0.1827	0.4274	0.1849
Mean	0.0049	0.0405	0.1555	0.2271	0.2306	0.2698	0.0715

Fig. 1. The four Icelandic samples obtained in 1995.