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Demersal Fish (Northern) Committee.

On growth and fertility of Myoxocephalus scorpius in the Danish waters,

by
Else Nielsen. x)

Introduction.

The investigation is based on material collected in the Limfjord and the Sønderborg Bugt in 1968 and 1969, and the Køge Bugt in 1968. Two species of Cottidae was found, Myoxocephalus scorpius and Taurulus bubalis. T. bubalis was rare in the samples and is not further discussed in the present paper.

M. scorpius in the Limfjord is bycatch in eel-trawls, eel-traps and gill-nets and is used for fishmeal. In the Køge Bugt and the Sønderborg Bugt the species are bycatch in eel-traps only.

Age composition.

2502 specimens were investigated for age, growth and sex.

The sex distributions are:

Sønderborg Bugt:	male	607
	female	624
Limfjorden:	male	450
	female	517
Køge Bugt	male	204
	female	100

The age composition is given in table 1.

In 1968 and 1969 the yearclass 1965 is absolutely dominating in the Limfjord, constituting more than 50% of the total sample. In 1968 the yearclass 1965 too is dominating in the Køge Bugt, but in 1968 and 1969 in the Sønderborg Bugt the yearclass 1966 is the dominating one.

It appears from table 1 that there is a great fluctuation and the fluctuation is not the same on the three localities.

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Otolith.

The age was determined by examination of the otolith and contemporary it is analysed what time the formation of the opake zone was finished. For all age groups formation in the otolith of the opake protein rich zone is found to be finished in the Limfjord in September and in the Sønderborg Bugt in October; at the same time a sudden progress in the gonad development was found.

A smaller secondary zone around the nucleus, fig. 2, is believed to be formed at larval precipitation.

Growth.

The Bertalanffy parametres are calculated by the equation:

$$l_t = L_\infty (1 - e^{-K(t-t_0)})$$

the mean length per age group is used for calculation (table 2). The age length relationships are given in fig. 3.

The highest values of L_∞(♀♀ 27.25 and ♂♂ 21.85) are found in the Sønderborg Bugt (table 3). This fits with the less intensive fishery in the Sønderborg Bugt as compared with the Limfjord. On account of the different growth in the 3 localities it is possible that different stocks are present. This is seen, too, in the different fluctuation..

Weight-Length relationships.

Weight-length relationships were established from 4305 specimens (fig. 4).

The sex distributions were:

Sønderborg Bugt:	male:	1o28
	female:	1139
Limfjorden:	male:	780
	female:	1054
Køge Bugt:	male:	204
	female:	100.

The condition factors were calculated from the isometric equation:

$$w = q \cdot l^3$$

The obtained values of q (mean of the total sample)

	male	female
Sønderborg Bugt	o.o158	o.o163
Limfjord	o.o155	o.o163
Køge Bugt	o.o145	o.o165

The condition factors were calculated for females without gonades in the Sønderborg Bugt and the Limfjord too.

The obtained values (mean of total sample through 1 year)

Sønderborg Bugt	o.o156
Limfjord	o.o157

The seasonal variation throughout a year is given in fig. 5.; it shows the value of q increases through the spawning season and decreases after the spawning season with a minimum in August in the Limfjord, and August-September in the Sønderborg Bugt; through the summer the value of q has a constant level. The curve shows for values of q without gonad the same shape too, then the conditions are really better immediately before the spawning. It will be reasonable to think that the loss of weight primarily is due to the loss of coelomfluid more than a loss of fat, because full stomach in agreement with Kühl (1962) under the spawning and after the spawning is found. The allometric equations were calculated too.

$$w = K \cdot l^b$$

The value obtained:

	k	b	confidenslimit of b		
Sønderborg Bugt					
female	.0094	3.18	3.0863	b	3.2784
male	.0279	2.89	2.3418	b	3.4301
Limfjord					
female	.0093	3.18	3.0426	b	3.3146
male	.0343	2.73	2.5401	b	2.9283
Køge Bugt					
female	.0074	3.28	3.0800	b	3.4551
male	.0158	2.96	2.7519	b	3.1715

Only for males in the Sønderborg Bugt and the Køge Bugt the confidenslimit of b contains the value b =3, in the other cases b=3 must be rejected. Raitt (1933) found in a study on Haddock a similar deviation from the expected value 3, and he explains the deviation by a heterogeneos increasing and decreasing in the development of gonads throughout a year. It was not possible from the material to estimate confidensfactors for age group I, the age of which they spawn for the first time.

Fertility.

Throughout two years samples were collected every month. In this way it was possible to follow the development of the gonads for males and females respectively. It appears from fig. 6 that immediately before the spawning the weight of the female gonads constitute 29% of the total body weight.

Gonad development begins in August-September and is completed in November-December. A marked increase in the weight of the gonads is seen in September-October.

As mentioned in the section on otoliths the opake zone rich in protein was finished in September-October too. This is probably due to the enhanced protein uptake in the ovaries. Only ovaries in stage V and VI were used for egg counting. ~~from~~ 20 females from Køge Bugt, caught November 1968, measuring 16-27 cm belonging to the age groups I-VI, 37 females from the Limfjord caught November 1968, measuring 16.5-23.5 cm, and belonging to the age groups II-V, and 22 females from the Sønderborg Bugt measuring 15-25 cm and belonging to the age group II-VIII.

The ovaries of the fish were preserved separately in the "Gilson solution" (Simpson 1951) for 24 hours and then transferred to 80% alcohol. The "Gilson solution" separates the eggs and other tissues of ovaries disappear. 10% by weight of the eggs from each fish were weighed and counted.

The results are given in tables 4 and 5 and fig. 7 and 8.

The numbers of eggs varied from 4600-20000 for the Sønderborg Bugt, 6500-15000 for the Limfjord and 4800-16000 for the Køge Bugt.

In the tables 4 and 5 the quotient F/L and F/G is calculated. (Sønderborg Bugt 324-530, Limfjord 248-576 and Køge Bugt 341-582). F/L rapidly increased with increasing weight; F/G rapidly decreased with increasing weight (Sønderborg Bugt 71.9-36.2, Limfjord 58.6-51.7 and Køge Bugt 82.1-54.1). The correlation between F and L and the correlation between F and G therefore cannot be linear. The relationship between eggnumbers and length can be expressed in the equation:

$$F = aL^b. \qquad (1)$$

The weight-egg-numbers relationship is analogous with equation 1.

