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Age, growth and mortality of Lepidorhombus boscii (Risso), off the Galician coast, NW Spain

by

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Introduction

Spotted fluke (Lepidorhombus boscii) is commonly found all along the Galician coast but having well defined main concentration areas. This concentrations are found in the north of Galicia from El Ferrol to Ribadeo in depths between 150 and 375 m (López Veiga et al 1974, 1976 and in press).

This species has an important commercial value and the catches are carried out with bottom trawl gears, and it constitutes a by-catch of the main fishery of hake in the Galician area.

The spotted fluke biology is very little known. In the present paper age, growth, mortality and a yield per recruit analysis for this species in the Galician fishery is made.

Material and Methods

Data for the present study have been collected during a groundfish survey carried out on board the R/V "Cornide de Saavedra" during august-september 1975. The gear used is a stern trawl type one and it is described by López Veiga et al (1976). The mesh size in the cod-end was 35.56 mm (stretched, gauge strength 5 kgr) and the material was polya-mide. A total of 71 hauls were made with an average trawling time of 1 hour. Figure 1 shows the position of the midpoint of the hauls.

Otoliths were used for age determination, using transmitted ligth and they were inmersed in water. Hyaline rings were considered to be annual rings. Stratified sampling was used when collecting the otoliths. Age-length keys were then derived and taking into account the length frequency distribution for each sex, the mean length at age has been calculated (Table 1).

In order to express growth, the von Bertalanffy equation has been used (Beverton and Holt, 1957):

$$l_t = L_\infty \left(1 - e^{-k(t-t_o)}\right)$$

in terms of length, and

$$w_t = W_\infty \left(1 - e^{-k(t-t_o)}\right)^n$$

in terms of weight, where:

l_t = average fish length at age t
w_t = average fish weight at age t
L_∞ = asimptotic length
W_∞ = asimptotic weight
k = constant expresing the rate of change in length with respect to age
t_o = hypothetical age at zero length
n = exponent derived from the length-weight relationship

Ford-Waldford plot has been used to calculate the parameters of the von Bertalanffy expression in terms of length.

Total mortality instantaneus coefficient (Z) has been calculated from the catch curves, for each sex, fitting a straigth line to the points in figure 4. The slope of the fitted line gives then a direct estimate of Z, assuming constant recruitment.

Yield per recruit analysis for each sex independently, due to the differences found in growth, were made using the modified.expression of the yield per recruit equation (Beverton and Holt, 1966).

Results and discussion
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- Age and length distributions

Figure 2 shows the length frequency distributions in the survey for females, males and indeterminates. It can be noted that the length range for females is bigger than the one for males.

Figure 3 shows the composition of the catches in the survey by age groups. It can be seen that they are composed mainly of young individuals, age groups I, II, III and IV, and that 1973 year-class (age-group II) is the most abundant for both sexes.

Age group 0 does not appear in Figure 3 due to the difficulty of sex determination for individuals less than 100 mm length. All indeterminate individuals belonged to this age group (Figure 2).

We believe that the catches made during the groundfish survey may be taken as repressentative of the commercial catches since we have used the same type of fishing gear and the same mesh size opening than the fishing fleet uses.

Females life-span seems to be larger than males one, due the wider range of ages represented in the female population. The age groups represented in the samples ranged from 1 to 15 years for females and 1 to 10 years for males (Figure 3).

- Growth in length

Using the von Bertalanffy equation, the resultant growth curves are:

$$l_t = 428.79 \ (1 - e^{-0.15(t+1.36)}) \qquad \text{for females}$$

$$l_t = 347.12 \ (1 - e^{-0.19(t+1.37)}) \qquad \text{for males}$$

For the same age females reach a bigger length than males. Also the asimptotic length for females is greater than for males. Based on data related to spawning season of this species, it has been found more convenient to set the first of march as the "birthday" date for the year-classes.

- Length-weight relationship

Length-weight relationship have been calculated for each sex and the resultant equations were:

$$W = 3.70 \ 10^{-6} \ L^{3.12} \qquad \text{for females}$$

$$W = 5.47 \ 10^{-6} \ L^{3.05} \qquad \text{for males}$$

From 250 mm length the weight for females is greater than for males.

- Growth in weight

The growth in weight has been derived from the growth in length expression and the length-weight relationship. The resultant equations are, for each sex:

$$w_t = 603.68 \; (1 - e^{-0.15(t + 1.36)})3.12 \qquad \text{for females}$$

$$w_t = 306.51 \; (1 - e^{-0.19(t + 1.37)})3.05 \qquad \text{for males}$$

The asimptotic weight (W_∞) for females (603.68 gr) is nearly double than the resultant value for males (306.51 gr).

- Total mortality

Figure 4 shows the catch curves used for the estimation of the total mortality coefficient (Z), and the fitted regression line. The resultant values for Z calculated on this way were for females $Z = 0.51$, whereas . for males this value is $Z = 0.62$.

- Natural mortality

There are no direct estimates for natural mortality in spotted fluke populations. In order to get an idea of the magnitude of this parameter, we have used the indirect approach of Taylor (1959), resulting $M = 0.1610$ for females and $M = 0.2081$ for males, which seem to be in good agreement with the correspondent values found for other pleuro-nectiforms by other authors using other methods.

- Yield per recruit curves

In order to derivate the modified yield per recruit curves (Beverton and Holt, 1966), estimates of M/K and "c" are needed. Using M and K values calculated before we obtain $M/K = 1.0733$ for females and $M/K = 1.0953$ for males. In any case, it seems most probable that the value of M/K for spotted fluke will be in the range of 0.75 to 1.25, attending to this value for other pleuronectiform populations.

