Ödemål, Kville en, Bohuslän

Hällristning	Rock carving
Fiskare från	Bronze age
bronsåldern	fishermen
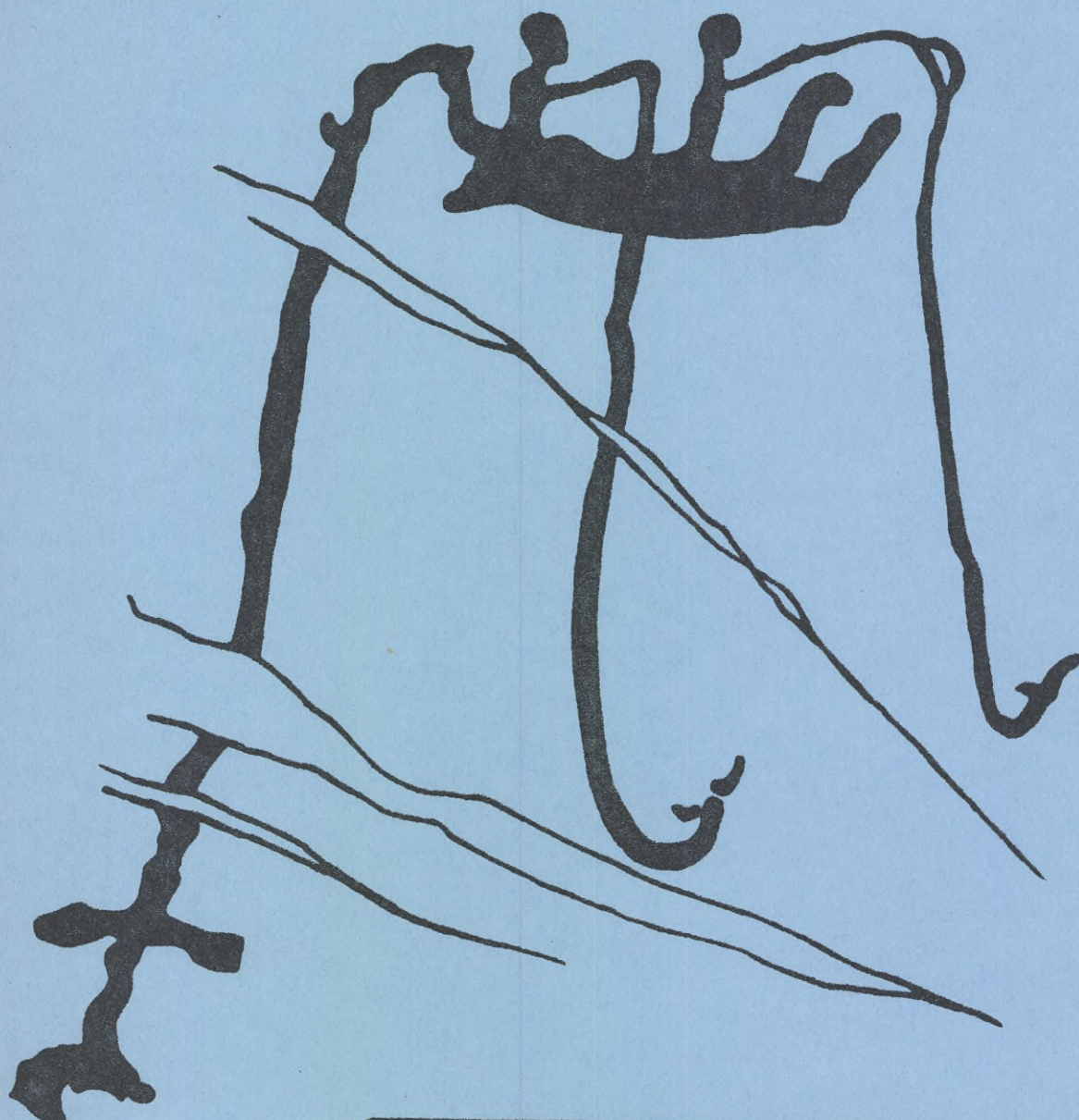
The meristic characters and the maturity
cycle of the Skagerrak Spring Spawners

by

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ABSTRACT

Skagerrak Spring Spawners are caught from October until April in the open waters of the inner Skagerrak. The adult population migrates probably to the North Sea in April-May and returns in October. The herring spawn from the end of January until the beginning of April along the Swedish and Norwegian coasts of the inner Skagerrak. In July-August the herring are recovered (stage VIII) and from August-September until January the number of herring in stage IV is great. The mean vertebrae number ranged from 56.62 to 57.29 and the mean number of keeled scales from 13.88 to 14.35.