The obtained values are:

<u>length-eggnumbers:</u>	a	b	confidenslimit of b
Sønderborg Bugt	20.47	1.98	$o.7661 \leq b \leq 3.2403$
Limfjord	5.22	2.46	$1.5734 \leq b \leq 3.3603$
Køge Bugt	11.86	2.24	$1.5472 \leq b \leq 2.9380$
<u>Weight-length:</u> ($F = aG^b$)	a	b	confidenslimit of b
Sønderborg Bugt	319.1	o.64	$o.3032 \leq b \leq o.9928$
Limfjord	68.5	o.95	$o.6984 \leq b \leq 1.2099$
Køge Bugt	236.4	o.77	$o.5844 \leq b \leq o.9574$

The confidenslimit of b may propose a value 2 for eggnumber-length relationship, and o.66 for eggnumber-weight relationship. Both equations indicate the same relationship.

This means that the eggnumbers possibly are dependent on the surface area of the fish. The reason may be that in other species examined the eggnumber is correlated with the body weight of the fish but in these species the eggs are pelagic, while M. scorpius has demersal eggs.

The slope of the regression line from each locality was statistically compared according to Hald (1957) pag. 579.

The tested regression line:

Length-eggnumbers

Sønderborg Bugt	$\log F = 1.3110 + 1.98 \log L$
Limfjord	$\log F = 0.7174 + 2.46 \log L$
Køge Bugt	$\log F = 1.0742 + 2.24 \log L$

Weight-eggnumbers

Sønderborg Bugt	$\log F = 2.5039 + 0.65 \log G$
Limfjord	$\log F = 1.8360 + 0.95 \log G$
Køge Bugt	$\log F = 2.3627 + 0.77 \log G$

The mean slope ($\bar{b}$) for the eggnumber-length relationship is 2.1933 (confidenslimit: $3.8890 \leq \bar{b} \leq 0.4976$)
and for eggnumber-weight 0.7527 (confidenslimit $0.9068 \leq \bar{b} \leq 0.600$)

The varians within and between the regressionlines are compared too.

The results are:

length-eggnumbers $v^2 = (s_2)^2 / (s_1)^2 = 2.59$

weight-eggnumbers $v^2 = (s_2)^2 / (s_1)^2 = 0.46$

$v^2_{95.} \quad (2.70) = 3.13$

This means that the three b values in each group do not differ statistically from each other. The eggnumber-length and eggnumber-weight relationship is the same and without relation to the locality.

This relation is interpreted as a surface relation, because the confidenslimit of b for weight contains the theoretical value 0.66 and for the length the theoretical value 2.0.

It was analysed by a t-test (Hald 1957) too, if the equations derived from the same theoretical equation. This hypotese must be rejected. The conclusion for the relation between eggnumber-length and eggnumber-weight are not in agreement with Kändler and Lamp (1965).

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Table 1. Age composition (in number) for Sønderborg Bugt, Køge Bugt and Limfjorden 1968 and 1969.

Sønderborg Bugt 1968 age / sex	I	II	III	IV	V	VI	VII	> VIII
♀♀	11	100	72	19	16	19	5	2
♂♂	2	140	84	53	7	13	1	-
Sønderborg Bugt 1969 age / sex								
♀♀	49	47	147	101	7	9	16	4
♂♂	41	61	136	48	6	5	9	1
Limfjorden 1968 age / sex								
♀♀	1	57	229	25	9	6	-	2
♂♂	5	49	200	32	12	5	-	-
Limfjorden 1969 age / sex								
♀♀	8	4	5	136	20	14	3	1
♂♂	10	4	18	96	13	6	-	-
Køge Bugt 1968 age / sex								
♀♀	14	24	40	14	3	2	1	2
♂♂	48	69	63	13	3	7	1	-

Table 2. The mean length ca. og the age-groups for the Sønderborg Bugt, the Limfjord and the Køge Bugt.

Sønderborg Bugt sex \ age	I	II	III	IV	V	VI	VII	≥ VIII
♀♀	14.6	18.5	21.4	22.5	24.1	24.3	26.2	(25.7)
♂♂	14.4	17.5	19.4	20.1	21.1	21.1	21.7	(23.o)

Limfjord sex \ age								
♀♀	14.6	17.9	18.9	20.3	21.6	22.8	(24.13)	(25.o)
♂♂	14.2	-	-	-	-	-	-	-

Køge Bugt sex \ age								
♀♀	15.6	18.9	20.9	22.9	22.1	25.o	(22.5)	(23.5)
♂♂	15.9	17.4	18.4	19.o	20.3	20.3	(21.o)	-

Table 3. The parametres of the Bertalanffy equation for the Sønderborg Bugt, the Køge Bugt and the Limfjord.

Sønderborg Bugt	K	L_∞	t_o
♀♀	.3629	27.25	- 1.o47
♂♂	.5338	21.85	- 1.o59
Limfjorden			
♀♀	.3381	24.37	- 1.642
♂♂	.5554	18.43	- 1.929
Køge Bugt.			
♀♀	.4282	25.48	- 1.290
♂♂	.3291	21.34	- 3.29

Table 4. Mean numbers of eggs per 2 cm length group for Sønderborg Bugt, Limfjorden and Køge Bugt.

n = number, L = mean length per 2 cm group, F = mean egg number per 2 cm length group.

