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ESTIMATES OF NATURAL MORTALITY FOR THE ICELANDIC STOCK OF SAITHE

by

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ABSTRACT

Using catch and effort data natural mortality (M) for the Icelandic stock of saithe was estimated in three different ways. The M values obtained ranged between 0.29 and 0.34 with an average value 0.32. Studies on effort likely to be directed to saithe showed that the effort in late sixties was 2-3 times higher than in the early fifties.

INTRODUCTION

Little is knownabout natural mortality of saithe. As for some gadoid species the ICES Saithe Working Group (Anon. 1977) has assumed a natural mortality coefficient of M = 0.2 for all saithe stocks. In view of the important role of natural mortality in stock assessment the present study was carried out.

MATERIAL AND METHODS

The basic effort data used in this paper are effort and catch per unit effort figures of the Fed. Rep. of Germany which are available since 1949. These are given as days fished in the statistics. Separated effort data for different fleet categories are available for steam and motor trawlers since 1954 and for stern trawlers since 1967. In order to account for changes in the efficiency and composition of the different fleet categories the effort data have been converted into standard effort units. The basis of the standard effort unit is the fishing day of 1949 steam trawler of the Fed. Rep. of Germany. During the period 1949-1954 the effort estimates are based on Lundbeck's study (1959), but

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since 1954 the effort data have been raised to a) the changes in average size of the steam trawlers, b) the higher demersal catch/day of motor and stern trawlers in comparison to steam trawlers, and c) the numbers of days fished by each fleet category each year.

The total effort on saithe was then estimated by raising the ratio of the effort and saithe catch of the Fed. Rep. of Germany to the total saithe landings.

Catch in numbers used to estimate fishing mortality by VPA differ from those used by the ICES Saithe Working Group (Anon. 1977) in that, they have been recalculated using a constant weight at age relationship during the 1949-1976 period. The VPA carried out in this study also differs from the ICES Saithe Working Group run by adding the 15+ age group and, the input F values for that age group are prior to 1973 on the results of the effort studies.

RESULTS

Trends in effort

Except for the years around 1950 the effort on saithe in Icelandic waters in the fifties has been relatively stable at a level of 30 000 standard units (Fig.1). Due to the overall increase in abundance and catches of saithe in all areas the effort on saithe increased rapidly in the sixties; in Iceland grounds it more than doubled with a peak in 1968 of nearly 70 000 standard units (Table 1). From 1969 to 1973 the effort has fluctuated between 50 000 and 67 000 standard units in a year.

ESTIMATES OF NATURAL MORTALITY

In order to estimate natural mortality of saithe three different approaches were carried out:

1. Numbers caught per days fishing were calculated for the age groups 4-14 from the numbers landed at each age in each year and the fishing effort in the corresponding year. From these data catch curves were plotted for the 1945-1960 year classes

(Fig.2). The slopes of the regressions fitted to $\log_e$ of these data give values for total instantaneous mortality ($\bar{Z}$).

By the method of Paloheimo (1961) these values of $\bar{Z}$ were plotted against the average effective fishing effort (f) for each year class. The intercept of this regression is an estimate of M. The calculated regression is significant ($p<0.05$) with an natural mortality estimate of 0.33 (Fig.3a).

2. Total instantaneous mortality ($\bar{Z}$) for each year class can also been derived from virtual population analysis, because VPA gives estimates of the survival rate (S) and hence Z for each age group by year class (Pinhorn , 1975). Z estimates by VPA (M=0,3) of the age groups 4-13 years for the 1945-1960 year classes were then plotted against average effective effort for the corresponding year class. This regression was highly significant ($P<0.001$). The estimated value of M=0.34.

3. The third method used to estimate M is also based on virtual population analysis. If the intercept of the regressions of fishing mortality (F) in each year calculated by VPA on the fishing effort (f) in the same year passes through the origin, it can be assumed that the M value chosen in VPA correspond to the true value of M. Hence any deviation of the intercept can be used as a measure of the validity of the assumed value of M.