"c" value has been calculated for two different mesh-sizes in the cod end, 40 mm, which is the one used generally in the Galician demersal fishery, and 60 mm the one recomended for the whole Galician demersal fishery in several papers (López Veiga et al, 1976 and in press, and Fuertes et al, 1977). Mean selection lengths have been calculated using the selection factor of 2.31 for polyethylene cod-ends given by Fuertes et al (1977). Using the correspondent L_∞ values for each sex we will obtain:

Females			Males	
mesh size	c		mesh size	c
40 mm	0.22		40 mm	0.27
60 mm	0.32		60 mm	0.40

Table 2, lists the values of Y'_{max} and F_{max} for values of M/K of 0.75, 1.00 and 1.25, and the beforesaid values of c for each sex. Figures 5 and 6 show the yield per recruit curves for M/K = 1.00 and 40 and 60 mm cod-end mesh size, and for each sex.

From Table 2 it can be seen that an increse of the cod-end mesh size from the 35-40 mm, used at present, up to 60 mm would result in a increase in yield in the fishery.

– Status of the fishery

Table 2 shows that the values of F_{max} are in the range of 0.11-0.17 in the case of females, and 0.15-0.23 in the case of males, depending on the assumption of the M/K value.

From the estimates of Z and M obtained before we may find the values of F at present in the spotted fluke population of Galicia. Those are F = 0.35 for females and F = 0.41 for males. Both values are well in excess of F_{max} as it is clearly shown in Figures 5 and 6. Thus we may affirm that the spotted fluke population off Galicia is in an overfishing situation, and beeing the effort directly proportional to F we may say that, roughly, the effort in the fishery is nearly double of that needed to maximize yield per recruit, on a long term basis.

Summary

In the present paper and based on data collected during a ground-fish survey carried out in august-september 1975, first studies on age, growth and mortality of spotted fluke (Lepidorhombus boscii) population off Galicia (NW Spain) are presented.

Otoliths were used for age determination. Females grow faster and reach greater sizes than males, and also their life span is longer than males. Differences in growth become more apparent from the second year of life. Catches were composed mainly of young individuals (age groups 0 to IV).

A yield per recruit analysis made separately for each sex shows that an increase in cod-end mesh size from 35-40 mm used at present up to 60 mm should be desirable. The fishing mortality, at present, is double of F_{max}. A reduction in effort should also be advisable.

Résumé

Dans ce travail on présente les premières études sur l'âge, la croissance et la mortalité de Lepidorhombus boscii de la pêcherie demersale de la Galice (NW de l'Espagne) d'après les données et le materiel recueillis dans une campagne de pêches expérimentales realisées pendant les mois d'Août-Septembre 1975. On présente aussi une analyse du rendement par recrue pour cette population.

On a lu les otolithes pour la determination de l'âge et on a vérifié une croissance differencielle par rapport au sexe. La croissance est beaucoup plus rapide pour les femelles que pour les mâles, surtout à partir de la seconde année. Les femelles peuvent atteindre de tailles et d'âges plus grandes. Les captures sont composées surtout par des individus jeunes (group d'âge 0 à IV).

En ce qui concerne le rendement par recrue on peut observer qu'il augmente lorsque la taille de première capture augmente aussi. Actuellement, l'effort de pêche est le double de celui qu'on a besoin pour obtenir le rendement maximum.

Acknowledgments

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Table 1.- Observed mean length and range for each age group, by sex.

Age group	Females		Males	
	Mean	Range	Mean	Range
I	149.6	115-175	146.0	120-170
II	204.7	165-235	184.3	160-205
III	234.1	210-255	207.9	190-235
IV	260.1	240-295	230.5	210-250
V	275.1	260-305	257.7	230-280
VI	280.4	270-310	266.1	260-270
VII	306.1	285-325	275.0	265-285
VIII	315.6	295-335	295.0	290-300
IX	326.3	310-340	305.0*	285-305
X	330.0	330	315.0	315
XI	340.0*	-	-	-
XII	350.0	350	-	-
XIII	382.5	380-390	-	-
XIV	393.8*	-	-	-
XV	405.0	405	-	-

*Values obtained by interpolation due to the scarcity of data

Table 2.- Values of the maximum yield per recruit (Y') and F_{max} for spotted fluke females and males for different values of "c" and M/K, using polyethylene nets

		FEMALES			
M/K	Mesh	l_c(mm)	c	F_{max}	Y'_{max}
0.75	40 mm	92.4	0.22	0.11	0.091313
"	60 mm	138.6	0.32	0.13	0.100208
1.00	40 mm	92.4	0.22	0.14	0.063596
"	60 mm	138.6	0.32	0.17	0.070936
1.25	40 mm	92.4	0.22	0.17	0.046694
"	60 mm	138.6	0.32	0.21	0.052843