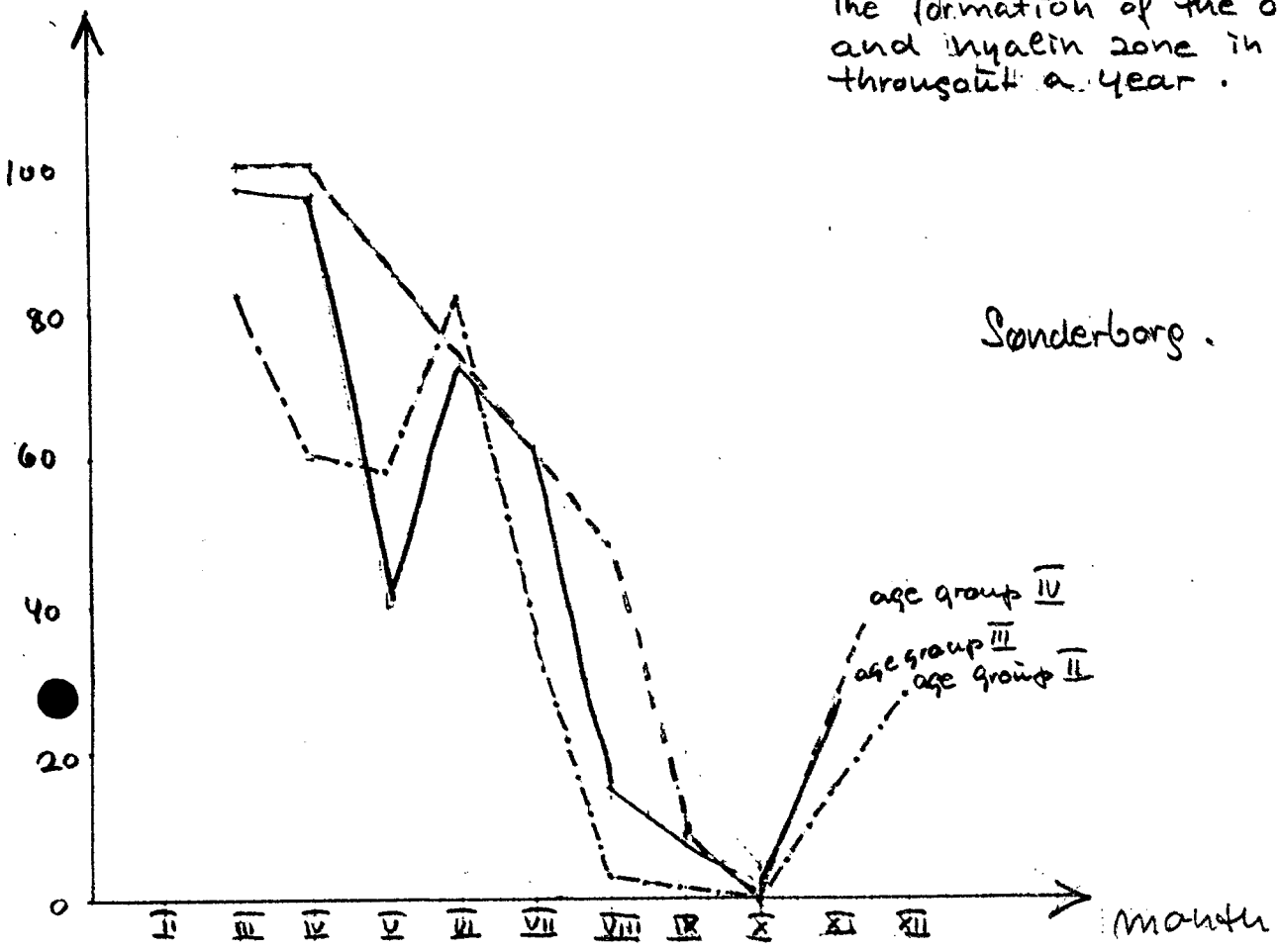
Sønderborg Bugt.	n	L	F	$F/_L$	$F/_L^2$
13.o - 14.9	-	-	-	-	-
15.o - 16.9	4	16.o	5195	324.1	20.3
17.o - 18.9	6	17.4	6320	363.2	20.8
19.o - 20.9	3	19.7	1o138	514.6	26.1
21.o - 22.9	5	21.6	9518	440.6	20.4
23.o - 24.9	3	23.o	12200	530.4	23.o
23.o - ∞	1	25.o	5700	228.o	9.12
Limfjorden					
15.o - 16.9	2	16.5	4100	248	15.o
17.o - 18.9	10	18.o	7199	399	22.2
19.o - 20.9	12	19.5	8207	420	21.5
21.o - 22.9	7	21.6	9722	450	20.8
23.o - 24.9	2	23.3	13360	576	24.8
25.o - ∞	-	-	-	-	-
Køge Bugt.					
15.o - 16.9	3	16.o	5459	341	21.3
17.o - 18.9	1	17.o	6134	360	21.2
19.o - 20.9	3	20.3	13128	646	31.8
21.o - 22.9	8	21.6	11730	543	25.1
23.o - 24.9	3	23.3	13544	581	24.9
25.o - ∞	2	26.o	15154	582	22.4

Table 5. Mean weight per 25 gr-group and mean eggnumbers per weight-group for Sønderborg Bugt, Limfjorden and Køge Bugt.

n = number per 25 gr.-group, G = mean weight per 25 gr.-group
F = mean eggnumber per 25 gr.-group.

Sønderborg Bugt	n	G	F	F/G
25.o - 49.9	1	44.o	2351	53.4
50.o - 74.9	3	72.3	5197	71.9
75.o - 99.9	5	86.6	7412	85.6
100.o-124.9	3	117.o	4723	40.4
125.o-149.9	-	-	-	-
150.o-174.9	2	163.o	14729	90.4
175.o-199.9	4	189.6	11037	58.2
200.o-224.9	1	200.o	9163	45.8
225.o-249.9	1	230.o	8984	39.1
250.o- ∞	2	250.o	9039	36.2
Limfjorden				
75.o - 99.9	2	87.o	4100	47.1
100.o-124.9	8	113.7	6669	58.6
125.o-149.9	8	132.1	7373	55.8
150.o-174.9	5	157.o	9061	57.7
175.o-199.9	6	189.5	9816	51.7
200.o-224.9	2	204.o	10981	53.8
225.o-249.o	1	230.o	11693	56.8
250.o- ∞	1	250.o	15025	60.1
Køge Bugt				
25.o - 24.9	-	-	-	-
50.o - 74.9	4	68.5	5627	82.1
75.o - 99.9	-	-	-	-
100.o-124.9	-	-	-	-
125.o-149.9	5	137.4	10775	78.4
150.o-174.9	4	164.o	13617	83.o
175.o-199.9	3	181.o	12125	66.8
200.o-224.9	2	205.5	14576	70.9
225.o-249.9	-	-	-	-
250.o- ∞	2	280.o	15152	54.1

Fig 1 :
The formation of the opake and hyalin zone in otolith throughout a year.



