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Sexual Maturity of Greenland Halibut in NAFO Subarea 1

by

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Abstract.

In order to clarify the spawning dynamics of Greenland halibut in Greenland waters maturity data was sampled in the period 1988-1994. Sampling was carried out during different seasons of the year, inshore in Divisions 1A and offshore in Divisions 1A-1D by means of longline and trawl. In total 4077 and 14442 Greenland halibut were sampled inshore and offshore, respectively. The relative weight of the gonads were used as a gonadosomatic index value for the sexual maturation of the fish. In the inshore areas high index values were obtained in some years for some fjord systems, indicating that spawning probably takes place sporadically, independently from one fjord to another. As catch compositions of the commercial fishery are stable throughout the year, there is no signs of a spawning migration from the fjords to the Davis Strait. For the offshore area Greenland halibut reached lowest and highest index values in the second and fourth quarter, respectively. Only a few percent of the fish matured in Div. 1A while more than 50 % of the fish matured in Div. 1D, indicating that spawning takes place in the deeper central part of the Davis Strait in winter and early spring.

Introduction.

Greenland halibut (Reinhardtius hippoglossoides , Walbaum) in the Northwest Atlantic is supposed to belong to a single spawning stock complex in the Davis Strait, that spawns in late winter - early spring south of the submarine ridge between Baffin Island and Greenland at 67°N, where bottom temperatures are between 3 °C and 4 °C (Templemann 1973, Smidt 1969). Local spawning has been observed in the Gulf of St. Lawrence (Bowering 1980), at Flemish Cap (Junquera and Zamarro, 1994) and in few cases in the West Greenland fjords (Riget and Boje 1989). The assumption on the location of the spawning ground in the Davis Strait is based on the observations of eggs and larvae dispersed by the currents off West Greenland, Baffin Island, Labrador and Newfoundland (Smidt 1969). No spawning and only a very few specimens of Greenland halibut in ripe or spent condition have been observed in the Davis Strait area. Smidt (1969) mention two observations of ripe females and three records of spent females from the continental slope off West Greenland in 1908-1909. No later records are obtained. Observations of specimens in ripe or spent condition from the fjords of West Greenland are numerous; from the period 1909 to 1960 Smidt (1969) reported 6 ripening or ripe specimens and 28 spent specimens, mainly from the fjords at Southwest Greenland, where the commercial fishery took place at that time. Later Riget and Boje (1989) reported observations of ripe males and females as well as spent females from fjords in Northwestern Greenland, Jakobshavn (Ilulissat) and Umanak (Uummannaq) in Div. 1A in 1987-1988. However, the number of ripe specimens have never reached a proportion of any sample that gave evidence of spawning in a larger scale.

Based on the somatic development of the gonads, this paper describes the sexual maturation of Greenland halibut in West Greenland waters and relate the observations to the stock dynamics of the Greenland halibut complex in the Northwest Atlantic.

Materials and methods.

In total 4077 Greenland halibut were sampled in February and August in the period 1989 - 1994 from three inshore areas in Division 1A: Ilulissat, Uummannaq and Upernavik. The material derives from the commercial fishery by longline and gill net and from longline surveys carried out by Greenland Fisheries Research Institute.

Offshore in the Davis Strait gonad data was sampled in the period 1988 to 1993 on board the Japanese trawler Shinkai Maru and the longliners Skarheim and Varsol from Norway and Faroe Islands, respectively. Sampling covered the period between late March and mid December but data was pooled by quarters. Data from different years was pooled because no differences between years within the same quarter were observed. In total 14442 Greenland halibut were sampled offshore.

Fish were measured as total length in cm below and gonad weights in 1.0 g or 0.1 g. The gonadosomatic index (GI) was calculated as:

$$GI = (\text{gonad weight} * \text{length}^{-3}) * 100$$

(or * 1000 depending on the accuracy of weight of the gonads).

The weight of the gonad in relation to the cubic length of the fish, as a measure of weight, was used as an index value for the maturation stage, instead of using the measured weight of the fish, in order to avoid bias due to variation in the condition of the fish.

Results.

Inshore
Numbers of Greenland halibut and proportions of fish with gonadosomatic indices greater than 1.5, for the three inshore areas in Div. 1A are given per 5-cm length group in Table 1. The level of a GI value of 1.5 for distinguishing fish beginning maturation is set arbitrarily, judged from plots of GI against length of fish (figs 1 and 3). Large proportions of fish which begin maturation (i.e. have GI values >1.5) occur only to some extend in Uummannaq, while for the two other areas maturation is insignificant. Within the area of Uummannaq there is apparently a great variation between the years in proportions of fish beginning maturation. Thus, in the samples from February 1989 and 1990 a higher proportion of the larger fish are beginning to develop their gonads compared to samples form February 1993 and 1994. In fig. 1, which shows the index values plotted against length for the three areas, plots for Uummannaq February samples are therefore divided into the given two periods. For the remaining samples data are pooled by month for a given area. From fig.1 it is obvious that only in samples from Uummannaq in February 1989 and 1990 and in August 1990, there is seen a development of the gonads above an index level of 1.5. 3 specimens of female Greenland halibut, at 94, 102 and 113 cm, respectively, were observed in a spent condition in Uummannaq in February 1993. Therefore, it seems likely that sexual maturation and spawning takes place only occasionally and locally and at different time of the year.

From fig. 2, which shows the length distributions of Greenland halibut in the commercial fisheries for different years, fjords and gears in February and August, respectively, it is seen that there are no clear differences in the length distribution at the two times of the year.

Offshore
In figs. 3a-3b the GI is shown by NAFO division and quarter. In tables 2-11 the same data is given by 5 cm length groups and four intervals of GI. From these figures and tables and from fig. 4, where the mean gonadosomatic index is given by divisions, quarter and sex it is seen that the there is a significant increase in GI through the year in most length groups for both males and females in Div. 1C and 1D. The same tendency is seen for males in Div. 1B although the increase is not significant, while the picture is somewhat blurred for females, probably due to few observations. In Div. 1A there were observations from third quarter only. If it is assumed that fish with a GI level above 1.5 can be considered to be maturing, a few males starts to mature at a length between 35 and 40 cm and at a length of 45 cm about 50 % are maturing (tab. 8 and 11). Females starts to mature at about 45 cm but first at 65 cm about 50%

are maturing. It should be noticed that a considerable fraction of both large males and females do not seem to mature.

