INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

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THE TOTAL FECUNDITY ESTIMATE OF WESTERN HORSE MACKEREL (*Trachurus trachurus L.*) IN 1992

by

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Abstract

In 1992 the western mackerel / horse mackerel egg surveys were carried out for the estimation of spawning stock biomass. A study was carried out on the total fecundity of horse mackerel, which is required for the conversion of total egg production to spawning biomass. In late April in 1992 RV "Scotia" collected 60 horse mackerel ovaries of which only 31 ovaries could be used for the analysis. In these investigations the potential total fecundity of western horse mackerel was estimated by the histometric method at 1,454 eggs per gramme pre-spawning female with a stand error of 70.03. The fish collected in 1992 for the total fecundity estimate were rather small (length range 24 - 32 cm), while the fish collected in 1987 and 1988 were rather large (length range 29 - 42 cm). A total fecundity estimate, which is covering the whole length range, can be obtained by combining the fecundity estimates of the ovaries collected in 1987, 1988 and 1992. This results in an estimate of 1,589 eggs per gramme pre-spawning female horse mackerel with a standard error of 52.70.

Introduction

In 1992 a mackerel / horse mackerel egg survey was carried out in the western area for the application of the annual egg production method (AEPM) and the new daily egg production method (DEPM) (Anon., 1993). For comparison of both methods a total fecundity estimate was required for the conversion of the total egg production over the entire spawning season to the spawning stock biomass as being part of the AEPM. For this purpose the Netherlands Institute for Fisheries Research carried out a research on the total fecundity of the western horse mackerel (*Trachurus trachurus* L.).

The spawning of western horse mackerel occurs between April and July over an area close to the edge of the continental shelf between the southern Bay of Biscay and the west of Ireland. Every third year the total egg production of western mackerel and western horse mackerel is estimated by egg surveys for estimating the spawning stock biomass of both species (Anon., 1993). The western egg surveys in 1977, 1980, 1983 and 1986 were originally intended to sample mackerel eggs, but the results showed that both the timing and the extend of the surveys made them suitable for estimating total horse mackerel egg production (Anon., 1988).

The total fecundity of western horse mackerel was estimated by Nazarov (1977), which has been used for the calculation of the spawning stock biomasses of horse mackerel from the total horse mackerel egg productions of the western egg surveys in 1980, 1983 and 1986 (Anon., 1987: Table 8.1). A more up to date fecundity estimate became available in 1989 based on ovaries collected in 1987 and 1988 (Eltink and Vingerhoed, 1989). This new study on the total fecundity was carried out to convert the total western horse mackerel egg production in 1992 to a the spawning stock biomass.

Material and Methods

Sixty horse mackerel ovaries were collected in ICES rectangles 25E0 (the majority), 26D9, 28D9 and 31D8 by RV "Scotia" in late April 1992. The histometric method is extensively described in Emerson *et al.*, (1990). The ovaries were put in 4% buffered formaldehyde and at the Netherlands Institute for Fisheries Research these were transferred into 50% alcohol. The relative volume of the ovaries was measured using a displacement technique (Scherle, 1970). Transverse slices were taken from the middle of the ovary. These were dehydrated in ethanol, embedded in resin and cut in 3 µm thick sections, which were stained with Harris haematoxylin and eosin. From each section 10 fields were randomly selected and photographed at a 25x magnification. The resulting slides were projected at a 10.5x magnification onto a screen of a microfilm viewer and a Weibel M168 multipurpose grid (d = 0.0091 cm) superimposed on the image (final magnification 141x). A point and intersection count of all vitellogenic oocytes was carried out on each photographed field. The number of oocytes in the ovary was estimated using the method of Weibel and Gomez (1962). The histological sections were examined: (i) to determine the total fecundity by raising the counts of vitellogenic eggs to the total volume of the ovary (in these ovaries spawning should not yet have commenced as is indicated by the presence of post-ovulatory follicles); (ii) to determine the egg loss by atresia by raising the counts of atretic eggs to the total volume of the ovary.

The total fecundity per gramme fish weight (F_{tw}) was estimated from a regression of total fecundity on fish weight. However, the regression was forced through the origin, so the F_{tw} was independent of fish size, and weights equal to the inverse of fish weight were assigned to each observation to allow for the greater variability in observations on larger fish. In this case, F_{tw} is simply the ratio of mean total fecundity to mean fish weight.