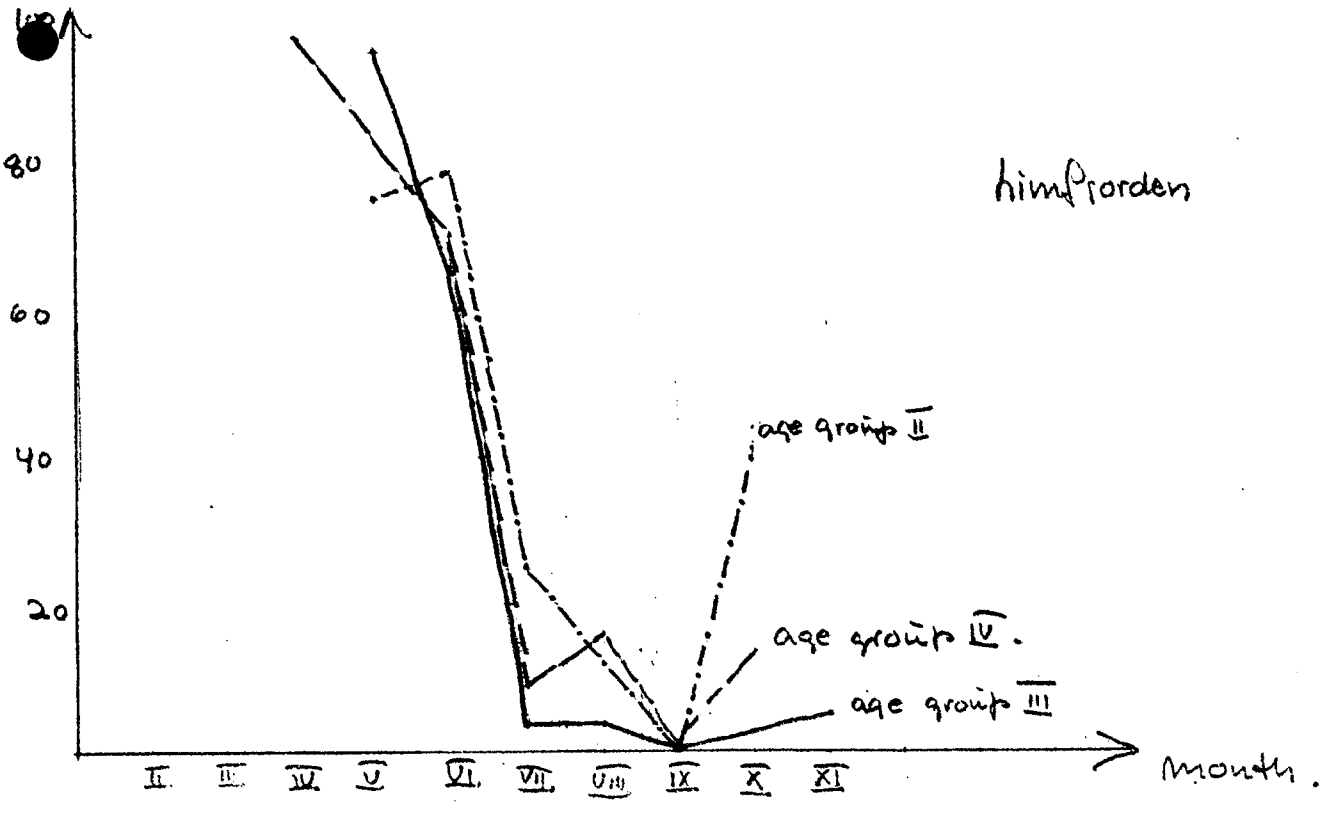
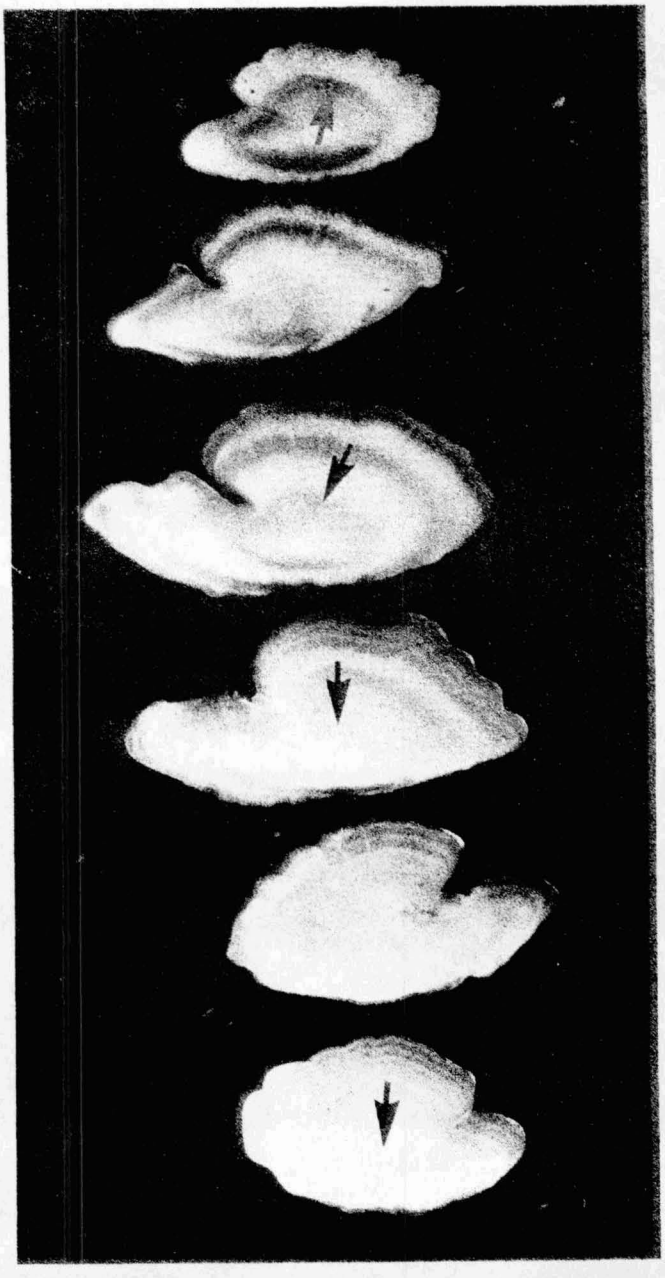


Fig.2: Otoliths of M. scorpius belonging the age groups I-VI. The zone developed by the larval precipitation is shown by →