A plot of GI against depth (only fish with a gonadosomatic index > 1.5) shows that for females there is a tendency towards an increase in mean GI from depth stratum 400-600 m to depth stratum 600-800 m in third quarter in Div. 1C and 1D (fig. 5). At depths above 800 m mean GI is at a constant level. In fourth quarter mature females are found at depths beyond 800 m only and the mean GI is constant by depth. The GI index for males is constant for all depths between 400 and 1500 m (only depths down to 1200 in Div. 1C). The mean GI is increasing from a level at about 2 in second quarter to about 4 in third quarter and further to about 5 in fourth quarter for females. The mean GI for males is increasing from about 2 in third quarter to about 3 in fourth quarter (fig. 5). No observations by depth are available from Div. 1A, but all mature fish were taken deeper than 800 m.

A one way ANOVA (model: GI=division + residuals) for third quarter, where there are observations from all 4 divisions, did not show any significant difference in the mean level of maturity in the different divisions (only fish with GI >1.5). However, there are only very few observations of mature fish in 1A and 1B (tab. 12).

The presence of large 2-4 mm hydrated eggs and spent gonads has not been recorded systematically, but in late August/early September 4 females out of 96 in Div. 1C and 1D at lengths between 57 and 102 cm had few large eggs together with small < 1mm eggs. One like specimen has also been recorded from October.

Discussion

Inshore

Judged from the Gonadosomatic indices from the inshore areas at West Greenland, spawning probably takes place sporadically, to an unknown extent and independently from one fjord to another. This is in good agreement with earlier observations by Riget and Boje (1989). As catch compositions of the commercial fishery are stable throughout the year (fig. 2), there is no signs of a spawning migration from the fjords to the Davis Strait. The lack of recaptures in the Davis Strait area from tagging experiments in the inshore areas of West Greenland (Boje, 1994) leads support to the hypothesis earlier given by Riget and Boje (1989), that Greenland halibut in the West Greenland inshore areas migrate towards the deeper fjords, where they stay as adults and only spawn sporadically.

The generally low temperatures in the West Greenland fjords (approximately 1-2°C) probably inhibit the maturation process as it is proposed that Greenland halibut in the Northwest Atlantic spawns at temperatures of 3-4°C (Smidt, 1969). A maturation cycle of more than one year or a resorption of the developing gonads could be a possible explanation of the observed GI for Greenland halibut in the West Greenland fjords.

Offshore

From the development in the gonads it can be concluded that spawning takes place in the first quarter, which is the same period given by Chumakov and Serebryakov (1982) for Div 0B but far from the peak spawning period at Flemish Pass in August (Junqera and Zamarro 1994). The size at M_{50} is about 45 cm and 65 cm for males and females which is in good correspondence with Bowering (1983) who found a M_{50} values for females at 65 cm at Saglek Bank in Div. 2G. The GI is constant by depth for both males and females except for a slight increase for females from depth stratum 400 - 600 to depth stratum 600-800 m. in fourth quarter. The absence of mature females below 800 m in fourth quarter and the drop in percentages of mature females from third to fourth quarter in addition to the total lack of observations of spawning in December could indicate that spawning takes place in Div. 1D or further south at depths below 1500 m at temperatures between 3.0 and 3.5 °C. This is supported by the observations by Jørgensen (1994) who showed that the main distribution area in winter is at deep water in Div. 1D and probably further south. The presence of (however, very few) mature females in Div. 1A. in third quarter could indicate that spawning might occur at different places in the Davis Strait i.e. north of the Greenland Baffin Island ridge.

The occurrence of a considerable number of large individuals that fail to mature is also observed by Fedorov (1971) in the Barents Sea and by Junqera and Zamarro (1994) in the Flemish Pass and seems to be a common phenomena among Greenland halibut.

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Table 1. Numbers of Greenland halibut per 5-cm group and proportions (%) with gonadosomatic indices greater than 1.5 (in brackets), given by area, year and month.

	Ilulissat							
	Aug.1990		Feb.1993		Aug.1993		Feb.1994	
length-group (cm)	♂	♀	♂	♀	♂	♀	♂	♀
35-39					7(0)	12(0)		
40-44					17(0)	22(0)		
45-49					19(0)	26(0)		
50-54	15(0)	28(0)	3(0)	7(0)	18(0)	34(0)	1(0)	2(0)
55-59	49(0)	59(0)	12(0)	13(0)	16(0)	34(0)	30(0)	9(0)
60-64	57(2)	58(0)	13(0)	14(0)	22(0)	28(0)	38(3)	34(0)
65-69	27(0)	51(0)	8(0)	17(0)	15(0)	34(0)	19(0)	34(0)
70-74	12(17)	22(0)	7(0)	14(0)	6(0)	45(0)	11(0)	24(0)
75-79	6(0)	6(0)	2(0)	14(0)	1(0)	42(0)	4(0)	17(0)
80-84		4(0)	2(0)	21(5)	1(0)	28(0)		30(3)
85-89		9(0)		21(5)		8(13)		15(0)
90-94		6(0)		18(22)		6(17)		17(0)
95-99		1(100)		12(17)		4(25)		6(0)
100-104				3(33)		1(0)		1(0)
105-109		1(0)		2(50)				2(50)
110-114								
Total nos.	166	245	47	156	122	324	103	191