		MALES			
M/K	Mesh	l_c(mm)	c	F_{max}	Y'_{max}
0.75	40 mm	92.4	0.27	0.15	0.095522
"	60 mm	138.6	0.40	0.19	0.108733
1.00	40 mm	92.4	0.27	0.19	0.067079
"	60 mm	138.6	0.40	0.26	0.077874
1.25	40 mm	92.4	0.27	0.23	0.049620
"	60 mm	138.6	0.40	0.35	0.058536
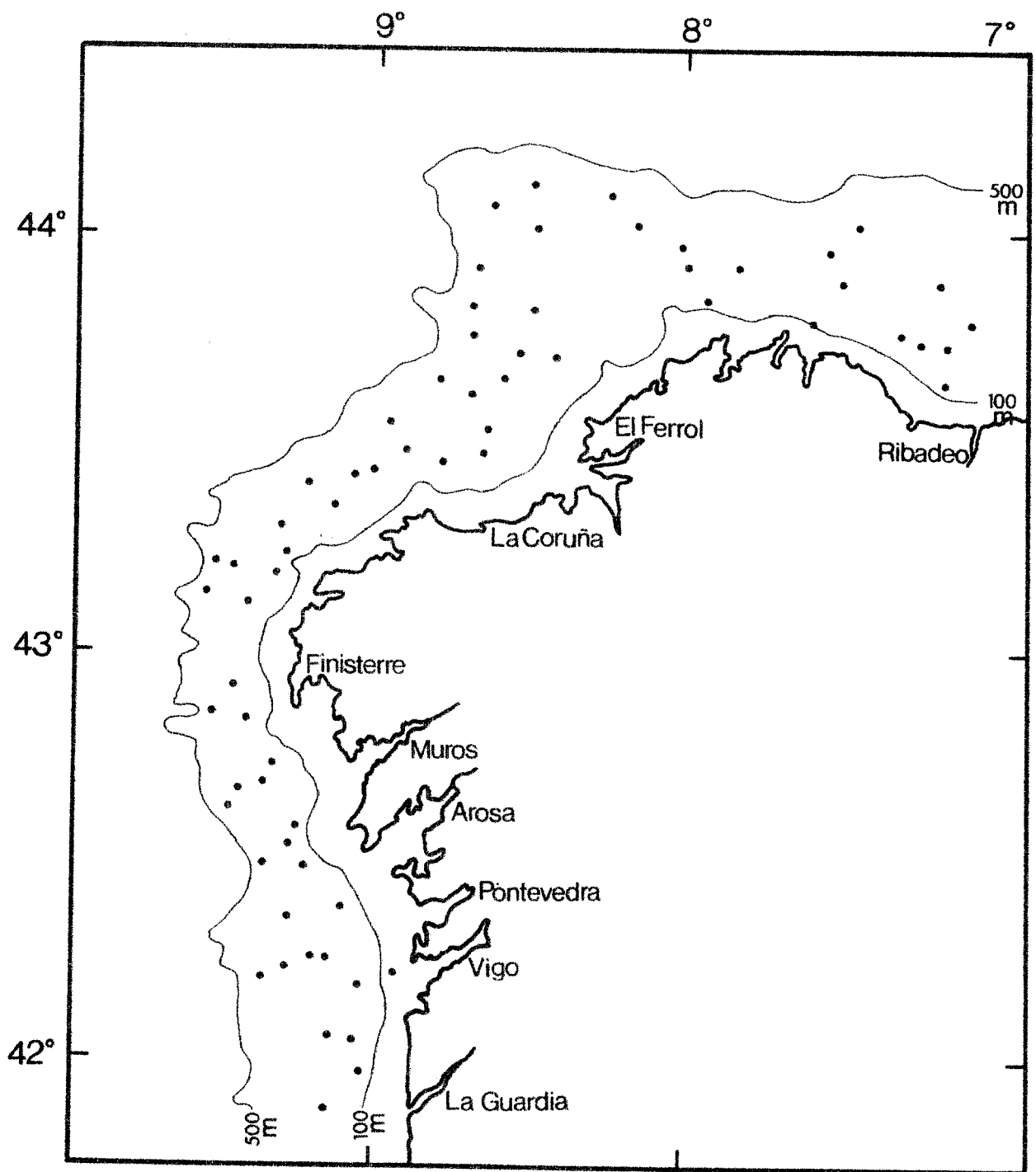
Fig. 1.- Sampling area and positions of trawl hauls.
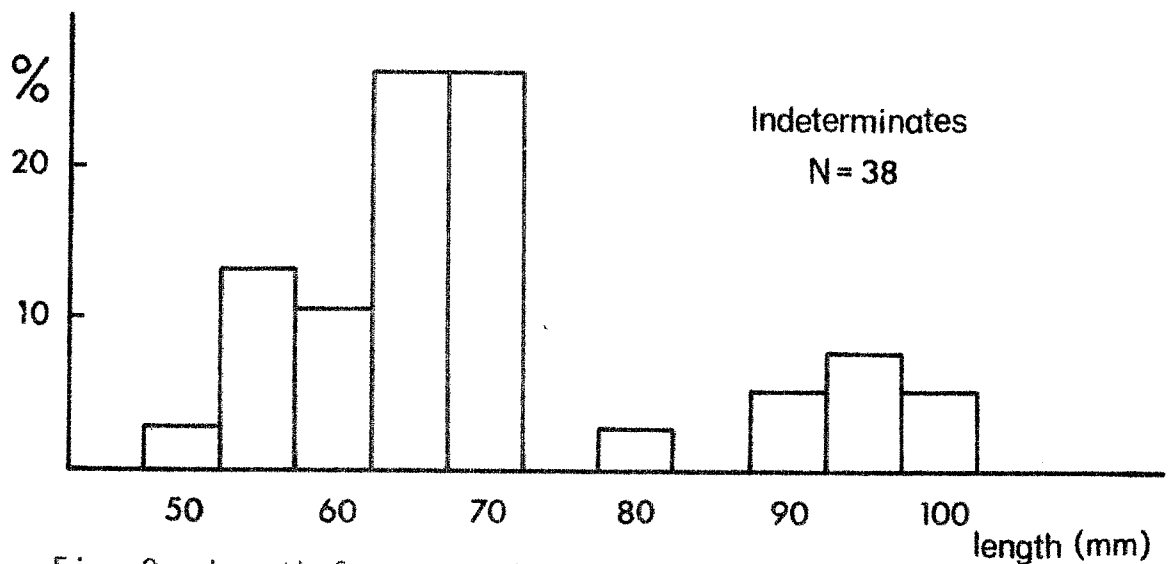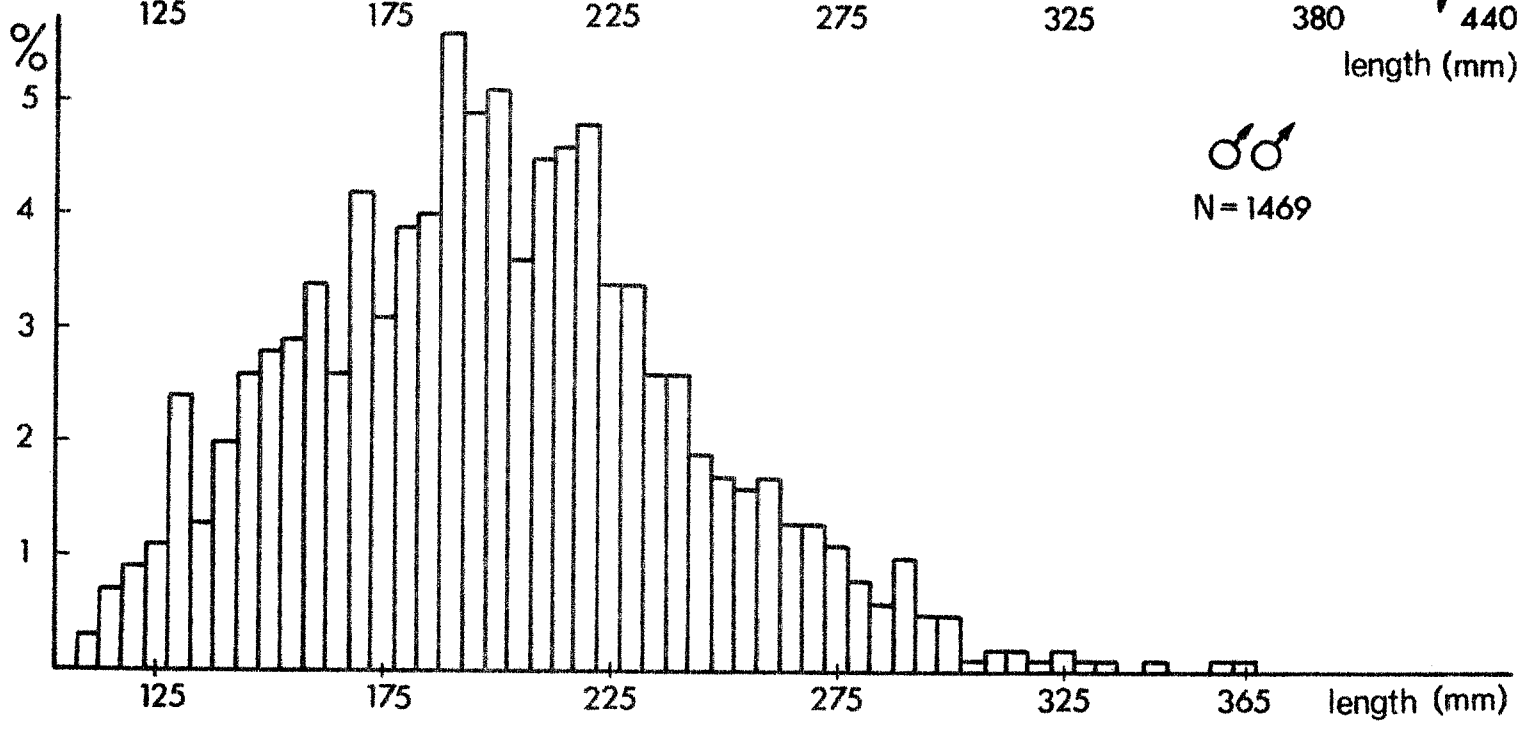