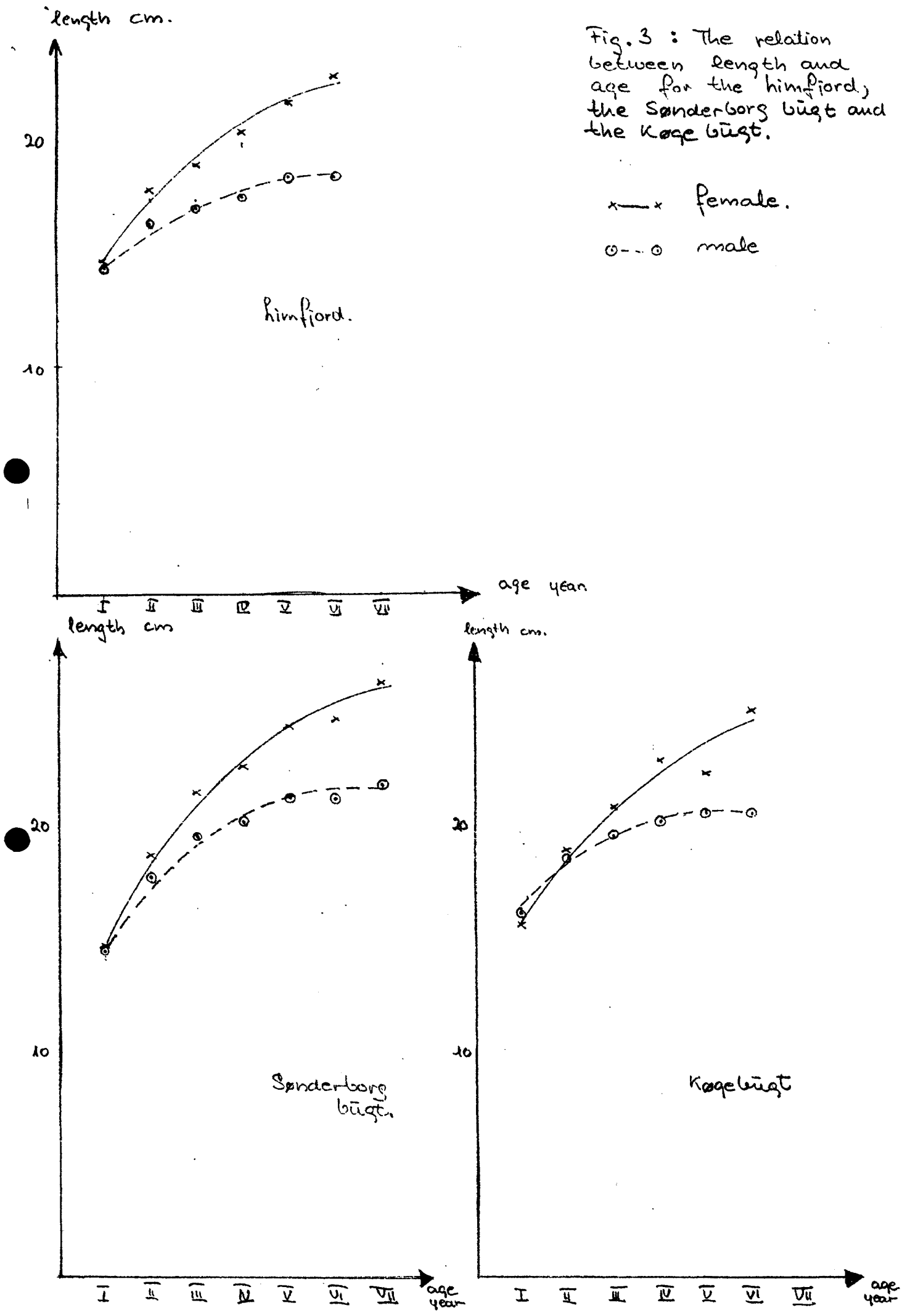


Fig. 3 : The relation between length and age for the himfjord, the Sønderborg bugt and the Kogebugt.

×—× female.

⊙--⊙ male

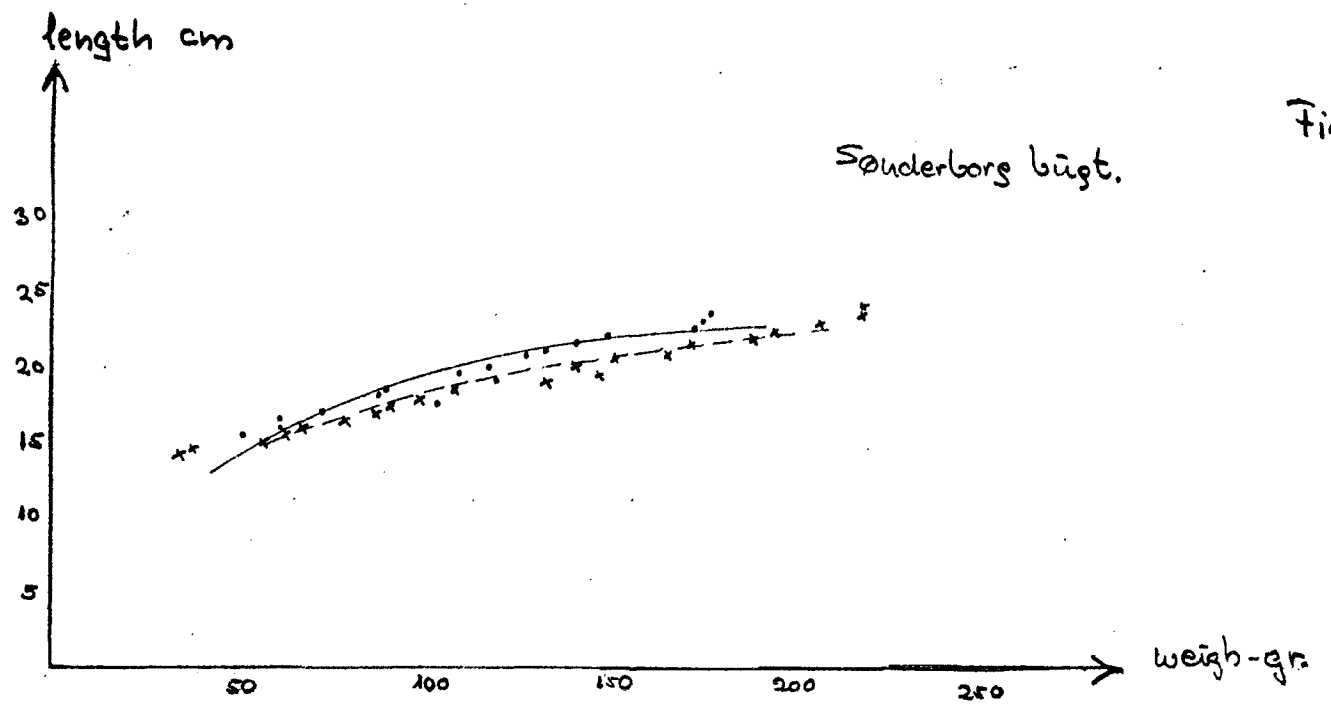
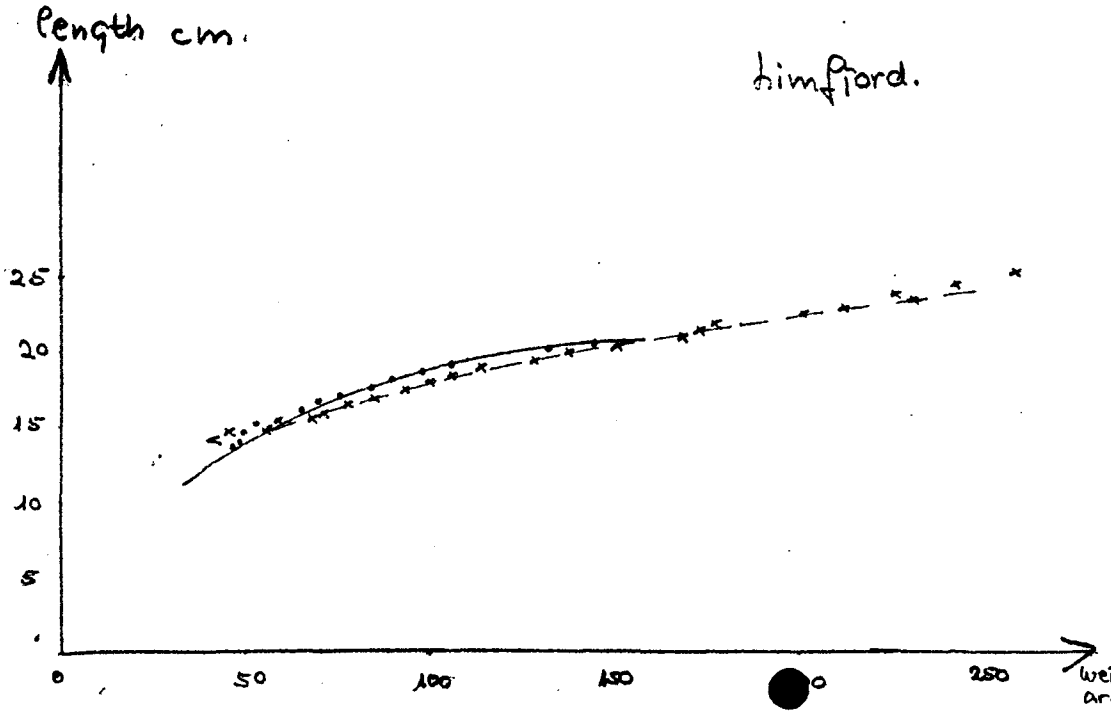


