ERRATA SHEET

"On fecundity of North Sea Mackerel (<u>Scomber scombrus</u>)".C.M.1980/H:47

Page 5, line 10 "... ratio of variance ($^{r}2/r_1$)" should be corrected to "... ratio of standard deviations ($^{s}2/s_1$)"

line 11 Delete "... and the correspondent number of fish as four, at 90% and 80% levels.

Table 1, line 11 "var.within S^2_2,L 10417.451..." should be corrected to "var.between $S^2_{2,}$L ....."

Table 2, last line "eleratums" should be corrected to "elevations"

This paper not to be cited without prior reference to the author

International Council for
the Exploration of the Sea

C.M.1980/H:47

ON FECUNDITY OF NORTH SEA MACKEREL (*Scomber scombrus*)

by

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ABSTRACT

This paper presents a preliminary analysis of the fecundity-length relationship of the North Sea mackerel. The relationship was compared to that of the Western mackerel stock (LOCKWOOD, 1978) by an analysis of covariance between the regression lines.

Further analysis is necessary before any decisive conclusion can be drawn. The results, however, seem to demonstrate a lower fecundity in the North Sea mackerel (140 000 - 360 000 eggs) as compared to the Western mackerel (400 000 - 990 000 eggs) at the same range of length.

A comparison of regression lines of fecundity-length for the North Sea and the Western area shows a significant difference between the two lines.

SOMMAIRE

Dans ce travail sont présentés les résultats d'une analyse préliminaire sur la relation fecondité/longueur du maquereau du Mer du Nord.

Cette relation a été comparée avec celle deja connue pour le maquereau de la zone Ouest (LOCKWOOD, 1978) en utilisant une analyse de covariance.

Les données ne sont pas suffisament detaillés, alors, les resultats doivent être considerés avec réserve. Malgré tout, ils nous montrent qu'il y a une fecondité inférior pour le maquereau du Mer du Nord que pour le maquereau de la zone Ouest, dans le même groupe de longueur. La comparaison entre les deux regression linéaires montrent une différence statistiquement significative.

INTRODUCTION

Since 1968, an annual Norwegian mackerel egg survey has been carried out in the North Sea in order to delineate the spawning area, estimate egg abundance, indices and possibly also estimate the size of the spawning stock (IVERSEN, 1973, 1977). For the latter purposes fecundity data on the North Sea mackerel is needed.

The fecundity of mackerel spawning to the west of the British Isles has been reported (MACER 1976, LOCKWOOD 1978), but it was found necessary to determine if these data could be applied to the North Sea mackerel. Samples of mackerel in a pre spawning stage in the vicinity of the spawning area in the North Sea were collected and the results of the egg counts are presented here.

The data available were scarce and the paper must be considered as a first attempt to estimate the fecundity-length relationship of this stock.

The fecundity-length relationship estimated for the North Sea mackerel was compared with the same relationship for the Western mackerel. The relationship for the Western mackerel is presented in LOCKWOOD (1978) and he has kindly provided the corresponding data.

MATERIAL AND METHODS

The fecundity is defined as the number of eggs a female mackerel spawns within one spawning season.

During May and early June 1979 and 1980 ovaries in the maturity stage IV were collected from mackerel caught in the coastal area about 10-30 miles south-west of Bergen. The mackerel from this location was selected as they were considered to spawn in the North Sea. Maturity stage IV means that the ovary is in a prespawning condition. The ova are still opaque, it is the last stage of development before some of the ova become transparent.

The gonads were preserved in 4% formalin solution and transferred to Gilson's fluid after a few days. Since the mackerel is a serial spawner, the eggs are in different development stages in the ovaries. Earlier experiments demonstrated that the smallest ova were ruptured if they were placed directly in Gilson's fluid. The jars were shaken until most of the connective tissue was broken down and the eggs appeared to be free. The eggs were then removed from Gilson's fluid.

A method of subsampling by area was applied: three small jars with known opening area were placed on the bottom of a large jar with known area. Water was added covering the small jars. The eggs were placed in another jar with water and agitated by stirring. This mixture was poured quickly into the first jar. After sedimentation of the eggs, each subsample of the small jars was counted.