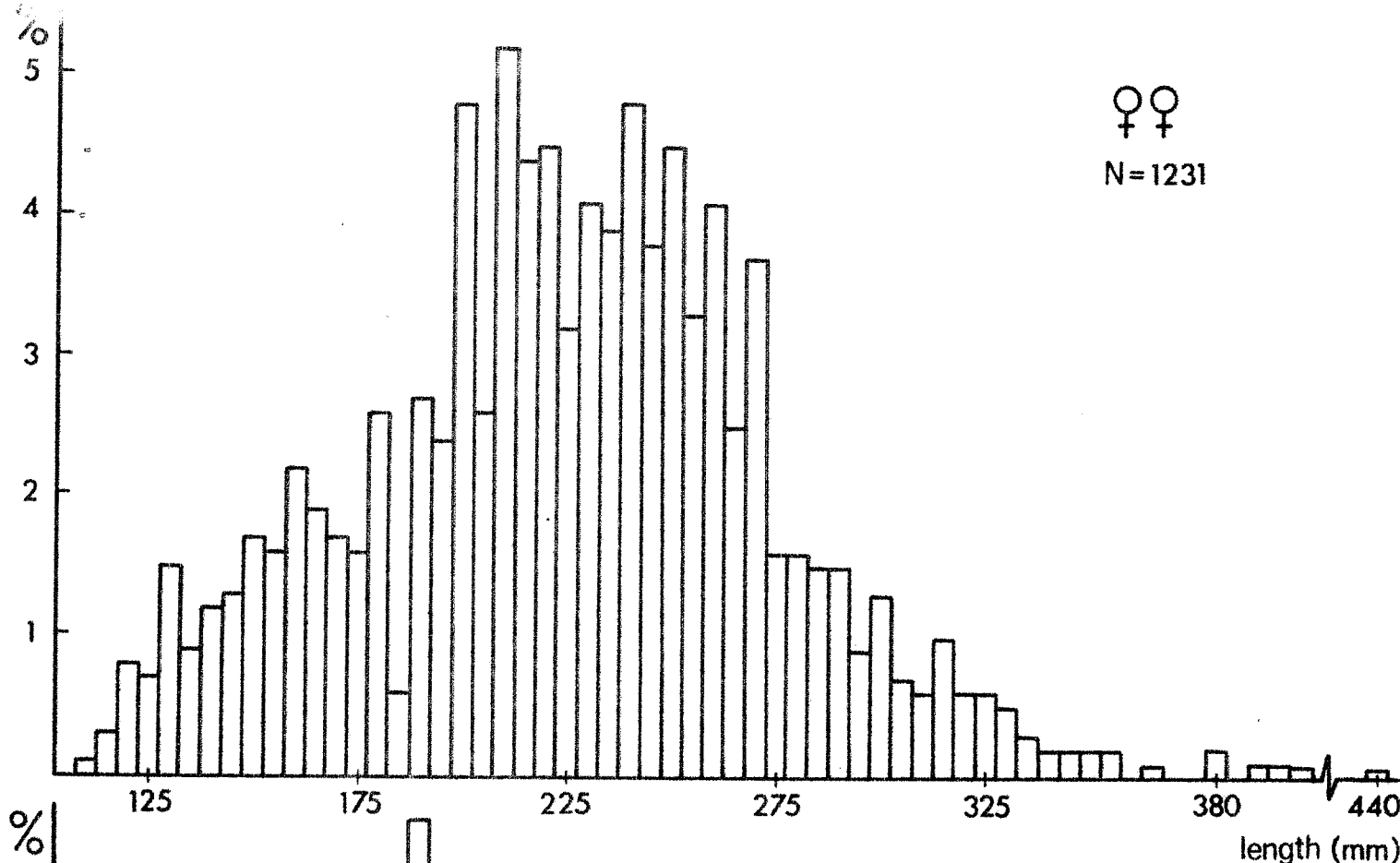
Fig. 2.- Length frequency distributions of spotted fluke (by sex).
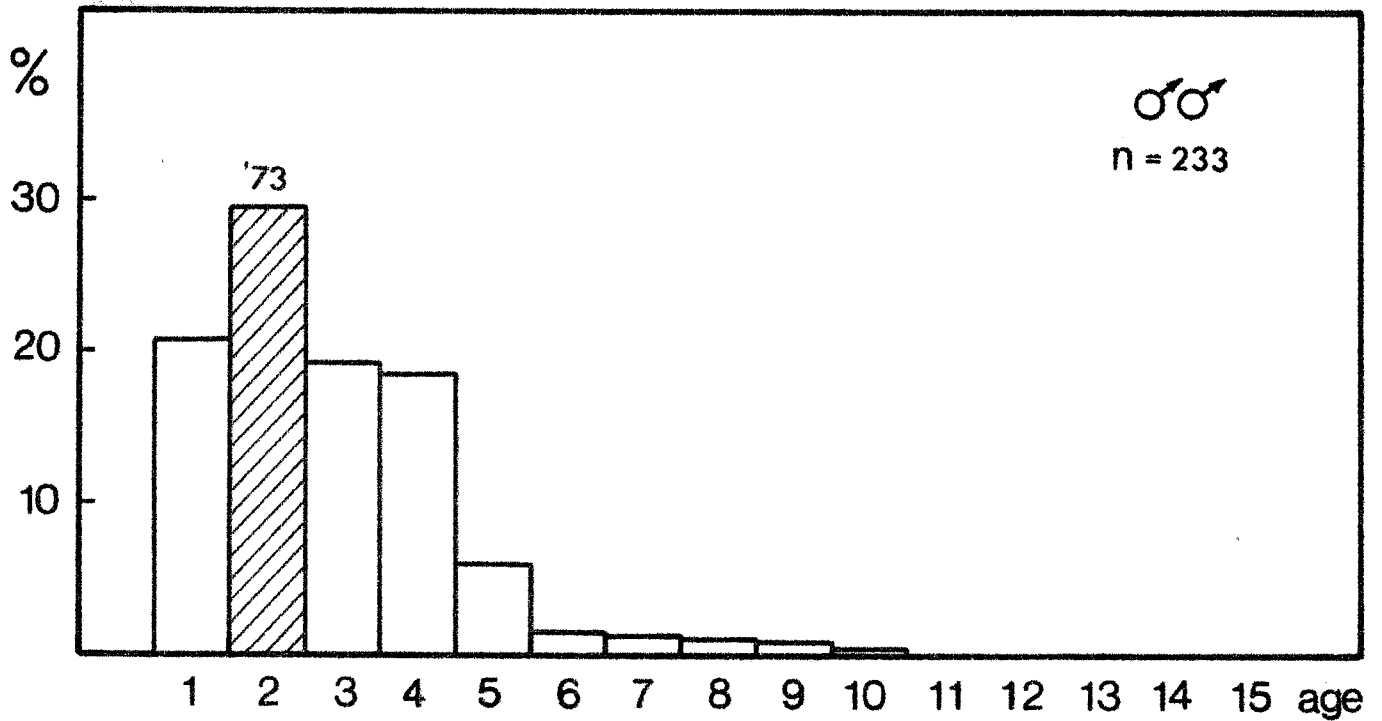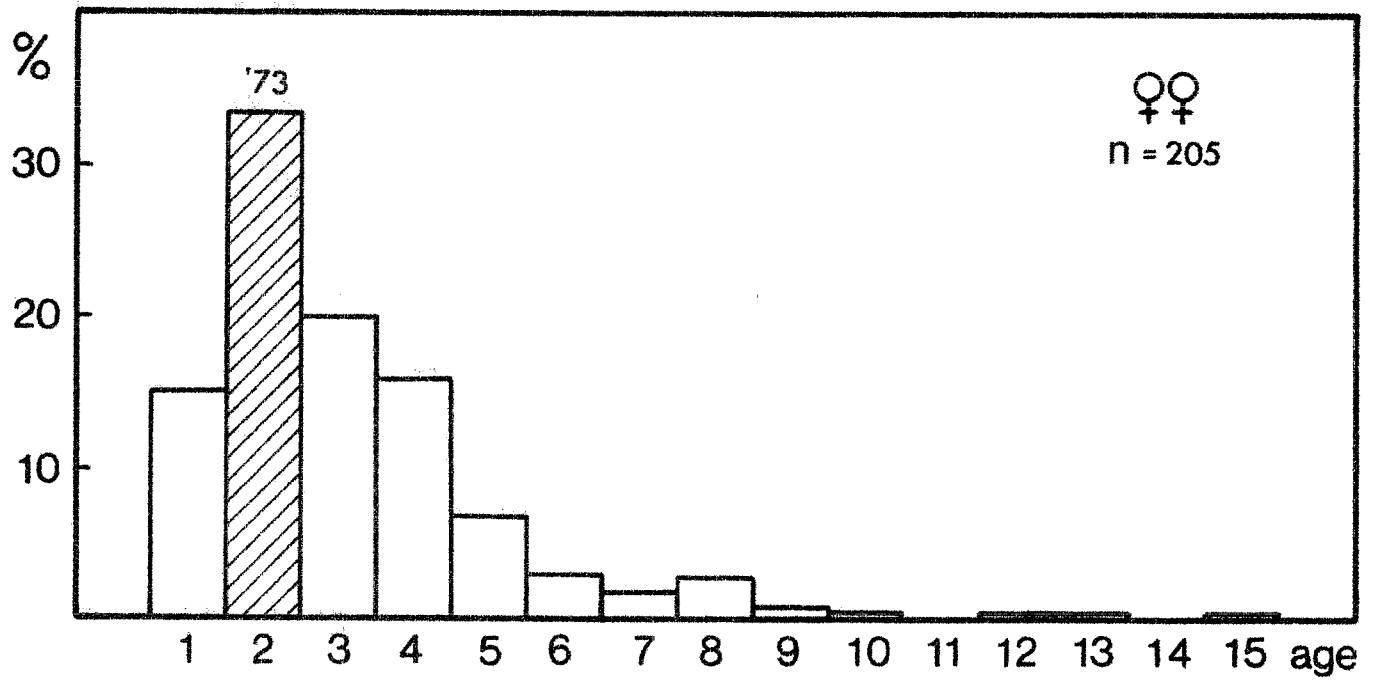(N = number of fish measured).