	Uummannaq											
	Feb.1989		Feb.1990		Aug.1990		Feb.1993		Aug.1993		Feb.1994	
length-group (cm)	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
< 44									7(0)	10(0)		
45-49									21(0)	16(0)	1(0)	5(0)
50-54									30(0)	23(0)	21(0)	33(0)
55-59	2(0)		2(0)	1(0)	7(0)	17(0)	2(0)	5(0)	20(0)	29(0)	12(0)	36(0)
60-64	16(0)		5(0)	9(11)	30(3)	43(0)	23(0)	2(0)	19(0)	29(0)	38(0)	12(0)
65-69	46(2)	1(0)	23(0)	24(0)	27(11)	49(0)	6(0)	19(0)	15(0)	36(0)	36(0)	15(0)
70-74	20(10)	27(7)	26(12)	23(0)	18(39)	50(0)	8(0)	17(0)	2(0)	47(0)	21(5)	29(0)
75-79	3(0)	75(4)	21(43)	26(4)	12(33)	31(0)	5(40)	21(0)	2(50)	48(0)	7(0)	32(0)
80-84		65(6)	6(33)	25(8)	2(100)	44(2)	1(0)	21(5)		26(0)		15(0)
85-89		45(31)		20(15)		44(0)		19(26)		9(0)		8(0)
90-94		22(32)		22(18)		42(7)		19(16)		3(0)		2(0)
95-99		14(36)		16(31)		19(11)		5(20)		1(100)		1(0)
100-104		2(50)		10(40)		9(22)		3(0)		1(0)		1(0)
105-109		2(100)		2(50)		1(0)		1(0)		1(0)		
>109						1(100)						
Total nos.	87	253	83	178	96	350	45	132	116	279	136	190

	Upernavik									
	Aug.1989		Feb.1990		Aug.1990		Feb.1991		Feb.1993	
length-group (cm)	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
35-40		1(0)				1(0)				
40-44	3(0)	1(0)			3(0)	9(0)		1(100)		
45-49	5(0)	13(0)			9(0)	17(0)				
50-54	20(0)	46(0)			12(0)	22(0)				
55-59	6(0)	29(0)	1(0)		10(0)	22(0)		2(0)		5(0)
60-64	2(0)	23(0)	6(0)	3(0)	6(0)	14(0)	4(0)	5(0)	2(0)	5(0)
65-69	1(0)	26(0)	8(0)	21(0)		9(0)	6(0)	16(0)	4(0)	20(0)
70-74		20(0)	4(0)	18(0)		5(0)	5(20)	18(0)	2(0)	23(0)
75-79	1(0)	20(0)	1(0)	18(0)		3(0)	1(0)	15(0)	1(0)	24(0)
80-84		8(0)		24(0)				14(0)		25(8)
85-89		7(0)		21(0)				11(0)		20(5)
90-94		4(0)		14(0)				3(0)		10(10)
95-99				10(20)		1(100)		1(0)		3(0)
100-104				2(0)						3(0)
105-109				4(0)						
110-114										
Total nos.	38	198	20	135	40	103	16	86	9	133

Table 2. Gonadosomatic index for Greenland halibut offshore in Div. 1A, 3. quarter.

	Males				Females				
	idx				idx				
	0-1.5	1.5-3.0	3.0-6.0	ALL	0-1.5	1.5-3.0	3.0-6.0	> 6.0	ALL
	N	N	N	N	N	N	N	N	N
Length									
30	51	.	.	51	35	.	.	.	35
35	68	.	.	68	66	.	.	.	66
40	92	.	.	92	69	2	.	.	71
45	101	1	.	102	75	1	.	.	76
50	49	.	.	49	71	2	.	.	73
55	19	1	.	20	60	3	1	.	64
60	17	5	.	22	48	2	.	.	50
65	19	3	1	23	28	3	.	.	31
70	4	.	1	5	38	1	1	.	40
75	2	.	.	2	31	5	.	.	36
80	.	.	.	.	23	5	1	2	31
85	.	.	.	.	11	3	1	.	15
90	.	.	.	.	4	1	3	.	8
95	.	.	.	.	5	1	1	.	7
ALL	422	10	2	434	564	29	8	2	603

Table 3. Gonadosomatic index for Greenland halibut offshore in Div. 1B, 2. quarter.

	Males		Females		
	idx		idx		
	0-1.5	ALL	0-1.5	1.5-3.0	ALL
	N	N	N	N	N
Length					
30	10	10	10	.	10
35	11	11	17	.	17
40	14	14	29	.	29
45	11	11	12	.	12
50	4	4	7	1	8
55	3	3	1	.	1
65	1	1	.	.	.
95	.	.	.	1	1
ALL	54	54	76	2	78

Table 4. Gonadosomatic index for Greenland halibut offshore in Div. 1B, 3. quarter.

	Males				Females			
	idx				idx			
	0-1.5	1.5-3.0	3.0-6.0	ALL	0-1.5	1.5-3.0	3.0-6.0	ALL
	N	N	N	N	N	N	N	N
Length								
30	70	.	.	70	49	.	.	49
35	67	.	.	67	77	.	.	77
40	60	4	.	64	57	.	.	57
45	44	2	1	47	39	.	.	39
50	36	4	1	41	42	.	.	42
55	8	3	.	11	17	.	.	17
60	8	2	1	11	9	2	.	11
65	3	.	.	3	3	.	.	3
70	1	1	.	2	.	.	2	2
75	1	.	.	1	1	.	.	1
80	.	.	.	.	2	.	.	2
85	.	.	.	.	.	2	1	3
90	.	.	.	.	.	.	1	1
ALL	298	16	3	317	296	4	4	304

Table 5. Gonadosomatic index for Greenland halibut offshore in Div. 1B, 4. quarter.

	Males					Females	
	idx					idx	
	0-1.5	1.5-3.0	3.0-6.0	>6.0	ALL	0-1.5	ALL
	N	N	N	N	N	N	N
Length							
35	3	.	.	.	3	5	5
40	4	.	1	.	5	4	4
45	1	.	1	.	2	1	1
50	.	.	5	.	5	5	5
55	1	1	1	1	4	.	.
60	.	.	.	.	.	3	3
65	.	.	.	.	.	1	1
ALL	9	1	8	1	19	21	21

Table 6. Gonadosomatic index for Greenland halibut offshore in Div. 1C, 2. quarter.

