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Young Cod Distribution and Abundance in West Greenland Inshore Areas, 1987

by

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Abstract : A young cod survey using strings of gill-nets with different mesh-sizes was carried out in three inshore areas in southwestern Greenland during July and August, 1987. Catches were dominated by the 1984 year-class which was abundant in all areas. The 1985 year-class were taken in highest numbers in the northern and southern area. The size of this year-class is estimated to 22% of the large 1984 year-class. Catches of the 1986 year-class were extremly low in the survey and this year-class is therefore considered as virtually non-existent in West Greenland.

1. Introduction

Prediction of year-class strength of prerecruit year classes is of considerable importance when forcasting the fisheries. In the West Greenland area predictions on cod year-class size have traditionally been based on larval abundance and hydrographic observations during June-July, but neither of these methods have been of a sufficient reliability (Hansen and Buch, 1986). One of the major problem is that a large proportion of the Greenland cod drifts as 0-group fish from Iceland to Greenland with the Irminger current (Hovgård & Messtorff, 1988). For this reason year-class size is better predicted from the abundance of young fish.

As the Greenland Fisheries Research Institute does not have access to research vessels fitted for large scale trawling operations a survey using links of gill-nets with different mesh sizes has been developed and used since 1984. The objective of this programe is dual a) to gain knowledge on the geographical distribution of young cod and b) to assess the relative year-class size of 1- and 2-year old cod.

2. Material and methods

The young-cod survey was carried out in July and August, 1987 in three inshore areas of West Greenland : Qaqortoq (NAFO Div. 1F), Nuuk (Div. 1D) and Sisimiut (Div. 1B) (Fig. 1).

The links of gill-nets contain separate sections with mesh sizes of 16.5, 18, 24, 28 and 33 mm (bar length) arranged in random order. The catching capacity of each mesh-size is bimodal as the

cod is attatched either behind the gill-cover or at the jaw (mandibulars). Catch efficiency at both catching sites are simply related to fish size but the gill catching is 4 to 5 times as efficient as the jaw-catching (Hovgård 1988). With the mesh-sizes used fish between 15 and 35 cm are efficiently caught whereas larger fish is caught with a substantially lower efficiency. The length distribution of the catches by mesh-size is shown in Fig. 2.

A total of 223 net settings were made (Table 1). Nets were set floating or at the bottom, at depths ranging from 2 to 35 m. Average fishing time was 8.2 hours, range 5.1 to 13.1 hours. On most stations temperatures were measured either by reversable thermometers or by CTD.

Catch rate (number caught per hour) for each age group is used as an index of abundance. The frequency distribution of the catch rates is, however, very far from the normal distribution (Fig.3), and standard statistical methods should only be applied with care. However, for large samples the estimated mean will be aproximately normaly distributed around the true mean for the population with a variance of S^2/n irrespective of the original distribution (central-limit theorem).

3. Results

Temperature observations

Temperatures at the fishing depths, averaged pr. 2 m intervals, are shown in Fig 4. Temperatures in the southern Qaqortoq area were significantly lower than those at at Nuuk and at Sisimiut. Temperatures in the latter two areas did not differ substantially from each other.

Distribution pattern of young cod

During the survey a total of 3991 cod were caught. Catches were dominated by 3- and 2-year old cod, i.e. the 1984 and 1985 year-classes (Fig 5). The 1985 year-class was found primarily in Div. 1F where it accunted for approximately half of the total catch. In Div. 1D and 1B the 1984 year-class were dominating.

Only two 1-year old cod were taken in the survey. When available, 1-year old cod (13-20 cm fish) are caught efficiently by the smaler mesh-sizes (Hansen and Lehmann, 1986) and the very low occurence in 1987 indicates therefore that the 1986 year-class is virtually non-existing in the West Greenland area.

Catch rates of 2-year old cod, by area and depth, are shown in table 2. Highest catch rates were found in Div. 1F and 1B and in demersal net settings above depths of 20 meters. A formal statisticl test of the significance of these differences is impeeded by the skew distribution of the catch rates. A major problem is that the standard deviation of the catch rates is dependent on the mean (Fig 6).