Fig 4: Weigh- length relationsship

x---x female
•——• male.



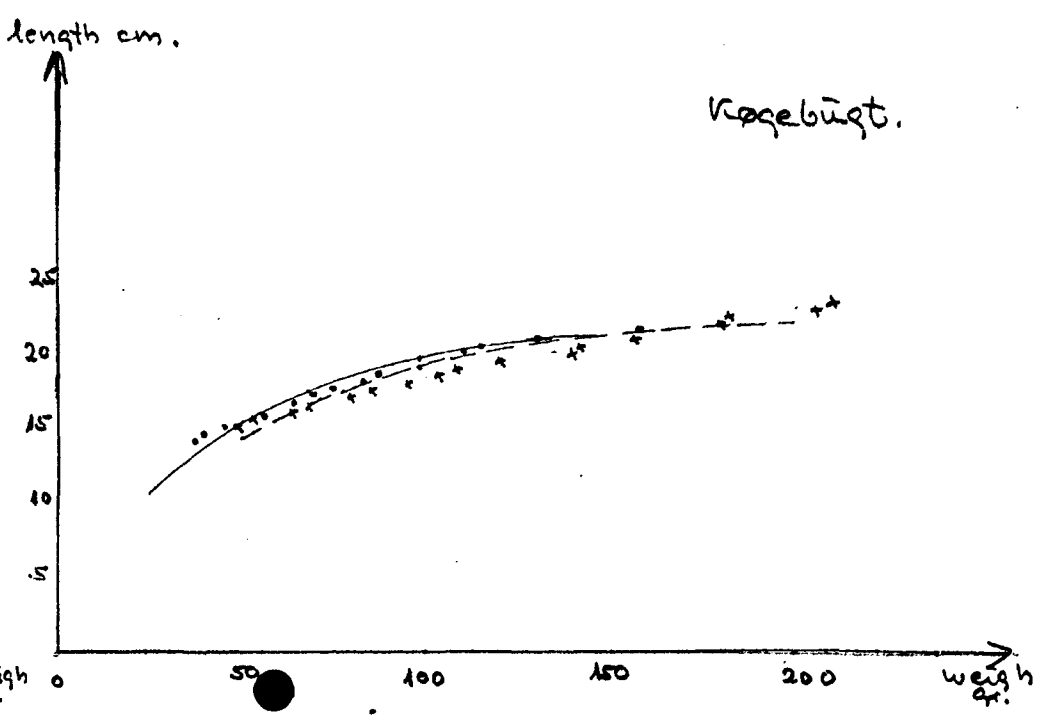