INTRODUCTION

The herring fishery in the Skagerrak and Kattegat was earlier based on the spring spawning herring of the Skagerrak, the autumn spawning herring of the Kattegat and the autumn spawning herring of the North Sea (Andersson 1958). The increasing effort in the herring fishery in the North Sea and adjacent areas in the sixties and seventies has affected the herring populations very much. The catches in 1965 increased to 1.4 million tons in the North Sea and Skagerrak from a normal annual catch of 0.7 - 0.8 million tons (Anon. 1971). Since then the catches have decreased very much. In 1967 and 1968 the catches were about 280 000 tons in the Skagerrak, but they have now decreased to less than 20 000 tons (Anon. 1977). The overfishing has also affected other herring population as the Skagerrak Spring Spawners and the Kattegat Autumn Spawners which migrate into the North Sea during their annual life-cycle. The migration of herring from the Skagerrak was shown in tagging experiments by Höglund (1955) and it is wellknown that the Kattegat Autumn Spawners also migrated to the North Sea and back again. The Kobbergrund herring or Kattegat autumn spawning herring has been seriously affected by the overfishing. This population is now almost extinct (Ackefors 1977 a). The bulk of the catches in the Skagerrak nowadays consist of spring spawning herring; the Skagerrak Spring Spawners and the Kattegat Spring Spawners (cf. Ackefors 1977 b). The purpose of this paper is to describe the meristic characters and maturity cycle of Skagerrak Spring Spawners.

METHODS AND MATERIAL

Many herring samples were analysed from the Skagerrak area 1971-1976.
The samples with maturity stages V, VI and VII were then selected
for pure stock analysis. Those samples were taken from commercial
catches along the Bohuslän coast in the Skagerrak (fig. 1). The samp-
les were taken from herring set net catches except no 39 (bottom
trawl), no 40 (fyke net) and no 48 (purse seine). Samples taken in
February-April as well as samples from other parts of the year were
used for the studies of the maturity cycle. They were taken in either
trawls or purse seins. The following parameters were measured; weight,
length, age from scales and otoliths, sex, maturity stage, intestinal
fat, vertebrae number (VS), keeled scales (K_2) and length at the
age of one year (l_1) was backcalculated from the scale. Data for the
whole samples and for the samples split up into yearclasses are
shown in tables 1 and 2.

RESULTS AND DISCUSSION

a. Meristic characters

The analysed herring samples came from the inner Skagerrak along
the Bohuslän coast (fig. 1). All the selected samples for studies
of the meristic characters consisted of herring in maturity stages
V, VI and VII except one sample which was a mixture of IV and V
(table 1). The herring in those maturity stages were mainly found
from February until April.

The analyses of the meristic characters indicated that all the her-
ring samples except one consisted of the Skagerrak Spring Spawners.
The mean vertebrae number ranged from 56.62 to 57.29 and mean num-
ber of keeled scales from 13.88 to 14.35. Sample no 40 consisted of
herring called the Kattegat Spring Spawners, according to the mean
VS and K_2 values. The VS was 56.07 and K_2 13.94. In fig. 2 K_2 versus
VS and l_1 versus VS are reproduced. For comparison the values of
the Kattegat Winter Spawners and the Kattegat Spring Spawners are
also included in the figure. It is quite obvious that the VS values
are different from those of Kattegat Spring Spawners. However,
Kattegat Winter Spawners have similar VS values. The K_2 values are
not quite similar although they are overlapping. It seems reasonable
to suppose that they are also closely connected with each other.
As is obvious in fig. 2 there is no difference in l_1 values between
the two or three populations.

b. The development of gonads

The maturity stages were analysed on the samples taken from October until April. No samples were available for the other months. The samples from the missing months all consisted of other herring po-pulations. Along the Norwegian coast a purse seine fishery takes place in the skerries from late summer. And it is obvious from Danielssen (1969) that Skagerrak Spring Spawners also occur during that time of the year in the inner Skagerrak. The tagging experi-ments by Höglund (1955), however, indicate a migration of spring spawning herring out of the area into the North Sea.

Table 3 shows the maturity stages in our analyses and table 4 the Norwegian analyses. By combining the two tables it is possible to follow the development of gonads except for the months of May and June.

The spawning takes place mainly in February-March. But there is also spawning in January and April. The percentage of spent herring (VII) is highest in April. The percentage of recovered herring (VIII) in-creases from March-April and is very high in July and August (table 4). In July the development of stage III has already started and the highest percentage of this stage is found in August-October. The high percentage of this stage in December is caused by recruitment of young herring from stage II. From September until January stage IV is dominating. From September onwards many herrings in stage V appear. Spawning herring (VI) are then found from January until April.