Fig. 3.– Age composition in the catches, by sex, of spotted fluke. August–September 1975, (n = number of otoliths read).
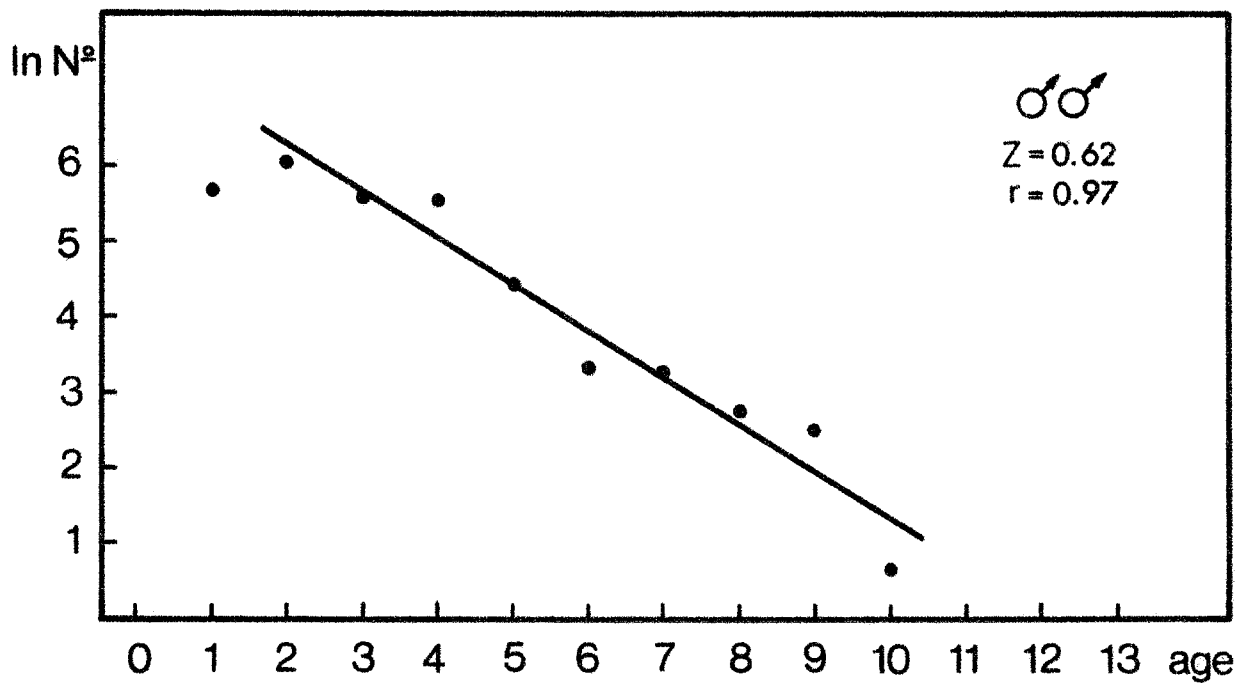