   Two VPA runs were made using different values of M. Average fishing mortalities ($\bar{F}$) for the age groups 4-13 each year were then plotted against fishing effort in the same years (1949-1973). Assuming M=0.2 in the VPA (Fig.4a) an intercept of 0.09 was obtained. Annother approach assuming M=0.3 (Fig.4b) produced an intercept of 0.02. The first case indicates a natural mortality estimate of M=0.29 the second one a M value of 0.32. In both cases the relationship between estimated $\bar{F}$ and fishing effort was significant at the 0.1% level.

DISCUSSION AND CONCLUSIONS

Although the proportion of the effort of the Fed.Rep. of Germany directed towards saithe only, were not known the saithe catch of the Fed.Rep. of Germany per unit effort is the best available data to estimate the effort on saithe in Icelandic waters. This is due to the fact that of all nations fishing for saithe at Iceland, Fed.Rep. of Germany had the highest proportion in the total landings up to 1964 and in later years, when its share in total saithe catches decreased somewhat, the trends in the effort of Fed.Rep. of Germany have been more directed to saithe.

The estimated total effort on saithe seems to be reliable; there is a good agreement between average fishing mortality estimated by virtual population analysis and the fishing effort estimates.

Natural mortality coefficients (M) estimated in the present study ranged from 0.29 to 0.34 with an average value of 0.32. By comparing the low range estimated M values it must be kept in mind that the various approaches are not independent - these are only different treatment of the same basic catch and effort data.

One of the factors which do influence the true value of M is migration. It is well known that saithe is a very migratory species. Results of tagging experiments (Olsen 1959, 1961, Jones and Jonsson 1971) and of age composition data (Schmidt 1958, Reinsch 1969) show that there has been both an immigration to Iceland grounds from Norwegian and Faroese waters and an emigration from Iceland to other areas. By immigration the true value of M will be underestimated and vice versa. In such cases where both immi - and emigration have taken place it can be assumed that in a wide range of time, such factor will be more or less compensated and the estimated average value of M is not far away from true M value.

The results of the tagging experiments carried out in Icelandic waters in 1964 and 1965 (Jones and Jonsson 1971) can give some information on the validity of the present M findings. In their study Jones and Jonsson estimated a coefficient of other losses

than fishing mortality (X) of 0.44. This coefficient includes in addition to natural mortality factors like emigration, tag shedding and additional mortality of tagged fish. Jones and Jonsson pointed out that these additional mortality factors have been minimal during the experiments and suggested a natural mortality coefficient for the Icelandic saithe of 0.3.

REFERENCES:

Anon., 1977. Report of the Saithe Working Group. ICES C.M. 1977/ F:3, (mimeo).

Jones, B. and Jonsson, J., 1971. Coalfish tagging experiments at Iceland. Rit Fiskideildar. 5, No. 1: 1-27

Lundbeck, J., 1959. Biologisch-statistische Untersuchungen über die Deutsche Hochseefischerei. IV. Die Entwicklung der Hochseefischerei in fangtechnischer, räumlicher und biologischer Hinsicht. 4. Leistungsfähigkeit und Fangerträge der deutschen Fischdampferflotte 1885-1955. Ber.dt.Wiss.Komm.Meeresforsch. 15: 159-237

Olsen, S., 1959. Migrations of coalfish (Gadus virens L.) from Norway to Faroe Islands and Iceland. ICES C.M. 1959. Gadoid Fish Committee, Doc.No. 12, (mimeo).

Olsen, S., 1961. An account of Norwegian coalfish investigations with special reference to tagging experiments. ICES C.M. 1961. Gadoid Fish Committee, Doc.No. 125, (mimeo).

Paloheimo, J.E., 1961. Studies on estimation of mortalities. I. comparison of a method described by Beverton and Holt and a new linear formula. J. Fish Res. Bd. Canada, 18: 645-662.

Pinhorn, A.T., 1975. Estimates of natural mortality for the cod stock complex in ICNAF Divisions 2J, 3K and 3L. Res.Bull.int.Comm.Northw.Atlant.Fish.,No. 11: 31-36.

Reinsch, H.H., 1969. Die deutsche Dampferfischerei auf Köhler Pollachius virens (L.). 1964-1969 im Nordatlantik . Ber.dt.Wiss.Komm.Meeresforsch. 22: 184-210.