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Table 1. Analysed herring samples in maturity stages V, VI and VII from the Skagerrak, 1971 - 1976.

Sample	Date	Place	Catch position	VS	K_2	l_1 (cm)	Mean length (cm)	Mean weight (g)	Maturity stage
S 3	1971-04-26	Saltvik (Grebbestad)	N 58°4' E 11°1'	56,90 (88)	13,88 (83)	14,88 (90)	26,3 (100)	136,2 (92)	VI
S 10	1972-02-08	W. Måseskär	N 58°0' E 11°2'	57,29 (148)	14,28 (145)	13,73 (145)	31,5 (167)	252,2 (150)	V,VI
S 13	1972-04-18	Smögen	N 58°2' E 11°1'	56,62 (95)	14,22 (100)	14,83 (100)	30,8 (172)	193,1 (100)	VII
S 14	1972-04-25	Bottnafjorden (Bovallstrand)	N 58°2' E 11°1'	56,75 (95)	14,09 (98)	14,60 (100)	30,8 (144)	200,3 (100)	VII
S 19	1973-02-19	Malmöfjorden	N 58°2' E 11°2'	57,19 (73)	14,04 (79)	13,32 (79)	30,6 (80)	226,2 (80)	V
S 21	1973-02-27	N. Måseskär	N 58°0' E 11°2'	57,27 (94)	14,03 (97)	13,08 (98)	30,9 (100)	234,1 (100)	VI,VII
S 22	1973-03-06	Malmöfjorden	N 58°2' E 11°2'	57,07 (85)	14,00 (98)	13,75 (99)	29,1 (100)	188,5 (100)	VI
S 23	1973-03-13	Sannäsfjorden	N 58°4' E 11°1'	56,86 (91)	13,93 (98)	13,17 (98)	27,6 (181)	162,6 (101)	IV,V
S 24	1973-03-16	Brofjorden	N 58°2' E 11°2'	56,95 (73)	14,35 (65)	13,17 (73)	30,4 (135)	222,7 (75)	VII
S 25	1973-03-19	W. Måseskär	N 58°0' E 11°1'	56,96 (71)	14,14 (71)	13,48 (72)	29,7 (185)	217,9 (75)	VI

Table 1., cont.

Sample	Date	Place	Catch position	VS	K_2	l_1 (cm)	Mean length (cm)	Mean weight (g)	Maturity stage
S 37	1974-03-13	Malmöfjorden	N 58°1' E 11°1'	56,93 (91)	13,98 (99)	13,31 (98)	28,9 (173)	184,0 (100)	VI
S 38	1974-03-21	W. Malmön	N 58°2' E 11°1'	56,79 (89)	13,78 (93)	12,49 (98)	28,1 (126)	171,9 (100)	VI
S 39	1974-04-02	Malmöfjorden	N 58°2' E 11°2'	56,93 (84)	13,96 (95)	12,97 (91)	28,3 (161)	147,1 (96)	VII
S 40	1974-04-27	Brofjorden	N 58°2' E 11°2'	56,07 (138)	13,94 (138)	11,02 (147)	25,1 (195)	115,1 (150)	VI
S 46	1975-02-21	Kärringön	N 58°0' E 11°2'	56,92 (97)	14,02 (91)	13,01 (91)	28,4 (129)	188,6 (100)	V
S 47	1975-02-24	W. Malmön	N 58°1' E 11°1'	56,76 (105)	13,95 (103)	13,42 (98)	28,3 (106)	191,7 (106)	V
S 48	1976-03-03	Väderöarna	N 58°3' E 10°5'	56,72 (103)	14,21 (100)	13,74 (103)	29,4 (129)	231,0 (105)	V,VI

Table 2. Analysed herring samples from the Skagerrak by year-classes.
Mean values for VS and K_2 are given. Other data according to table 1. S = spring.