	Males				Females			
	idx				idx			
	0-1.5	1.5-3.0	3.0-6.0	ALL	0-1.5	1.5-3.0	3.0-6.0	ALL
	N	N	N	N	N	N	N	N
Length								
30	15	.	.	15	11	.	.	11
35	36	.	1	37	27	.	.	27
40	134	.	.	134	69	.	.	69
45	303	.	.	303	99	.	.	99
50	257	3	.	260	97	2	.	99
55	129	1	.	130	59	7	.	66
60	60	1	.	61	29	9	.	38
65	18	1	.	19	18	12	.	30
70	8	.	.	8	13	13	2	28
75	3	.	.	3	7	14	1	22
80	.	.	.	.	6	8	3	17
85	.	.	.	.	4	11	3	18
90	.	.	.	.	.	6	1	7
95	.	.	.	.	1	2	1	4
100	.	.	.	.	.	.	1	1
105	.	.	.	.	.	1	.	1
110	.	.	.	.	.	.	1	1
ALL	963	6	1	970	440	85	13	538

Table 7. Gonadosomatic index for Greenland halibut offshore in Div. 1C, 3. quarter.

	Males				Females				
	idx				idx				
	0-1.5	1.5-3.0	3.0-6.0	ALL	0-1.5	1.5-3.0	3.0-6.0	> 6.0	ALL
	N	N	N	N	N	N	N	N	N
Length									
30	83	.	.	83	52	.	.	.	52
35	168	8	.	176	91	.	1	.	92
40	230	24	1	255	134	.	.	.	134
45	262	68	5	335	128	1	.	.	129
50	186	88	5	279	139	4	1	1	145
55	72	51	9	132	69	1	.	.	70
60	28	15	7	50	49	3	3	.	55
65	15	5	3	23	17	2	9	.	28
70	2	3	1	6	9	8	8	.	25
75	2	.	.	2	2	1	6	2	11
80	.	.	.	.	2	3	4	1	10
85	.	.	.	.	.	2	7	1	10
90	.	.	.	.	1	3	3	.	7
95	.	.	.	.	.	1	5	2	8
100	.	.	.	.	.	.	3	.	3
105	.	.	.	.	.	.	1	.	1
115	.	.	.	.	.	.	1	.	1
ALL	1048	262	31	1341	693	29	52	7	781

Table 8. Gonadosomatic index for Greenland halibut offshore in Div. 1C, 4. quarter.

	Males					Females				
	idx					idx				
	0-1.5	1.5-3.0	3.0-6.0	> 6.0	ALL	0-1.5	1.5-3.0	3.0-6.0	> 6.0	ALL
	N	N	N	N	N	N	N	N	N	N
Length										
30	24	.	.	.	24	17	.	.	.	17
35	61	1	2	.	64	35	.	.	.	35
40	126	18	14	1	159	68	.	.	.	68
45	121	57	85	3	266	109	1	1	1	112
50	74	36	129	9	248	120	1	4	1	126
55	42	23	106	14	185	136	1	11	6	154
60	11	13	50	17	91	62	5	11	8	86
65	9	8	20	4	41	41	4	27	11	83
70	6	4	6	1	17	17	2	19	14	52
75	2	.	4	.	6	12	3	25	13	53
80	.	.	1	.	1	10	.	17	11	38
85	.	.	.	.	.	4	1	22	12	39
90	.	.	.	.	.	.	.	11	10	21
95	.	.	.	.	.	.	.	3	5	8
100	.	.	.	.	.	.	1	3	3	7
110	.	.	.	.	.	.	.	2	1	3
ALL	476	160	417	49	1102	631	19	156	96	902

Table 9. Gonadosomatic index for Greenland halibut offshore in Div. 1D, 2. quarter.

	Males		Females				
	idx		idx				
	0-1.5	ALL	0-1.5	1.5-3.0	3.0-6.0	> 6.0	ALL
	N	N	N	N	N	N	N
Length							
30	.	.	3	.	.	.	3
35	23	23	8	.	.	.	8
40	132	132	32	.	.	.	32
45	447	447	129	1	.	.	130
50	530	530	205	2	.	.	207
55	356	356	137	7	.	.	144
60	215	215	76	15	1	.	92
65	72	72	59	27	2	1	89
70	23	23	32	43	3	.	78
75	2	2	19	45	1	.	65
80	.	.	16	40	4	.	60
85	.	.	9	39	8	.	56
90	.	.	1	24	4	.	29
95	.	.	.	17	3	.	20
100	.	.	.	4	1	.	5
105	.	.	.	.	1	.	1
110	.	.	.	2	.	.	2
ALL	1800	1800	726	266	28	1	1021

Table 10. Gonadosomatic index for Greenland halibut offshore in Div. 1D, 3. quarter.

	Males				Females				
	idx				idx				
	0-1.5	1.5-3.0	3.0-6.0	ALL	0-1.5	1.5-3.0	3.0-6.0	> 6.0	ALL
	N	N	N	N	N	N	N	N	N
Length									
30	11	.	.	11	5	.	.	.	5
35	41	.	.	41	16	.	.	.	16
40	102	4	2	108	56	.	.	.	56
45	224	51	1	276	86	1	.	.	87
50	236	83	8	327	101	3	.	.	104
55	147	56	2	205	97	8	2	.	107
60	82	49	2	133	65	10	4	.	79
65	26	12	2	40	45	19	8	.	72
70	9	10	.	19	29	27	13	.	69
75	2	1	.	3	18	45	27	1	91
80	.	.	.	.	10	39	27	1	77
85	.	.	.	.	5	33	43	1	82
90	.	.	.	.	3	34	44	2	83
95	.	.	.	.	1	15	46	.	62
100	.	.	.	.	.	9	26	3	38
105	.	.	.	.	.	2	13	1	16
110	.	.	.	.	.	.	2	.	2
115	.	.	.	.	.	.	1	.	1
ALL	880	266	17	1163	537	245	256	9	1047

Table 11. Gonadosomatic index for Greenland halibut offshore in Div. 1D, 4. quarter.