The limit size of the diamter of the ova that will be spawned the actual season, was defined as 0.13 mm, assuming that those less than 0.13 mm will be resorbed. This is the same size limit as MACER (1976) histologically found for ova from mackerel in the Western area.

Since the preparing of the ovaries, subsampling and counting of eggs is very time consuming, only 15 ovaries are analysed for this presentation. The length group available ovaries ranged from 36.5 cm to 45 cm. It was planned to use the ovaries from two fish and in each three subsamples were counted to carry out an analysis of variance.

Each length group is considered as a population, which is divided into primary units (ovaries) and these units into elements (subsamples). As the units and elements were selected by simple random sampling, the theory of two stage sampling was used on variance estimates (COCHRAN, 1963, page 275).
The choice of an optimal number of subsamples and correspondant numder of samples which will give an acceptable level of precision, was also carried out (COCHRAN, 1963, page 279).
The slope of the regression line of the fecundity-length relationship was tested whether it is different from zero.
A comparison of logaritmical regression lines from the two areas was also carried out considering the correspondant range of length groups (SNEDECOR and COCHRAN, 1971)

RESULTS

Fecundity-length relationship

The 15 ovaries which were counted gave a fecundity ranging from 140 000 - 360 000 eggs (Figure 1, Table 2) for mackerel in the length groups 36.5 - 45 cm.

The sets of data are few and the correlation coefficient is poor, so this relationship must be considered as a first approximation and to improve the results more data will be necessary.

The fecundity-length relationship was obtained as,

$$\text{Fecundity} = 11543.59\ l - 259474.87$$

with $r = 0.512$

Analysis of variance

The analysis of variance demonstrates that variance within sampled fish is 23% of the variance between fish at the same length (Table 1). This indicates that more ovaries rather than more subsamples from each ovary should be analysed.

If the relationship between the cost of getting the subsamples is three times the cost of getting one sample with the estimated ratio of variance (r_2/r_1) equal to 0.48, the optimal number of subsamples is obtained as one and the correspondant number of fish as four, at 90% and 80% levels.

Comparison between regression lines

The test of the null hypotheses, slope (b)=0, was applied to North Sea area regression line, and the hypotheses were rejected with $t = 1.621$ ($t_{0.05} = 2.306$).

Fig.2 and Table 2 present the analysis of covariance between the North Sea area and Western area logaritmical regression lines, for the length range 36.5 - 45 cm.

First the residual variance were compared, then the slopes and lastly the elevations:

a) Comparison between residual variances

$F = 0.035/0.078 = 0.449$ (d.f.10.8)

This indicates different residual variances at $F_{0.05}$ level.

b) Comparison between slopes

$F = 0.032/0.054 = 0.593$ (d.f.1.18)

This indiates different slopes between the regression lines. The comparison between interceptions confirmed the results with a highly significant value.

DISCUSSION

As outlined above, a limited number of ovaries have so far been examined. It is necessary to extend the analyses before any decisive conclusion can be drawn. However, the preliminary results presented indicate that the fecundity of the North Sea mackerel is lower than that of the Western mackerel. According to the analysis of co-variance the logaritmical regression lines for the two areas cannot be combined and regarded as one.

The first analyses were carried out on three subsamples of each ovary. An analysis of variance indicates that the variance within subsamples from each ovary is 23% of the variance between ovaries. Therefore, the number of subsamples from each ovary were reduced, and for further analyses the number of fish analysed within each length group should be increased. The difference between the observed fecundity in the North Sea and the Western area should be further investigated since different methods of subsampling have been used. There are indications that the method of subsampling may influence the results. The limit size of the eggs which are not spawned is also critical for the results. In this investigation the same size limit as found for the Western mackerel was applied.