Year	Sample	S 73	S 72	S 71	S 70	S 69	S 68	S 67	S 66	S 65	S 64	S 63 +
1971	S 3					57,07(59) 13,98(57)	56,56(16) 13,43(14)	56,89(9) 13,88(8)	55,75(4) 14,00(4)			
1972	S 10					57,55(20) 14,19(21)	57,12(25) 14,16(25)	57,22(60) 14,40(58)	57,46(13) 14,08(13)	57,50(10) 14,56(9)	56,67(3) 13,67(3)	57,35(17) 14,25(16)
1972	S 13					56,60(5) 14,20(5)	56,68(40) 14,10(41)	56,55(20) 14,59(22)	56,41(17) 14,17(18)	56,67(3) 13,75(4)	57,17(6) 14,00(6)	56,50(4) 14,50(4)
1972	S 14					57,12(43) 13,98(42)	56,47(17) 14,44(18)	56,19(21) 13,88(25)	56,75(8) 14,50(8)		57,00(1)	57,00(4) 14,00(4)
1973	S 19				57,29(7) 13,88(8)	57,10(50) 14,02(51)	57,80(10) 14,42(12)	57,50(2) 13,33(3)	56,33(3) 13,67(3)		S 64 +	
1973	S 21				57,71(7) 14,38(8)	57,24(41) 14,00(41)	57,50(6) 14,17(6)	57,00(12) 13,75(12)	56,80(5) 14,00(5)	57,20(5) 14,40(5)	57,39(18) 14,00(20)	
1973	S 22				56,94(33) 14,03(36)	57,27(44) 14,00(53)	56,50(4) 14,00(4)	56,50(2) 13,67(3)		57,00(1) 14,00(1)		
1973	S 23			57,00(9) 13,90(10)	56,87(61) 13,98(64)	56,80(20) 13,71(21)	56,00(1) 14,50(2)	14,00(1)				
1973	S 24				56,80(5) 13,80(5)	56,94(33) 14,21(28)	57,15(13) 14,93(14)	56,91(11) 14,50(8)	56,50(4) 14,00(3)	57,00(3) 13,67(3)	57,00(4) 14,50(4)	
1973	S 25				56,84(19) 14,05(20)	56,97(39) 14,13(40)	57,00(3) 14,00(3)	57,00(2) 15,00(1)	56,50(4) 14,00(3)	58,00(2) 14,50(2)	57,50(2) 15,00(2)	
1974	S 37			56,83(23) 14,21(24)	57,00(42) 13,86(49)	57,00(23) 14,00(23)	55,50(2) 14,50(2)		58,00(1) 13,00(1)			
1974	S 38			56,87(31) 13,82(33)	56,81(43) 13,76(45)	56,57(14) 13,86(14)	56,00(1) 13,00(1)	14,00(1)				

Table 2., cont.

Year-class	Sample	S 64	S 65	S 66	S 67	S 68	S 69	S 70	S 71	S 72	S 73	S 74
1974	S 39		57,00(1) 14,00(1)	57,00(2) 14,00(2)	57,00(1) 13,00(1)		56,82(17) 14,00(17)	56,94(32) 13,79(38)	57,00(29) 14,15(33)	56,50(2) 14,00(2)		
1974	S 40					57,00(1) 14,00(1)	56,27(11) 13,92(13)	55,88(56) 13,76(54)	56,04(53) 13,94(50)	56,56(16) 14,42(19)	57,00(1) 15,00(1)	
1975	S 46				58,00(1) 14,00(1)		56,67(3) 14,00(2)	57,08(12) 13,83(12)	56,94(52) 14,04(52)	56,79(29) 14,08(24)		
1975	S 47						56,25(4) 14,00(4)	56,75(24) 13,64(22)	56,88(33) 13,85(33)	56,73(44) 14,18(44)		
1976	S 48						57,33(3) 14,50(2)	57,00(5) 14,40(5)	57,00(16) 14,00(16)	56,60(72) 14,22(69)	56,83(6) 14,43(7)	57,00(1) 14,00(1)

Table 3. Skagerrak Spring Spawners. Maturity stage by month in percentages. Herring samples with VS = 56.6 - 57.3.

Month	n	Maturity stages in percentages						
		I - II	III	IV	V	VI	VII	VIII
Jan	513	6.0	4.5	67.4	19.5	1.4	0.6	0.6
Feb	670	5.7	3.1	19.8	36.0	27.0	8.4	
Mar	654	0.3		8.1	30.4	50.9	3.4	1.8
Apr	187			10.1	14.4	1.6	69.5	4.3
May-Sep	-	-	-	-	-	-	-	-
Oct	220	17.7	25.9	54.5	0.9			0.9
Nov	127	27.6	3.1	62.2	3.9			3.1
Dec	96	3.0	15.6	81.3				

Table 4. Maturity stage by month in percentages from Danielssen (1969) for the months July - September.

Month	Maturity stages							
	I	II	III	IV	V	VI	VII	VIII
Jul	20.6	18.4	16.9	2.9	1.5			39.7
Aug	7.2	11.5	30.9	24.5	5.8			20.1
Sep	8.2	3.5	25.9	43.5	18.8			

LEGENDS

Fig. 1. The catch positions of the samples from the Skagerrak.