For this reason the catch rates has been log-transformed by, $Y = \log (CPUE + 1)$, and Y then described by the General Linear Model

Y= Area (i) + Depth (j) + Temp. + error

where (i) denotes the three areas and (j) the 7 depth zones, and where temperature is a covariate. All effects are statistically significant (Table 3). The catch rates are significantly lover in Div. 1D compared to Div. 1B and 1F. The statistical difference of depth is caused by the floating nets (dermersal catch rates not different). The effect of temperature is positive, ie. the higher the temperature the higher the catch rate.

As noted (Fig. 4) temperature is correlated with area and notably depth. If ignoring the temperature information lower predicted values will arise in the deeper cold water layers. It can therefore be concluded that 2-year old cod are concentrated near bottom in the upper 20 meters although its relative scaricity at greater depths can be attributed to an effect of low temperatures.

The 3-year old cod are too big to be caught effectively by the net links, and a more formal analysis of their distribution is therefore, not conducted. However, as survey effort has been distributed evenly between areas, it can be deducted from Fig. 5, that 3-year old cod were relatively evenly distributed in West Greenland in 1987 although with a somewhat higher abundance in the northern area surveyed (Div. 1B).

Year-class indices

In the calculation of an index of year-class strength technics from stratified sampling have been used, ie.

$$\text{Mean} = \sum W_h x_h \qquad V(x) = \sum (W^2_h \; S^2_h) / n_h$$

Where W(h) are strata weights and x, S, and n are strata means, standard deviation and number of observations, respectively (Cochran, 1977). The depth-area combinations from Table 2. are used as strata. Surface and the deeper settings (deeper than 20 m) where cod were scarce have not been included. As no information is availible concerning strata size all are given equal weight.

The index for 2-year old cod is found to be 0.94 cod per hour ± 10.4%. As the index is based on 166 observations it might be supposed to be effected only slightly by the skew catch-rate distribution. The index for 1-year cod is set as zero.

In 1986 only mesh sizes of 16.5, 24 and 33 mm were used. For comparison an index using the catch from only these meshsizes has also been computed. This index is compared to to the 1986 survey index below. By comparing this abundance index of 2-year cod in the two surveys the size of the 1985 year-class is estimated to be 22% of the large 1984 year-class.

Index of year-class strength

	Age Group	
Survey	1	2
1986	0.09	1.61
1987	0	0.36

Discussion

The 1984 year-class is probable the largest year-class seen at West Greenland since 1961 with an estimated size of not less than 200 million fish at age 3 (Anon. 1987). The year-class is believed to be largely of Icelandic origin (Hovgård and Messtorff, 1988) and is abundant at both Southeast and Southwest Greenland. In the Greenland gill-net surveys the highest abundance was found in the most norhern area surveyed (Div. 1B) in 1986 as well as in 1987. The German trawl surveys, conducted offshore in October/November 1985-1987, also indicate a relativ northern distribution (highest abundance in Div. 1CE) of this year-class (Anon., 1988).

The 1985 year-class is also believed to be primarily of Icelandic origin (loc. cit.). From the German trawl surveys its abundance in early winter is highest at southwest Greenland (Div. 1EF). (Anon., 1988). The distribution of this year-class in the greenland gill-net survey shows a somewhat different distribution pattern as no statistical difference in abundance could be detected between Div. 1B and 1F whereas the abundance in Div. 1D was significantly lower. The same pattern of distribution of this year-class was found in the 1986 gill-net survey (Hovgård, 1987). The difference in distribution between the German and the Greenland surveys is probably caused by a seasonal southward migration of the cod during the fall.

The size of the 1985 year-class is in this study estimated to 22% of the size of the 1984 year-class. Similar calculations based on the difference in abundance as 1-year cod in the 1985 and 1986 gill-net surveys lead to an estimate of 17% (Hovgård, 1987). Using the same procedure on the German trawl survey data gives an estimated relative size of the 1985 year-class of 30 and 35 % of the 1984 year-class size, when comparing 1- and 2-year abundance respectively. It might therefore be concluded that the 1985 year-class of cod off West Greenland is roughly in the size of 26 % of the 1984 year-class.