	Males					Females				
	idx				ALL	idx				ALL
	0-1.5	1.5-3.0	3.0-6.0	> 6.0		0-1.5	1.5-3.0	3.0-6.0	> 6.0	
	N	N	N	N	N	N	N	N	N	N
Length										
30	5	.	.	.	5	6	.	.	.	6
35	42	3	1	.	46	24	.	.	.	24
40	94	17	17	1	129	57	2	.	.	59
45	132	67	73	5	277	106	.	1	.	107
50	89	84	81	4	258	136	2	1	1	140
55	24	66	73	6	169	87	.	4	3	94
60	14	51	52	6	123	61	2	7	7	77
65	8	25	26	7	66	27	4	11	8	50
70	4	10	9	.	23	20	7	20	12	59
75	1	4	3	.	8	14	7	33	11	65
80	.	1	.	.	1	6	5	27	12	50
85	.	.	.	.	.	.	5	17	5	27
90	.	.	.	.	.	.	2	23	9	34
95	.	.	.	.	.	1	.	13	11	25
100	.	.	.	.	.	.	.	10	4	14
105	.	.	.	.	.	.	.	4	4	8
110	.	.	.	.	.	.	.	.	1	1
115	.	.	.	.	.	.	.	1	.	1
ALL	413	328	335	29	1105	545	36	172	88	841

Table 12. Percentage of mature Greenland halibut by division in third and fourth quarter.

	Percentage of mature fish			
	3. quarter		4. quarter	
Division	M	F	M	F
1A	3	6		
1B	6	3	53	0
1C	22	11	57	30
1D	26	49	63	35

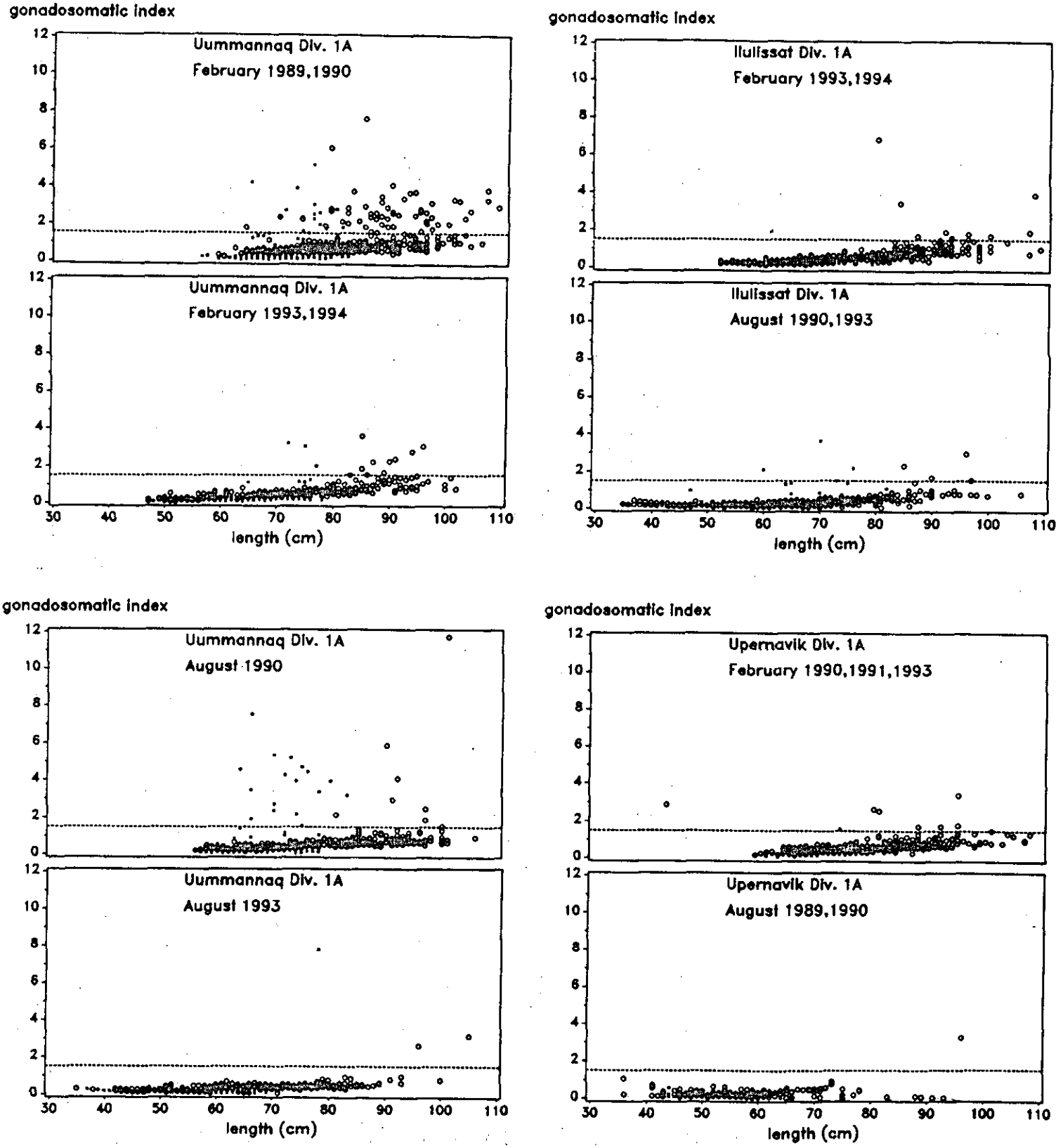

Fig. 1. Gonadosomatic index form Uummannaq, Ilulissat and Upernavik. Males=squares, females=circles.