Schmidt, U., 1958. Die deutschen Köhleranlandungen 1946/47-1956/57 aus norwegischen und isländischen Gewässern und ihre Abhängigkeit vom Fischbestand. Ber.dt.Wiss.Komm.Meeresforsch. 15: 145-158.

Table 1: Estimated effort on saithe in Icelandic waters (standard units)

Year	Fed.Rep. Germany	Iceland	Others	Total
1949	7062	12112	4008	23182
1950	10999	4798	4205	20002
1951	10377	4385	3036	17798
1952	12707	9140	3561	25408
1953	15712	14252	7289	37253
1954	16975	7747	8112	32834
1955	14190	7634	7868	29692
1956	12126	9931	4635	26692
1957	12495	8270	6246	27011
1958	14695	8967	8214	31876
195	12858	8271	5661	26790
1960	13937	7560	7142	28639
1961	11800	7261	7927	26988
1962	11972	6715	6495	25182
1963	12890	10795	11754	35439
1964	14269	14630	11900	40799
1965	16229	24153	18070	58452
1966	15790	19294	12938	48022
1967	15854	19141	15443	50438
1968	15372	33736	20603	69712
1969	15703	24409	12650	52762
1970	15596	35831	14105	65532
1971	19224	28428	16945	64597
1972	18750	36353	12395	67498
1973	18111	26459	7506	52076