The size of the 1986 year-class of cod seems to be extreemely low as this year-class was almost absent in the Greenland gill-net survey. The same were found in the German trawl survey in October/November 1987 (Anon. , 1988), where this year-class was found to be less than 1 percent of the 1984 year-class as age 1.

5. References

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Table 1 : Number of gill-net settings by area and depth (hours fished in brackets), 1987.

Area	Qaqortoq	Nuuk	Sisimiut
Div.	1F	1D	1B
Depth (m)			
Surface	7 (59)	10 (77)	10 (79)
0 - 5	14 (109)	12 (92)	11 (85)
5 -10	17 (150)	16 (148)	14 (119)
10 -15	16 (131)	16 (125)	13 (101)
15 -20	12 (93)	11 (101)	14 (111)
20 -20	7 (56)	10 (80)	9 (71)
30 -40	2 (16)	1 (9)	1 (10)
Total	75 (614)	76 (632)	72 (575)

Table 2 : CPUE (number per hour) of 2-year old cod (1985 year-class) by area and depth.

Area	Qaqortoq	Nuuk	Sisimiut
Div.	1F	1D	1B
Depth (m)			
Surface	0.58	0.01	0.04
0 - 5	1.62	0.30	0.71
5 -10	2.10	0.26	1.28
10 -15	1.14	0.28	1.21
15 -20	0.66	0.08	1.51
20 -30	0.42	0.06	0.77
30 -40	0.21	0.52	0.06

Table 3 : Basic statistics from the General Linear Model :

log(cpue+1) = my + area(i) + depth(j) + temp. + error

Source	Df	SS	Mean Sq.	F	P
Area	2	9.07	4.54	23.87	<0.0001
Depth	6	5.86	0.98	5.14	<0.0001
Temp.	1	1.10	1.10	5.77	0.0172
Error	194	52.89	0.19		

Parameter	Estimate	P(Est.=0)
My	-0.226	0.32
Area		
1B	0.388	<0.001
1F	0.547	<0.001
1D	0	
Depth		
Surface	-0.289	0.25
0 - 5	0.187	0.43
5 -10	0.372	0.11
10 -15	0.338	0.14
15 -20	0.224	0.33
20 -30	0.121	0.61
30 -40	0	
Temp.	0.043	0.017

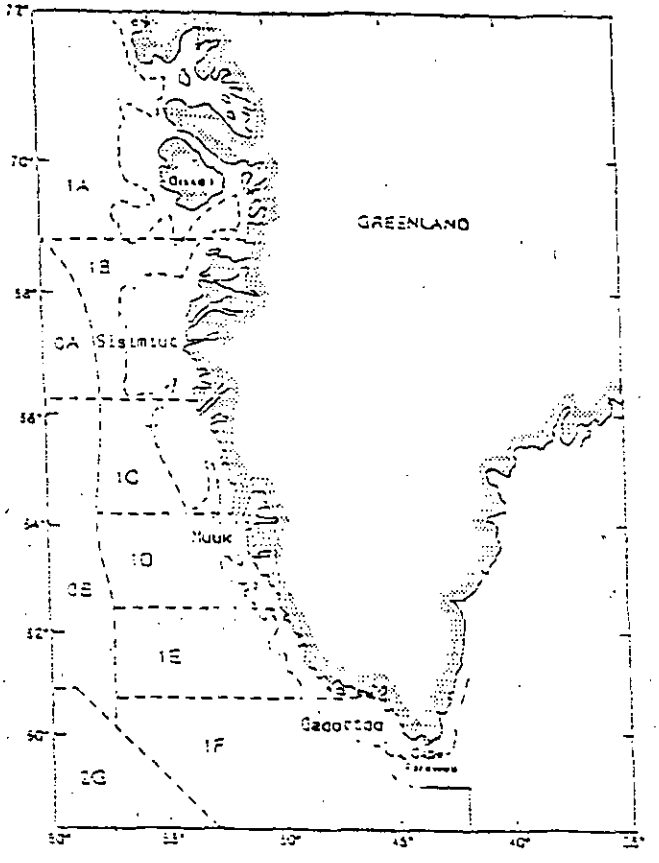

Fig 1 : Map of southern Greenland showing the areas of investigations.