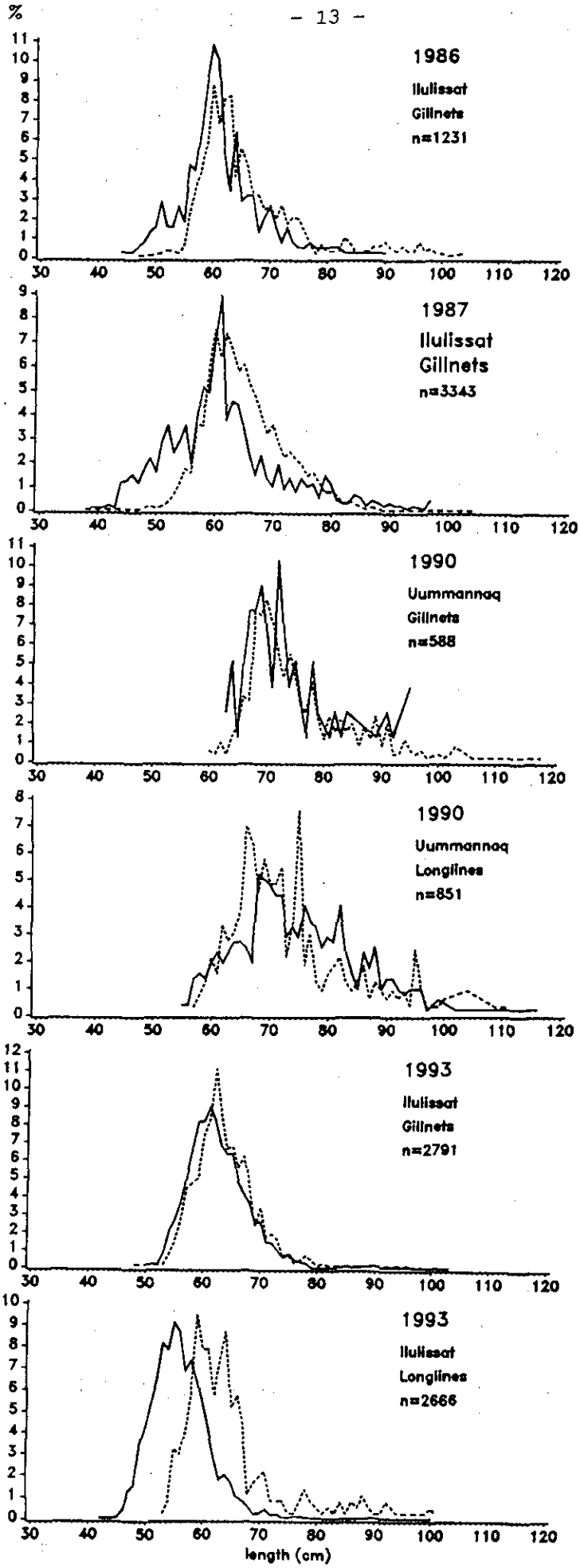

Fig. 2. Length distribution from longline and gillnet fisheries in different fjords. August: solid line, February: dashed line.

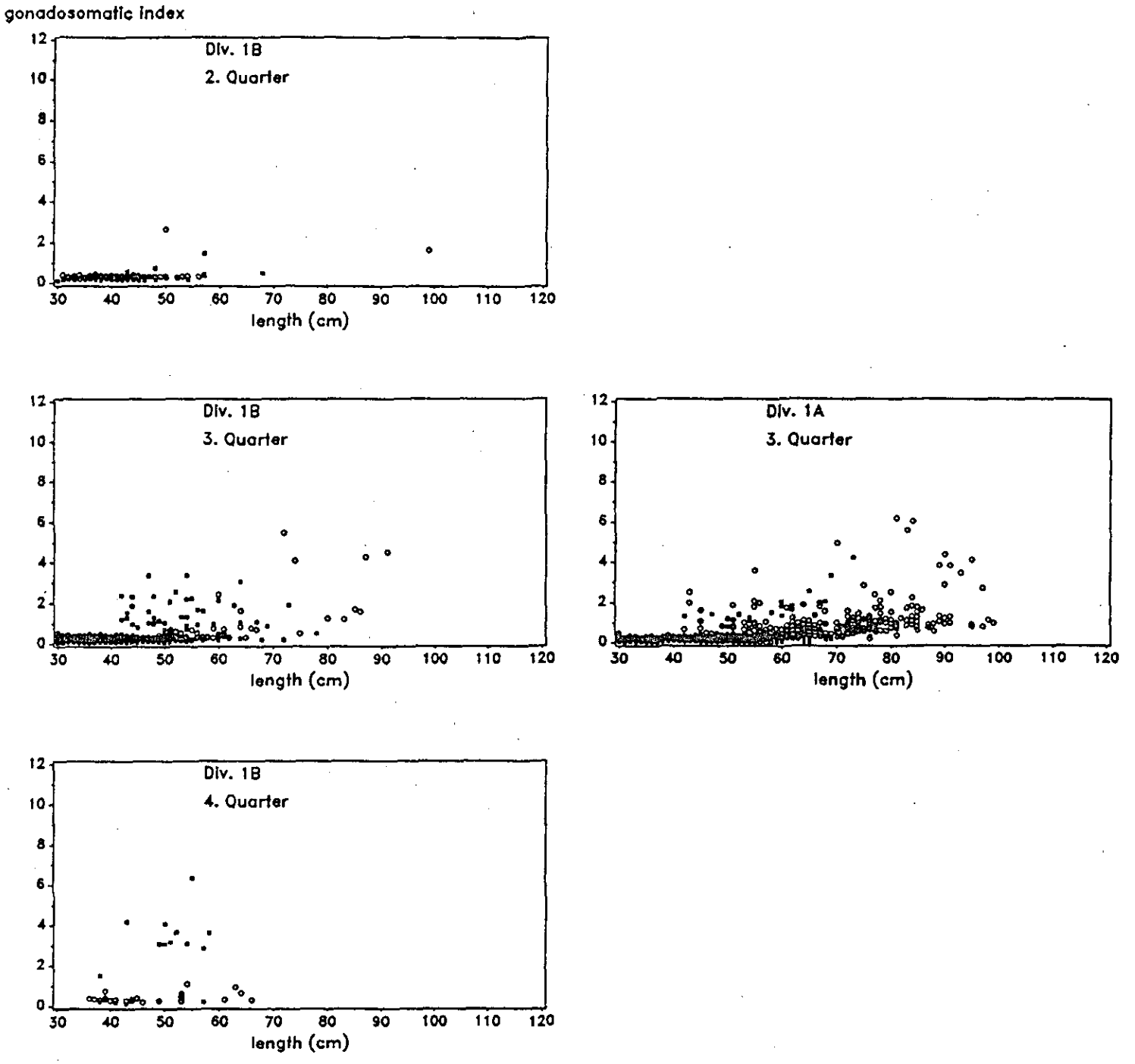

Fig. 3a. Gonadosomatic index by division, quarter and sex. Males=squares, females=circles.