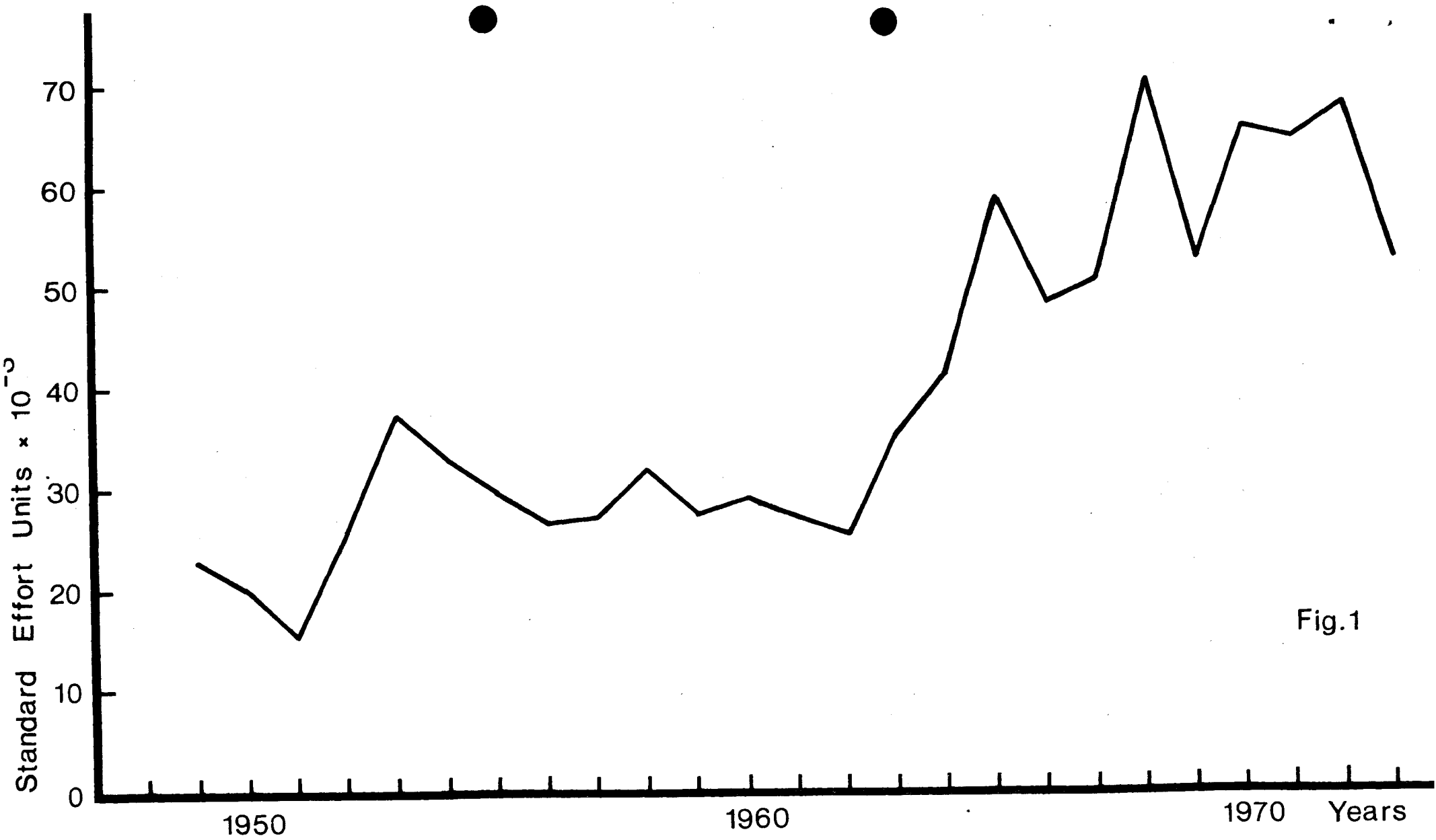

Fig. 1. Estimated total effort on saithe in Icelandic waters during the period 1949-1973.

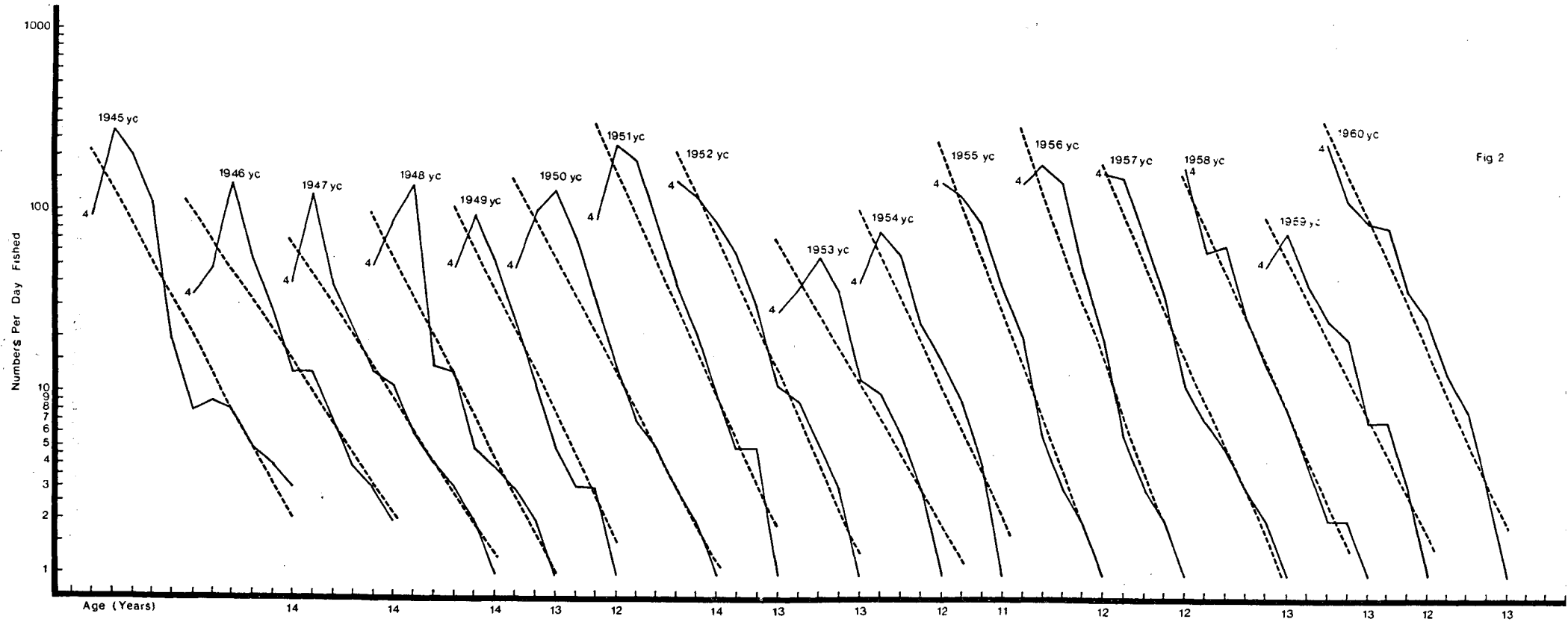

Fig. 2. Catch curves of the age groups 4-14 of Icelandic saithe for the 1945-1960 year classes. Broken lines show the calculated regressions.