Results

Histological examination showed that only 31 ovaries could be used for the estimation of the total fecundity, because 29 ovaries already contained post-ovulatory follicles. Table 1 shows the length, weight and age of the fish and the total fecundity estimate of each ovary together with the SE. Most of the fish used for the total fecundity estimate were of the 1982 year class. The length range was only 24 - 32 cm and the weight range was only 105 - 275 g.

The fecundity-weight relationship from ovaries collected in 1992 is shown in Figure 1. There was some evidence of a non-zero intercept. The total fecundity was estimated at 1,454 eggs per gramme pre-spawning female horse mackerel with a standard error of 70.03.

The fecundity-weight relationship from ovaries collected in 1978, 1988 and 1992 is shown in Figure 2 (fecundity estimates from ovaries collected in 1987 and 1988 are from Eltink and Vingerhoed, 1989). There was some evidence of a non-zero intercept (broken line). The regression was forced through the origin for the estimation of the total fecundity per gramme fish weight. It was estimated at 1,589 eggs per gramme pre-spawning female horse mackerel with a standard error of 52.70.

Atresia (all stages) was observed at a level of 105 oocytes per gramme pre-spawning female horse mackerel.

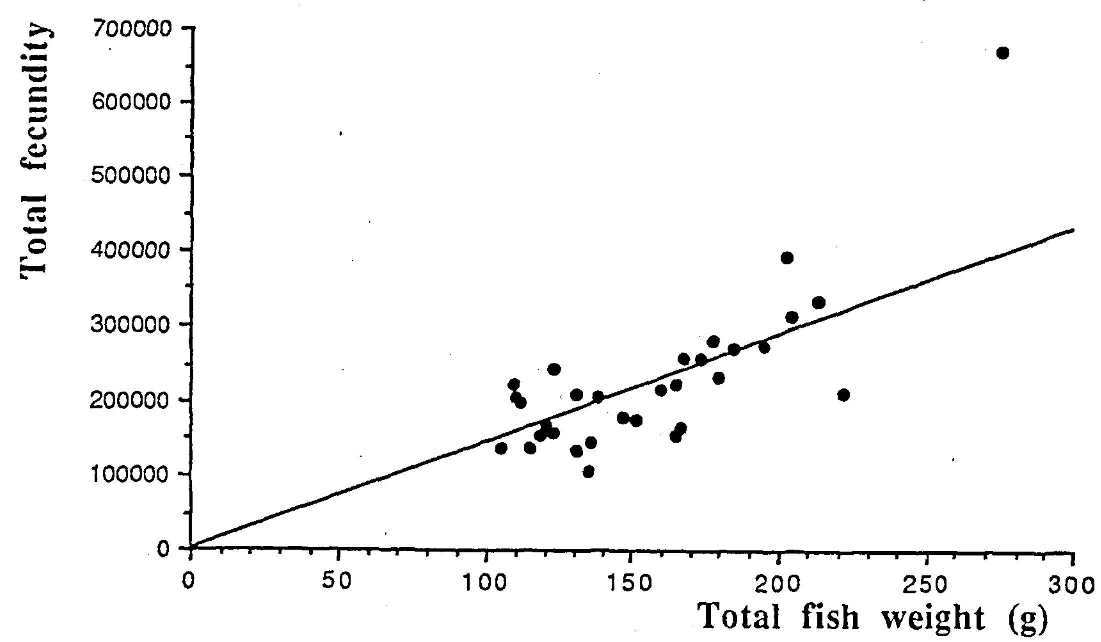

Figure 1. The relationship between weight (g) and total fecundity of 1,454 eggs per gramme pre-spawning female as estimated by the histometric method from 31 western horse mackerel collected by RV "Scotia" in late April 1992. The regression line is forced through the origin.