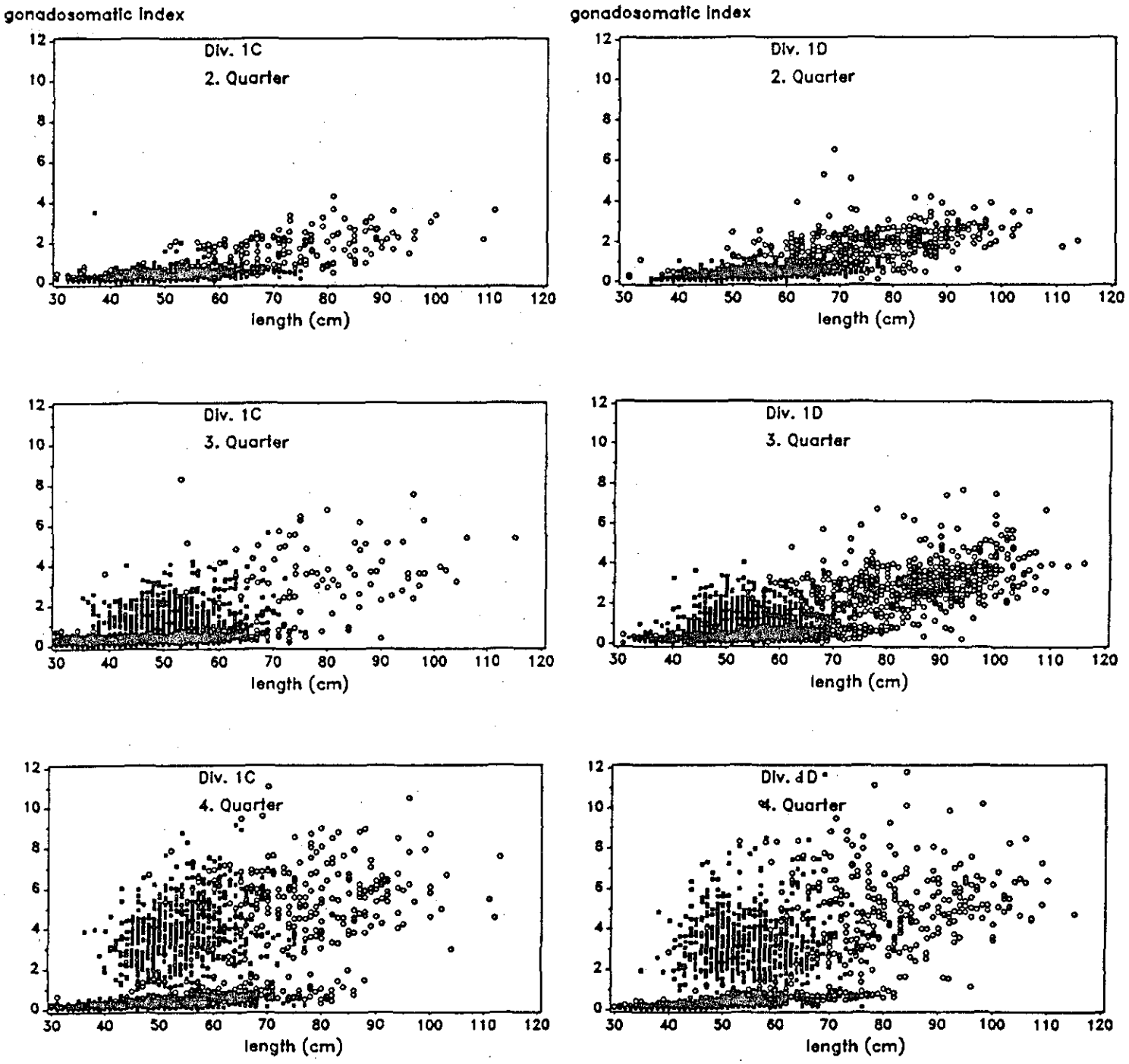

Fig. 3b. Gonadosomatic index by division, quarter and sex. Males=squares, females=circles.