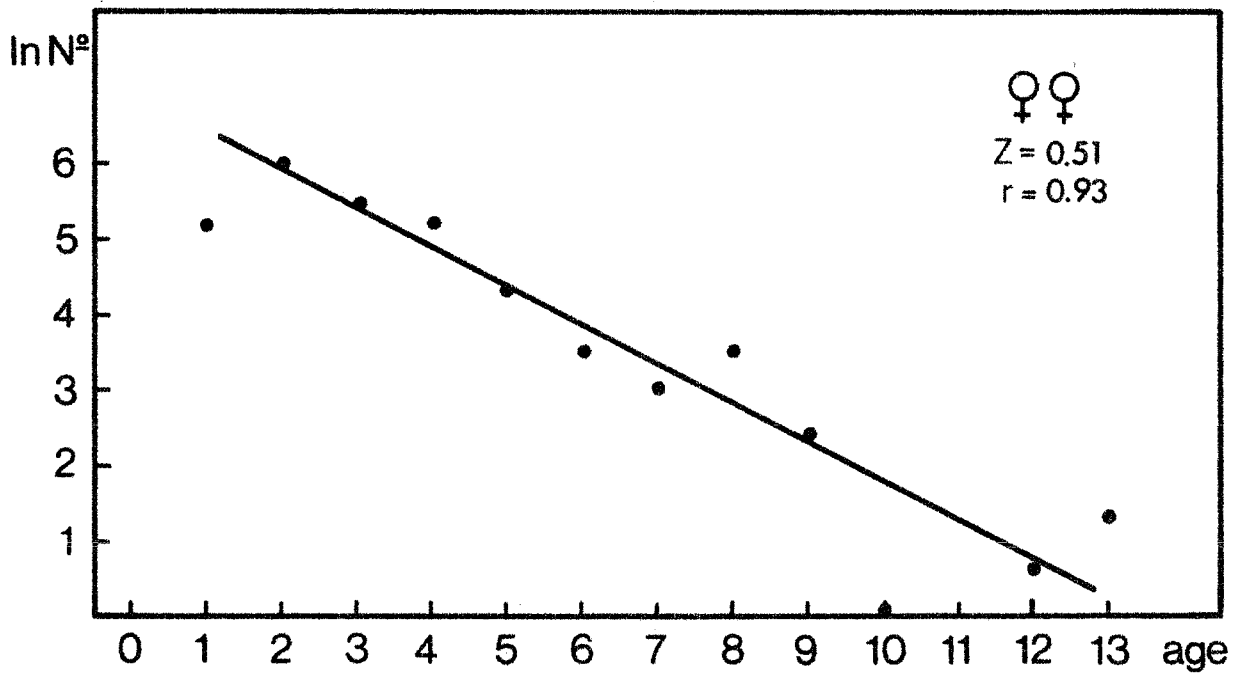
Fig. 4.- Catch curves for female and male spotted fluke.
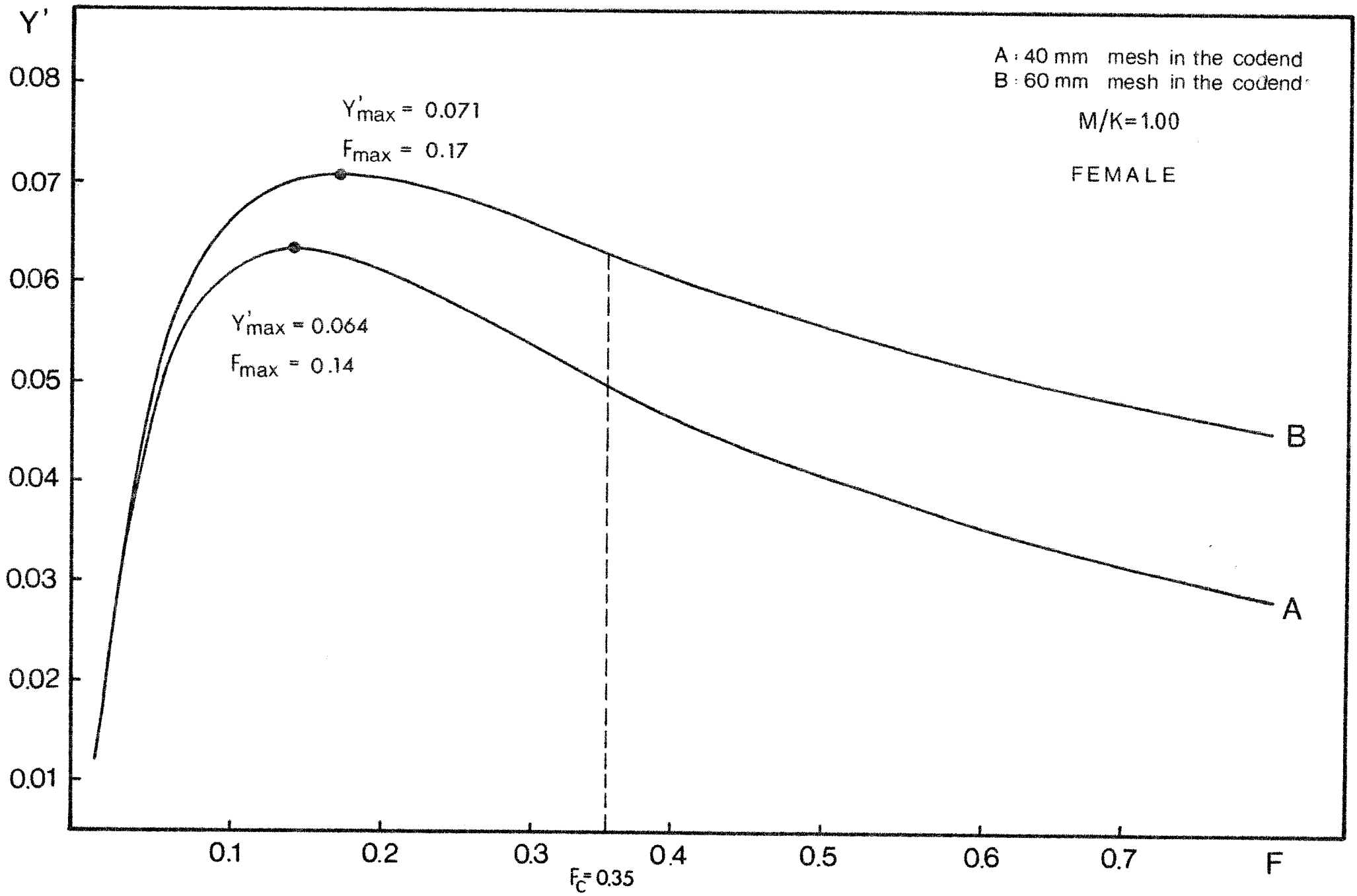August-September 1975.