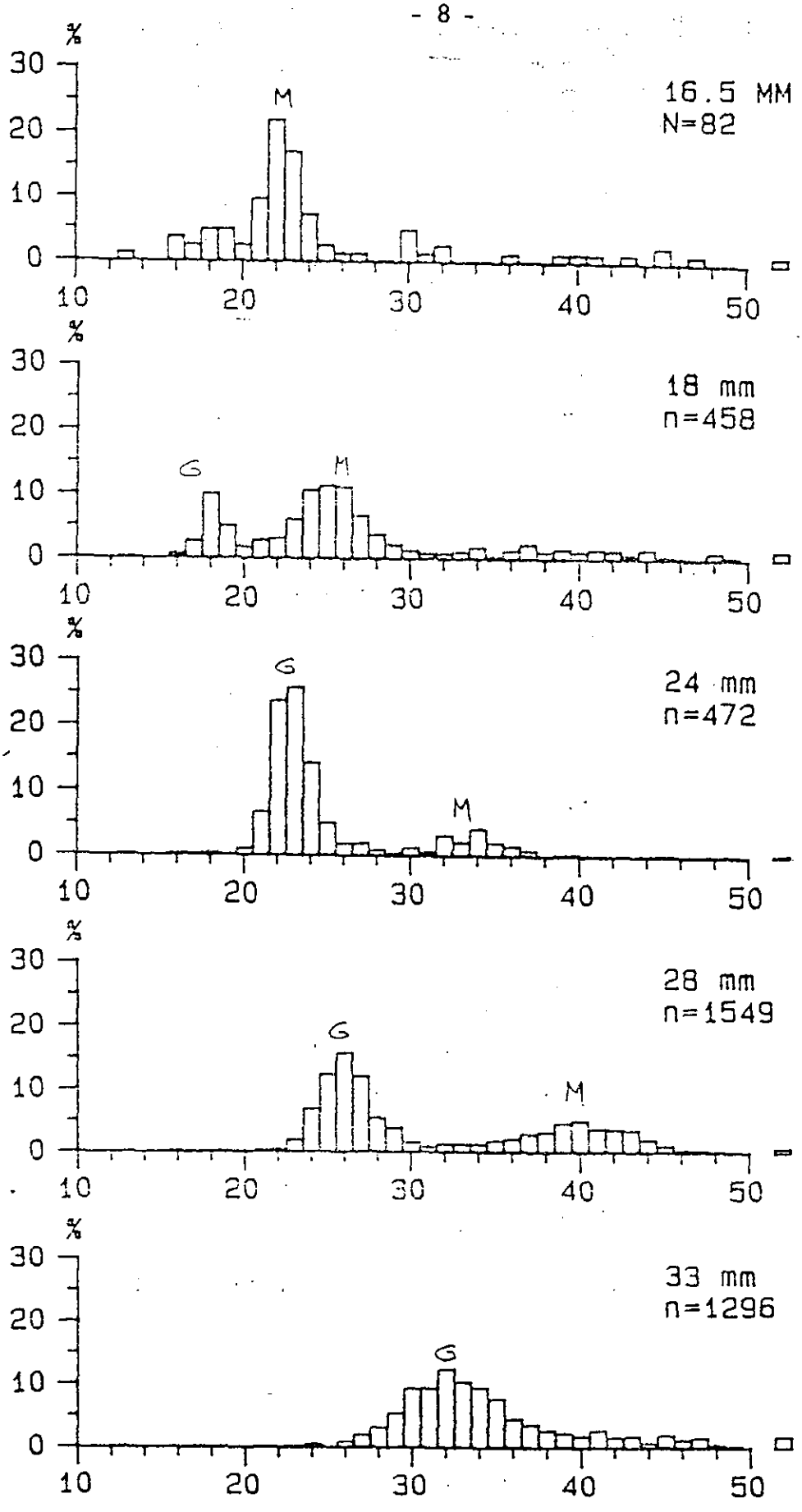

Fig 2 : Length frequency distributions (%) for each mesh size. 'G' indicates modes of gill-catching and 'M' modes of mandibular-catching.