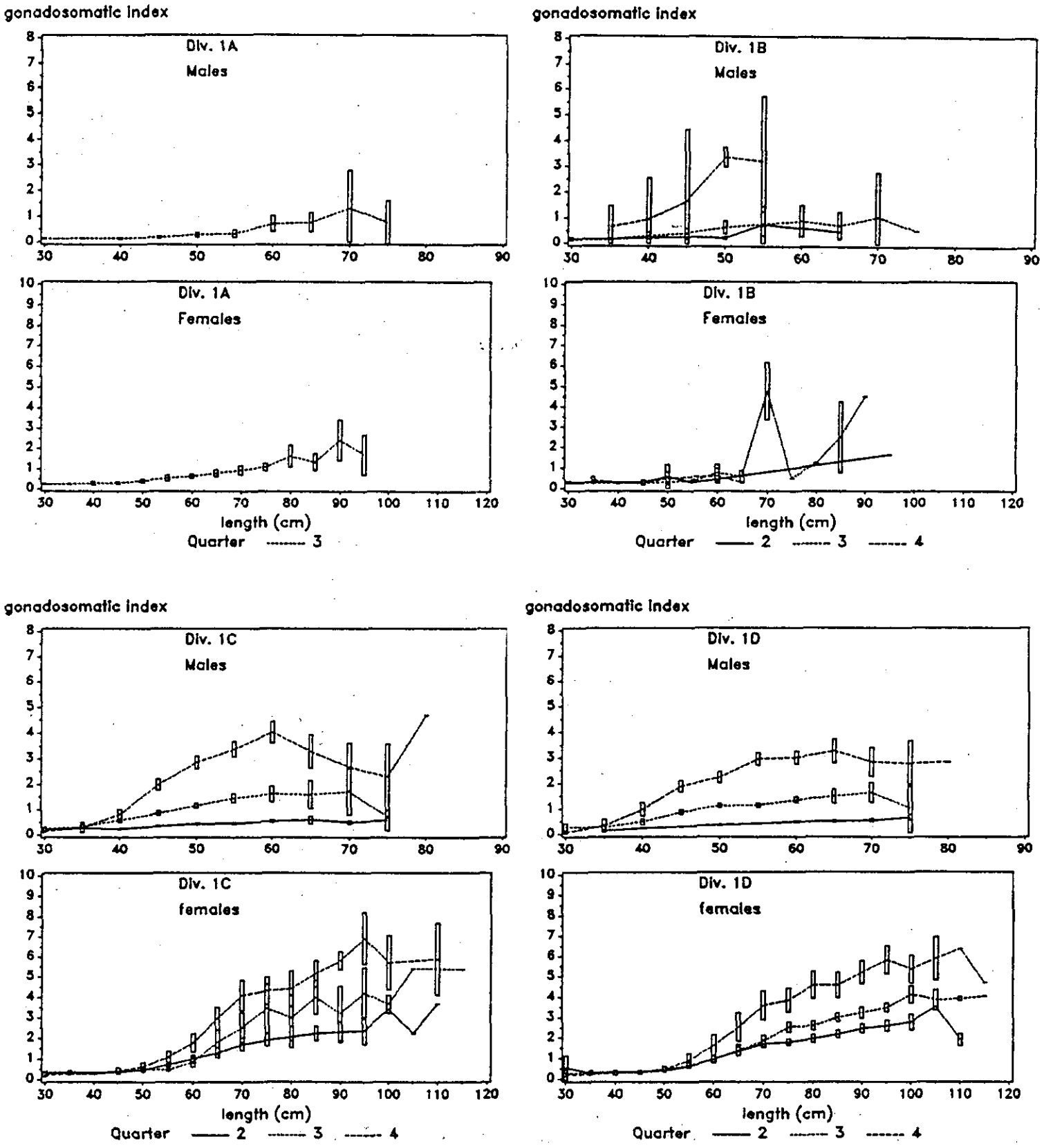

Fig. 4. Mean gonadosomatic index, with standard deviation, by division, sex, quarter and 5-cm groups.

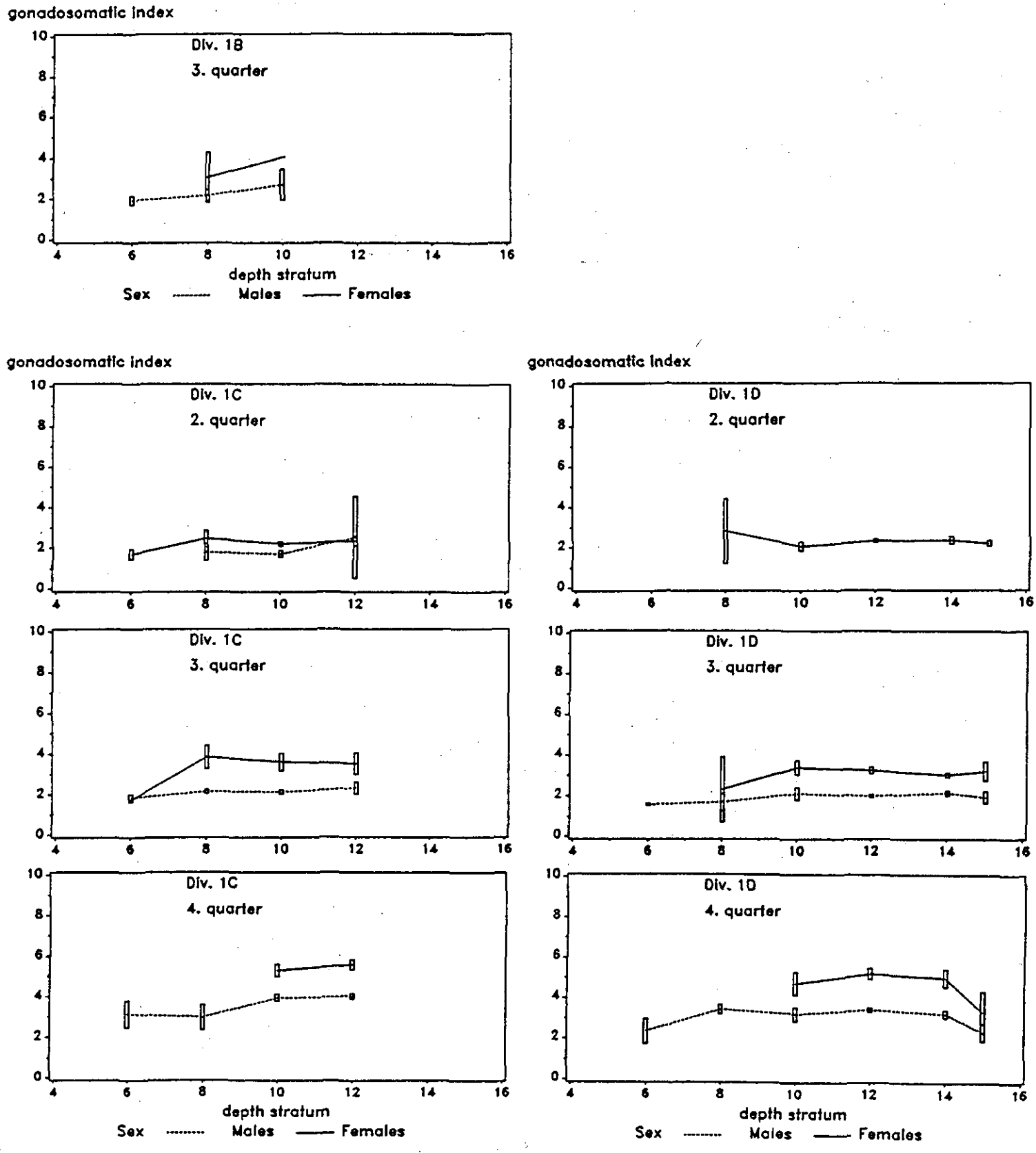

Fig. 5. Mean gonadosomatic index, with standard deviation, by division, quarter, sex, and 200 m depth intervals.