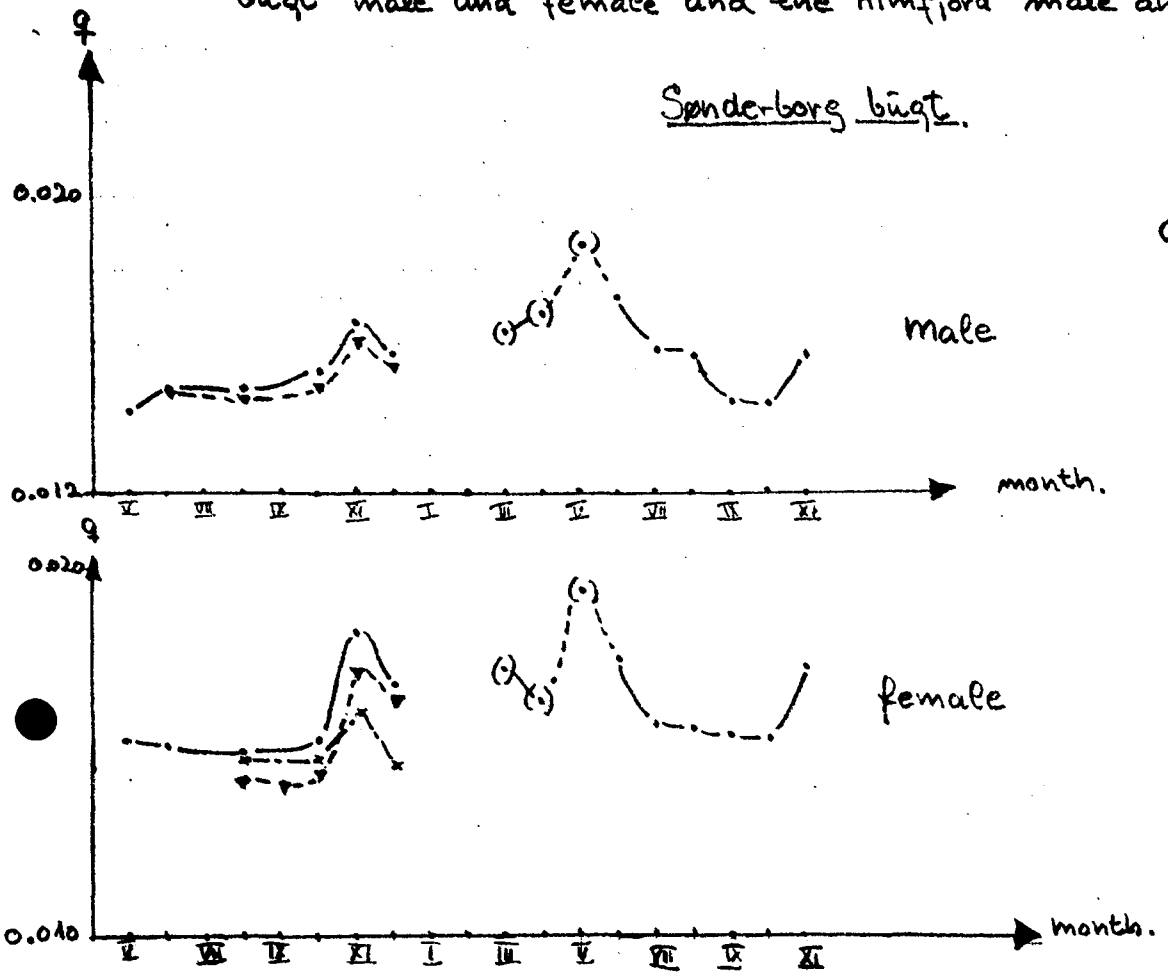
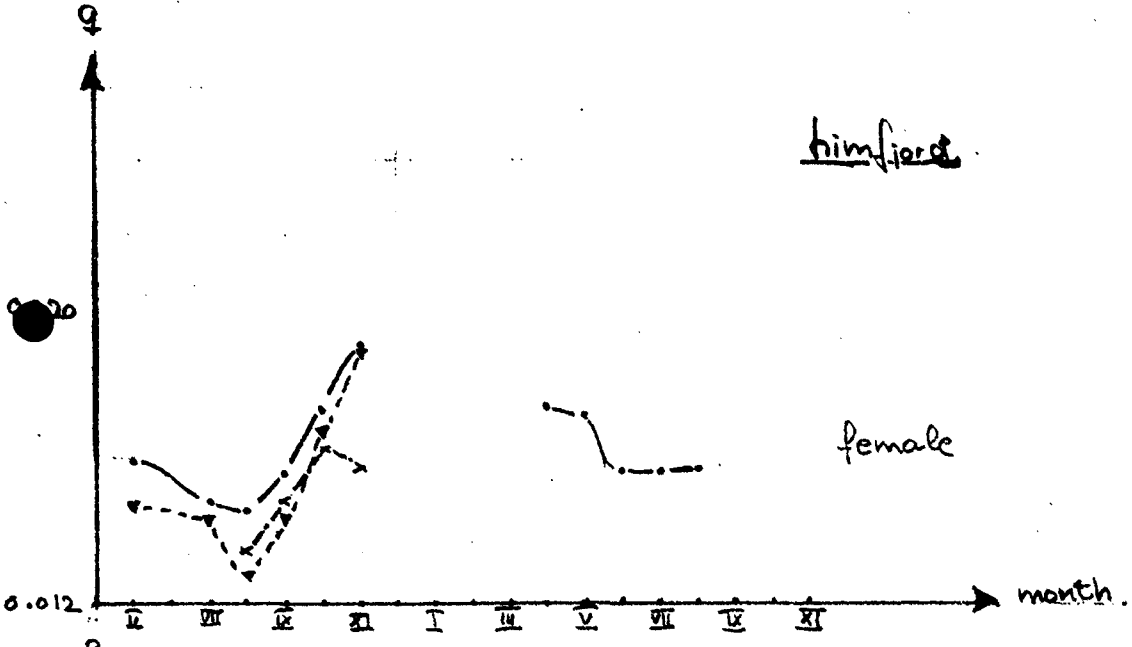
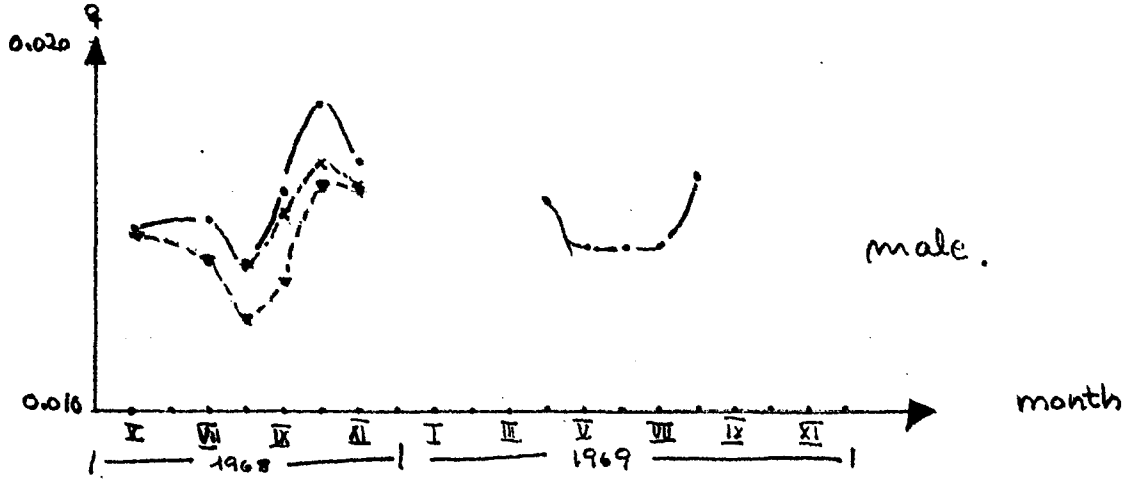