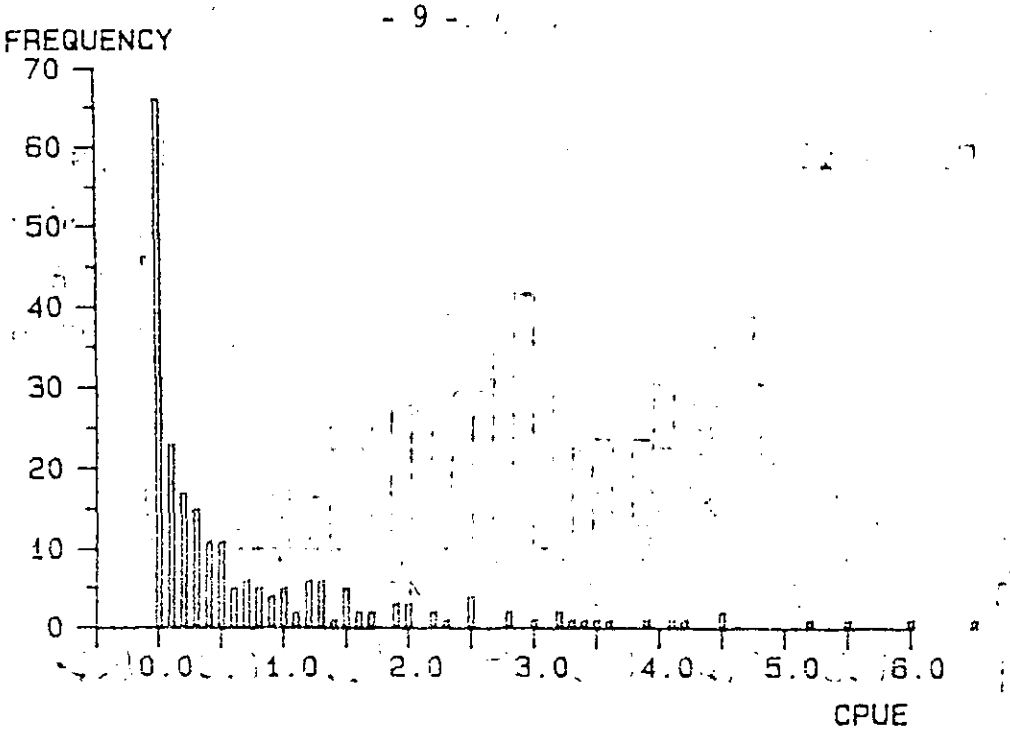

Fig 3 : Frequency of net settings by catch rates.