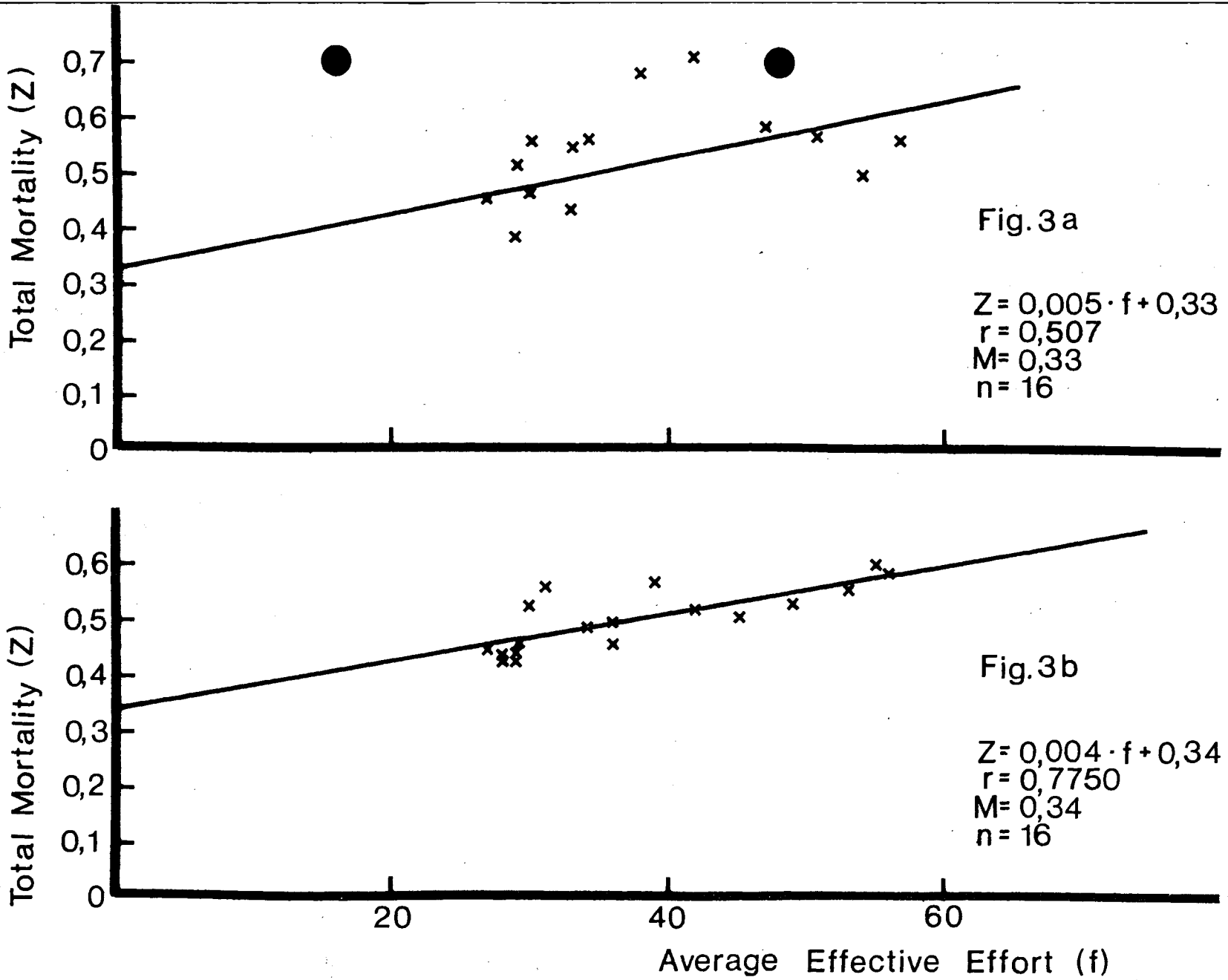

Fig. 3. a) Regressions of $\bar{Z}$ from the year class catch curves on the average effective fishing effort (f).

b) Regressions of $\bar{Z}$ of the age groups 4-13 from VPA on the average effective fishing effort (f).