Fig. 5.- Yield per recruit (Y') curves for female spotted fluke. F_c = present level of fishing mortality in the fishery.
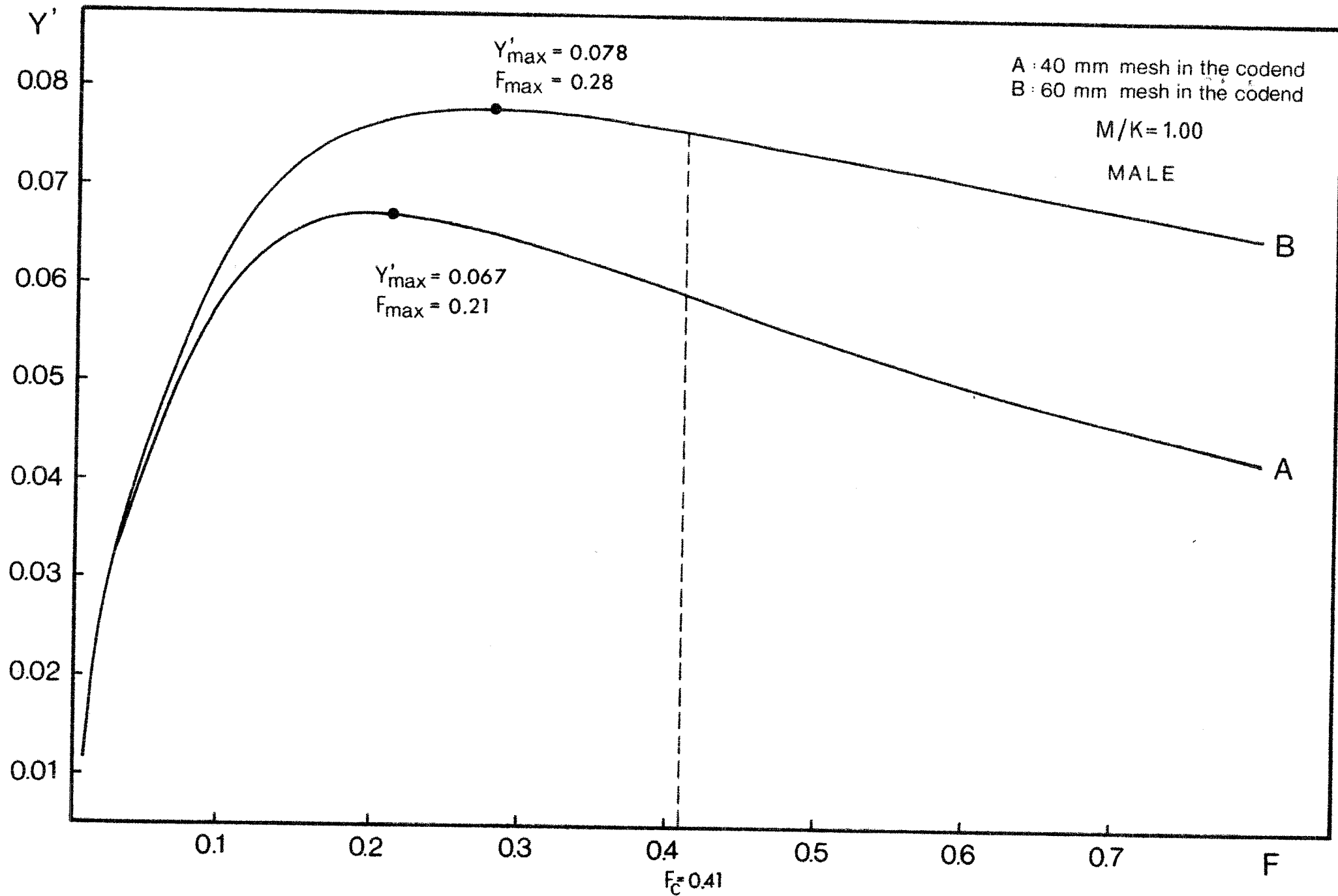
Fig. 6.- Yield per recruit (Y') curves for male spotted fluke. F_c = present level of fishing mortality in the fishery.