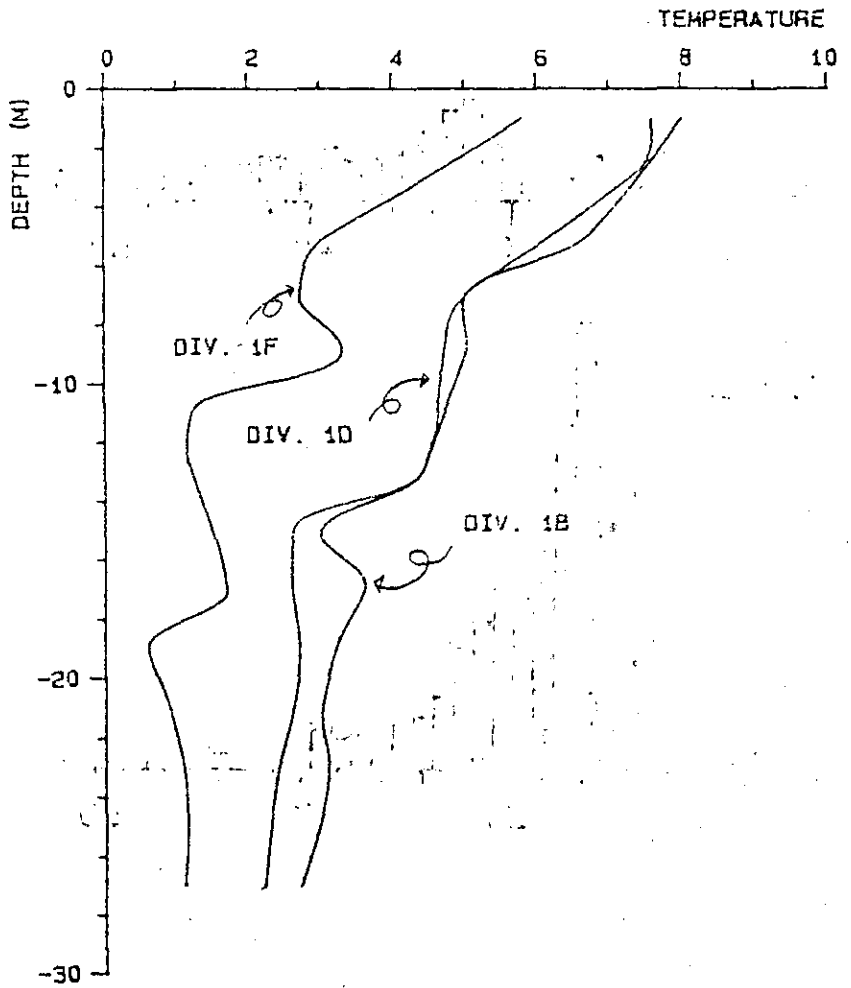

Fig 4 : Mean temperature at fishing depths in the three areas.