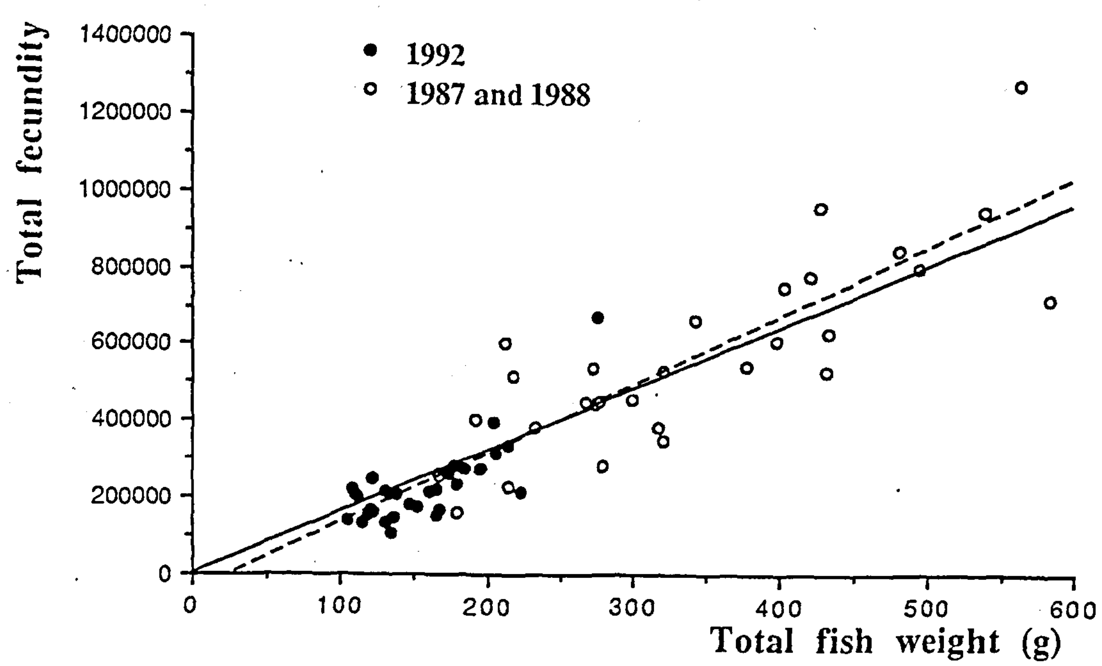

Figure 2. The relationship between weight (g) and total fecundity as estimated by the histometric method from 60 western horse mackerel collected in 1987, 1988 and 1992. Solid line is the regression line forced through the origin and the broken line is regression line not forced through the origin.

Table 1. The length, weight, age, total fecundity and the standard error (SE) of each total fecundity estimate from 31 western horse mackerel collected by RV "Scotia" in late April 1992. The total fecundity estimates do not include the number of atretic oocytes.

Length (cm)	Weight (g)	Age	Total fecundity	SE	atretic oocytes
24	105	10	138,336	14,502	312
24	109	10	224,127	22,460	0
24	110	10	205,636	18,295	0
24	112	10	198,411	18,749	370
25	115	7	136,577	8,587	0
26	119	10	156,751	19,770	613
26	120	10	169,554	18,476	0
26	123	10	159,095	9,335	960
26	123	10	244,953	13,672	0
26	131	10	211,814	10,616	1491
26	135	5	107,073	8,534	6239
27	131	5	136,157	13,036	0
27	136	5	144,193	8,367	0
27	138	10	205,522	15,104	0
27	147	10	178,493	15,401	0
27	151	10	174,795	10,715	0
27	160	?	215,866	9,428	9776
28	165	10	224,264	25,282	0
28	165	10	156,005	11,894	1275
28	167	10	166,928	20,311	0
28	168	10	259,600	19,924	0
28	180	10	233,804	15,616	132182
29	174	10	258,806	12,391	2687
29	178	8	283,743	19,516	672
29	185	10	272,802	32,036	5259
29	195	10	274,930	5,785	0
29	203	10	393,263	35,861	0
29	205	10	314,392	26,142	20114
30	213	10	335,804	18,053	46807
32	222	10	212,759	13,797	0
32	275	?	671,987	35,275	0

Discussion

Volumetric (with Gilson's fluid) and histometric (from histological sections) estimates of the total fecundity gave similar results (Eltink and Vingerhoed, 1989). Therefore, only the histometric method has been used to estimate the total fecundity from the ovaries collected in 1992.