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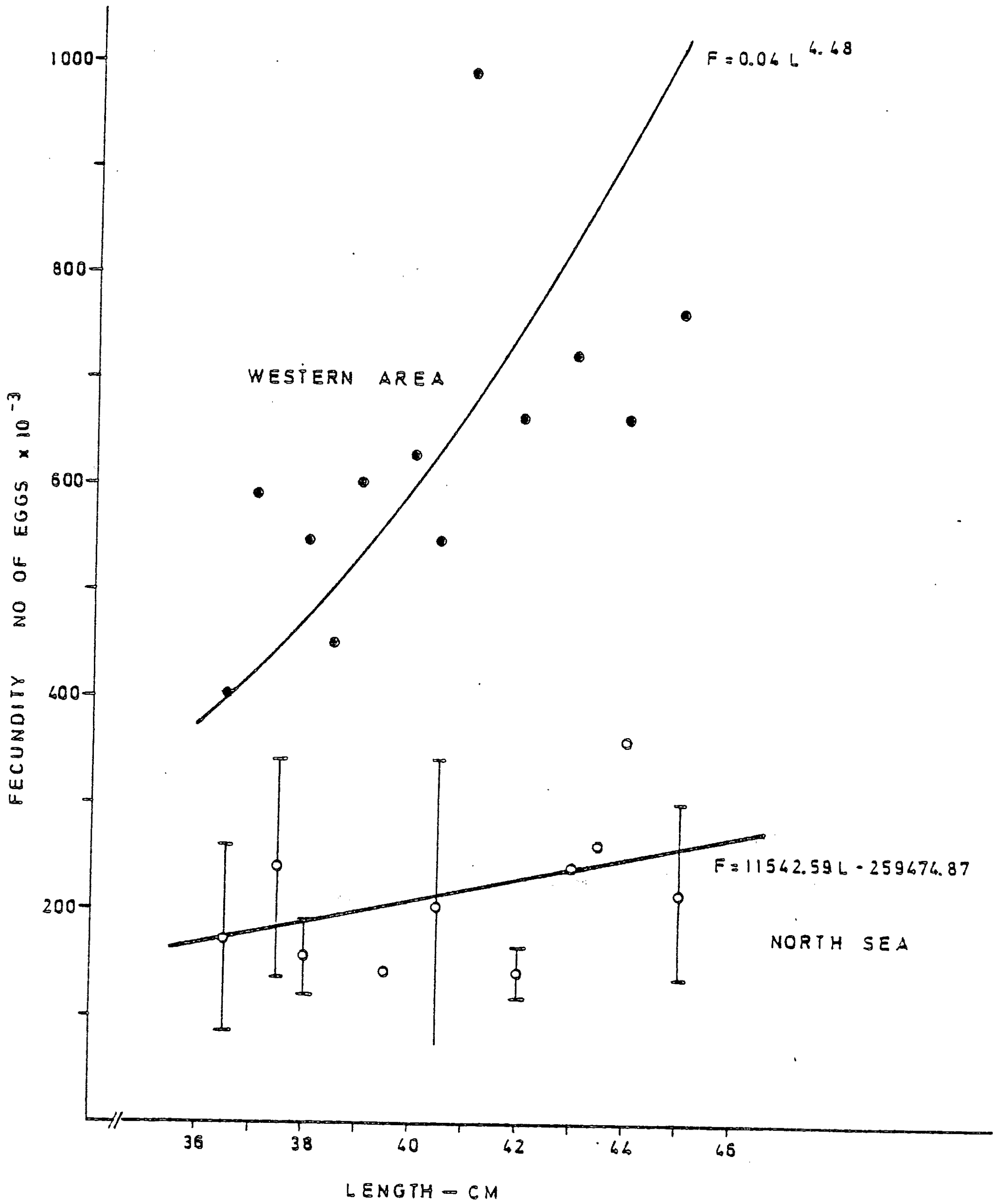

Fig. 1. Fecundity by length of North Sea and Western mackerel, 95% confidence limits are indicated as vertical lines.