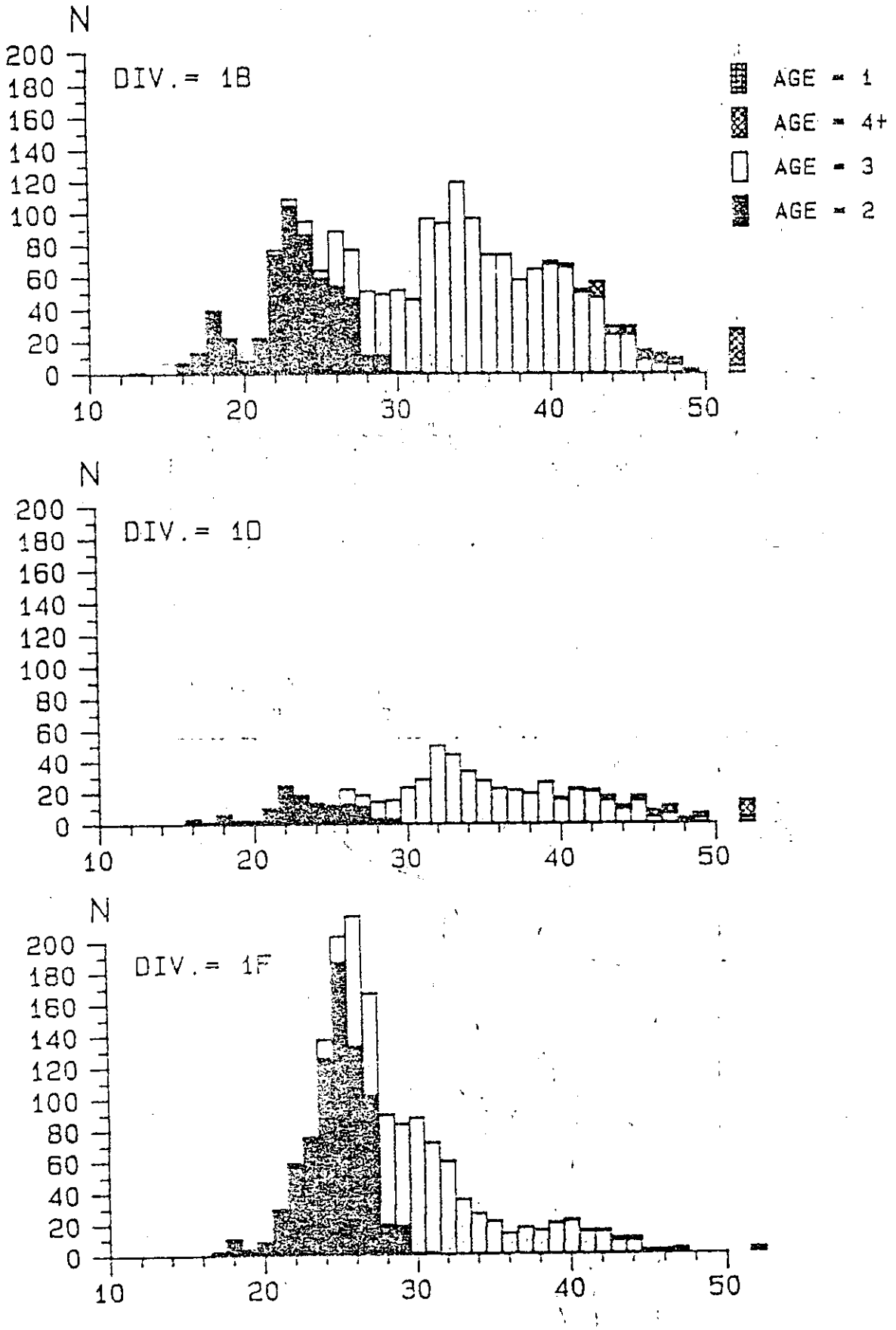

Fig 5 : Length frequency and age compositions of catches by area.

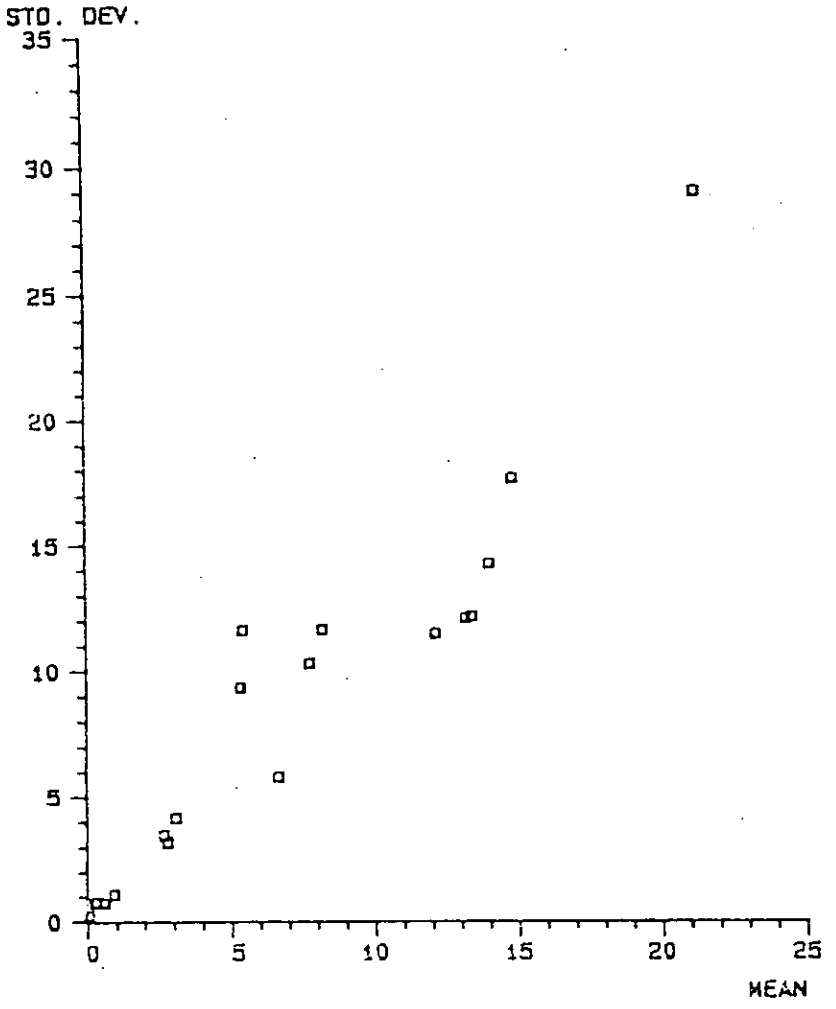

Fig 6 : The relationship between the mean and the standard deviation for each area-depth combination.