Sampling of the ovaries was later in the spawning season in 1992 (late April) than in 1987 (April) and 1988 (March-April). The total potential fecundity should be estimated before the fish starts to spawn. 48% of the ovaries collected in 1992 contained post-ovulatory follicles (POFs) indicating spawning already took place. Ovaries containing these POFs were excluded from the analysis. However, possibly one batch of eggs could have been released by these fish used for the total fecundity estimate, if the spawning interval in the onset of spawning would be longer than the POF stage duration. It is assumed that the fish used for the total fecundity estimate did not yet spawn.

Macer (1974) showed that in horse mackerel ovaries vacuolation of oocytes virtually ceased during the pre-spawning stage and that, subsequently, the non-yolky, vacuolated oocytes disappeared because of either the development of yolk or resorption. Therefore, the onset of vitellogenesis was assumed to correspond to the oocyte size at which 50% of the oocytes showed vacuolation. A total fecundity estimate according the volumetric method should be estimated by counting all oocytes above this size threshold (corrected for shrinkage), but according the histometric method the total fecundity should be estimated by counting all vitellogenic oocytes.

In the text table below the fecundity at different fish lengths is compared with other relevant estimates of fecundity in the western and North Sea area together with the size threshold above which the oocytes have been counted by the volumetric method.

Area	Length range of fish (cm)	Range total fecundity ($*10^{-3}$ eggs)	Eggs per g female pre-spawn.	Threshold (µm) above which oocytes are counted
English Channel and North Sea. (Macer, 1974)				
Volumetric method	25 - 38	168 - 860	1,492*	118
Celtic Sea. (Nazarov, 1977)				
Volumetric method	25 - 41	54 - 833	818**	175
Celtic Sea. (Eltink and Vingerhoed, 1989)				
Volumetric method	29 - 42	156 - 950	1,478	96
Histometric method	29 - 42	164 - 1272	1,655	-
Celtic Sea. (Ovaries collected in 1992).				
Histometric method	24 - 32	107 - 672	1,454	-

* Derived from Macer's (1974) conversion of total egg production to biomass: fish with a mean weight of 231 g and a mean length of 29.5 cm have a fecundity of 344,700 eggs, which is equal to 1,492 eggs per gramme female.
** Nazarov's figure of 818 eggs per gramme female is based on gutted females.

The threshold of 175 µm as used by Nazarov (1977) is probably too high, because this threshold probably represents a size above which all oocytes have vacuoles and it is not the threshold above which 50% of the oocytes are vacuolated. This has resulted of course in a relatively low fecundity, which caused an overestimation of the spawning stock size in earlier years (Anon., 1987: Table 8.1). Macer's (1974) estimate of 1,492 eggs per gramme pre-spawning female is similar to the estimate of Eltink and Vingerhoed (1989) and to the estimate based on the ovaries collected in 1992.

The recent estimate of 1,454 eggs per gramme female, being based on the fish collected in 1992, is 12% lower than the earlier estimate of 1,655 eggs per gramme female (Eltink and Vingerhoed, 1989), being based on fish collected in 1987 and 1988. An important difference between the two data sets is that the fish collected in 1987 and 1988 were mainly older than the 1982 year class, covering a length range of 29 - 42 cm and a weight range of 168 - 585 g, while the fish collected in 1992 were predominantly of the 1982 year class, covering a length range of 24 - 32 cm and a weight range of 105 - 275 g. Figure 2 shows that both data sets have only a relatively small overlap in weight (168 - 275 g), while the weight range of both data sets is 105 - 585 g. Therefore, the fecundity estimates from the ovaries collected in 1992 should be regarded as supplementary to the fecundity estimates from the ovaries collected in 1978 and 1988. When the horse mackerel ovaries collected in 1987, 1988 and 1990 are used for the total fecundity estimate, it results in a total fecundity of 1,589 eggs per gramme pre-spawning female with a standard error of 52.70. The regression line has a small negative intercept, because smaller fish tend to have a relatively lower fecundity than larger fish (broken line in Figure 2). This possibly explains the lower total fecundity estimate of 1,492 eggs per gramme female from the ovaries collected in 1992, which were from relatively smaller fish.

If total fecundity data of horse mackerel are to be used to convert egg production to spawning biomass, it is preferred to use the total fecundity of 1,589 eggs per gramme pre-spawning female for all egg surveys from 1977 to 1992, because this fecundity estimate is based on fish covering the whole length range.

Acknowledgement

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