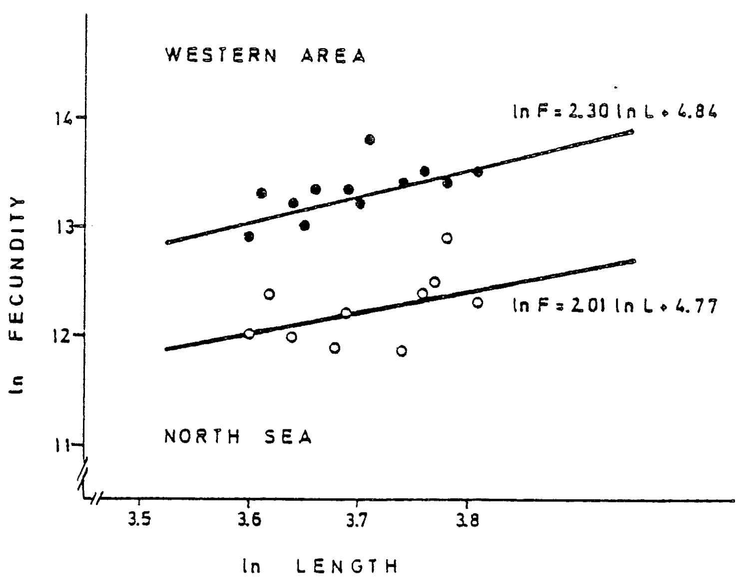

Fig. 2. The logaritmical regression lines for fecundity by length of North Sea and Western mackerel.

Table 1 Analysis of variance of the fecundity estimates of North Sea mackerel.

Y_i	L / Y_{ij}	36.5	37.5	38.0	40.0	42.0	45.0
	$Y_{1,1}$	257.594	302.393	165.299	375.968	176.171	284.981
1	$Y_{1,2}$	271.492	339.099	211.569	192.930	147.886	339.181
	$Y_{1,3}$	203.067	330.270	150.584	344.331	122.625	173.147
	$Y_{2,1}$	109.872	201.432	145.270	85.372	143.635	180.586
	$Y_{2,2}$	105.948	132.517	115.513	127.203	112.161	161.620
	$Y_{2,3}$	83.303	125.241	150.911	98.264	138.893	152.954

L / s^2	36.5	37.5	38.0	40.0	42.0	45.0
var within $s^2_{2,L}$	756.870	1067.475	687.244	4989.103	502.753	3684.176
var.within s^2_{2},L	10417.451	14596.228	744.556	19959.421	150.182	5071.956
$s^2_{2,L}/s^2_{1,L}$	0.073	0.073	0.923	0.250	3.348	0.726
pooled W s^2_2	1 947.937					
pooled b s^2_1	8 489.966					

Unit = F x 10^{-3}

Table 2. Analysis of co-variance between the logaritmical regression line of North Sea mackerel and the logaritmical regression line of Western mackerel for the length range 36.5 - 45 cm.

North Sea Area		Western Area	
Length L	N. of eggs F	Length L	N. of eggs F
36.5	171 880	36.5	406 700
37.5	238 492	37.0	590 444
38.0	156 524	38.0	545 525
39.5[1)]	139 057	38.5	450 000
40.0	204 512	39.0	600 250
42.0	140 229	40.0	626 941
43.0[1)]	241 163	40.5	541 300
43.5[1)]	257 758	41.0	989 600
44.0[2)]	361 144	42.0	662 867
45.0	215 412	43.0	721 933
		44.0	662 500
		45.0	758 000

1) 1 fish (1 subsample)
2) 1 fish (3 subsamples)

	d.f.	Σx^2	Σxy	Σy^2	Reg. coef.	Deviations from regress. d.f.	S.S.	M.S.
Within (W)								
Western Area	11	0.049	0.014	0.608	2.33	10	0.346	0.035
North Sea Area	9	0.048	0.098	0.823	2.04	8	0.625	0.078
						18	0.971	0.054
Pooled (W)	20	0.097	0.212	1.431	2.01	19	0.968	0.051
Difference between slopes						1	0.032	0.032
Between (B)	1	0.003	-0.072	6.622				
W + B	21	0.100	0.140	8.060		20	7.863	
Between adjusted means						1	6.895	6.895

Comparison of residual variances: F = 0.035/0.078 = 0.449 (d.f. 10,8)
Comparison of slopes: F = 0.032/0.054 = 0.593 (d.f. 1,18)
Comparison of eleratums: F = 6.895/0.051 = 131.196 (d.f. 1,19)