Fig 5. the relation between the season and the value of q for the Sønderborg-bügt male and female and the himfjord male and female.







the gonade weigth as a percentage of the total weigh.

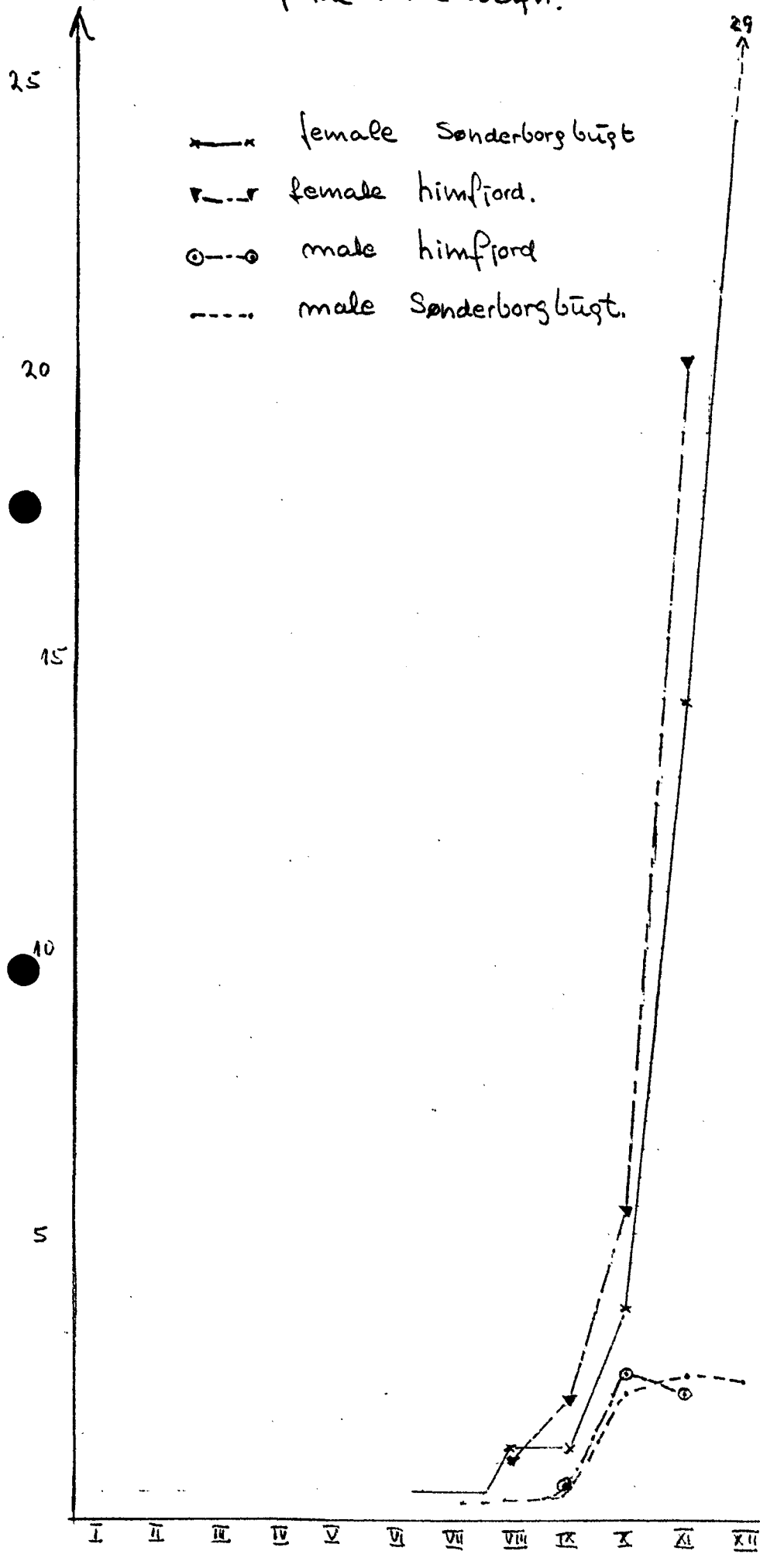


Fig 6. The development of gonads, as a percentage of the total weight. for the himfiord male and female and the Sønderborg bügt for male an female

Fig. 7: The relation between egg number and length for the Sønderborg bugt, the limfjord and the køge bugt.

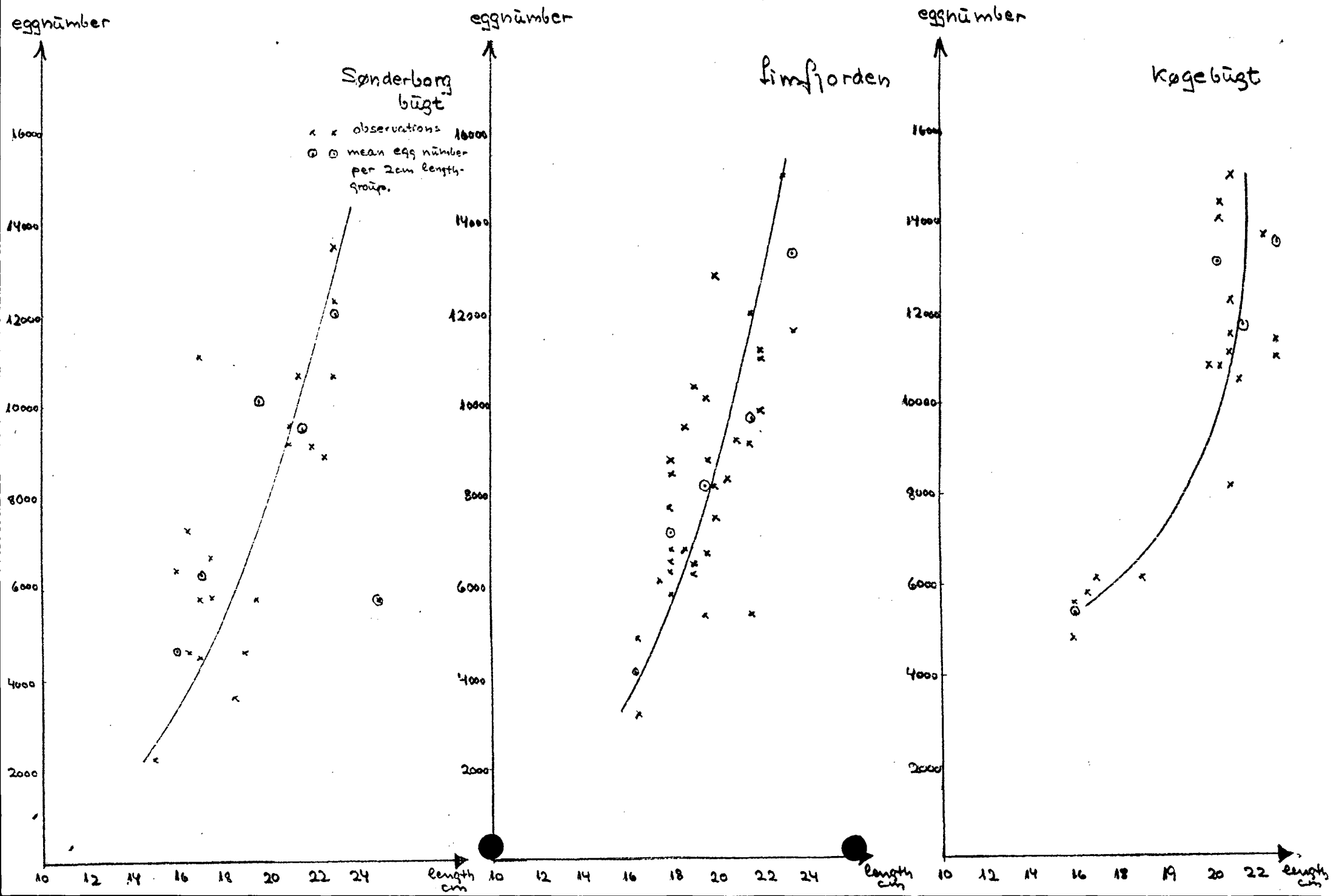


Fig. 8 : the relation between egg number and weight for the Sønderborg bugt, the himfjord and the Køge bugt.