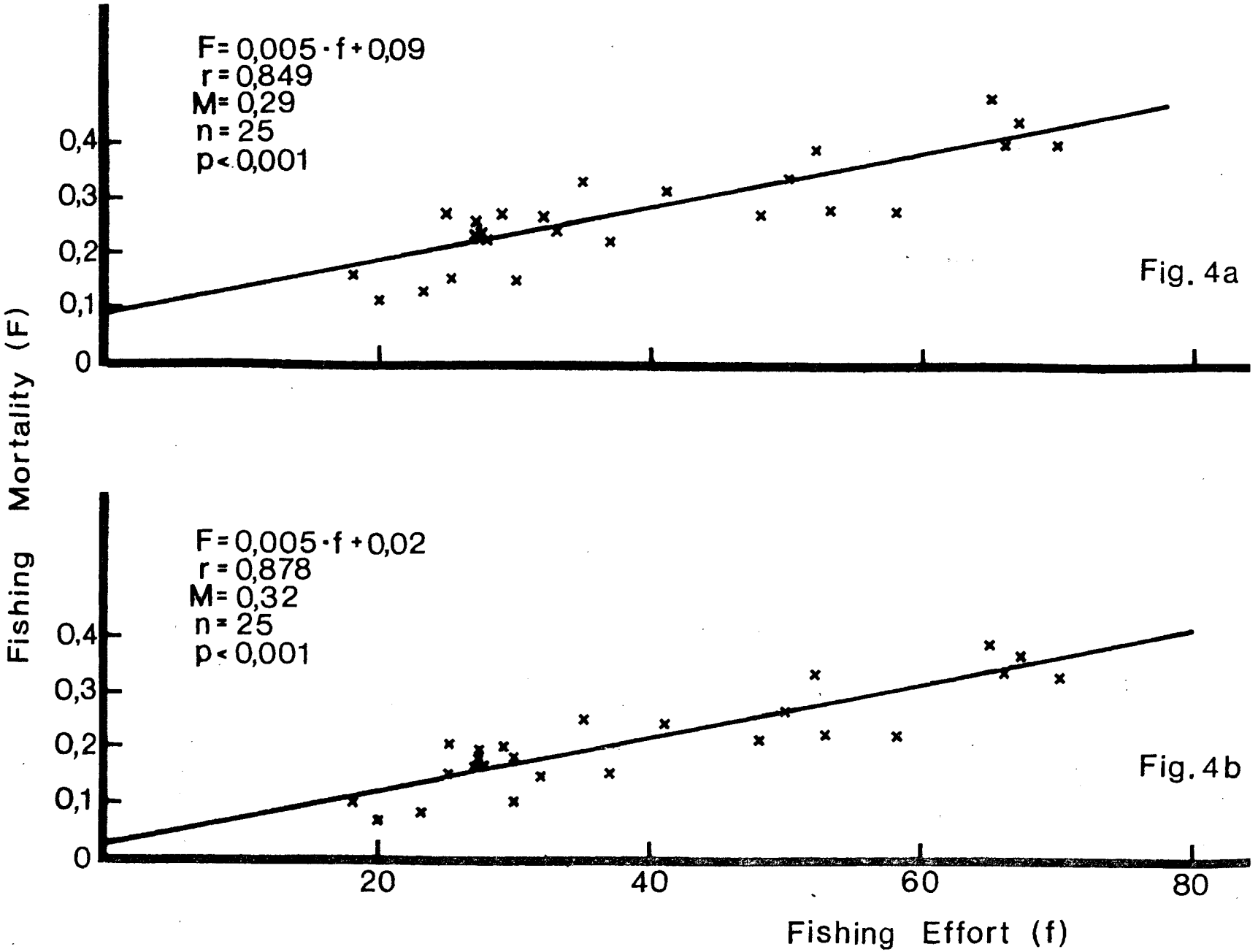

Fig. 4. Regressions of $\bar{F}$ of the age groups 4-13 from VPA on fishing effort (f). a) $M_{VPA} = 0.2$. b) $M_{VPA} = 0.3$.