Fig. 2. K_2 versus VS and l_1 versus VS for herring samples taken in
the Kattegat (X) and in the Skagerrak (O). The Kattegat
herring is divided into two groups; Kattegat Winter Spawners
(KW) with VS-values > 56.6 and K_2-values > 14.2, and Kattegat
Spring Spawners (KS) with VS < 56.6 and $K_2 < 14.2$. The mean
VS-values for Skagerrak Spring Spawners (SS) ranged from
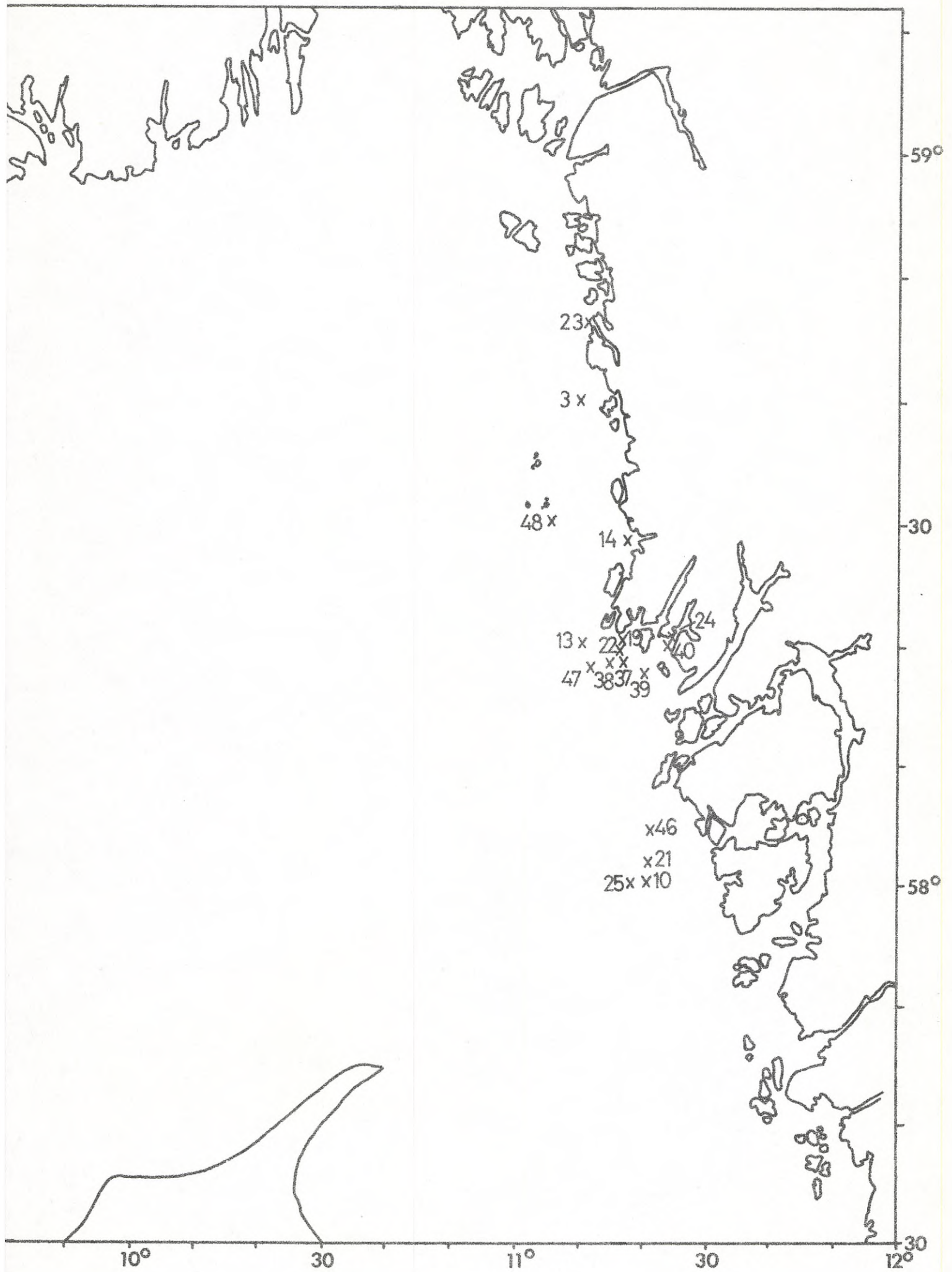56.6 to 57.3 and K_2 from 13.8 to 14.3.

Fig. 1

Fig. 2