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International Council for
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C.M. 1978 / F:13
Mariculture Committee
Ref: Shellfish Cttee

Preliminary Results of Investigations on the Maturation and Sex Ratio of Oysters (C. gigas) transplanted into the Flensburg Fjord, Western Baltic

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Abstract

1473 oysters (Crassostrea gigas) of the year classes 1972 to 1976 have been investigated for maturation and sex ratio.

Cultchless spat from Scotland was transplanted to the Flensburg Fjord, Western Baltic. Samples were taken at irregular intervals throughout 1977. Results showed a clear temperature relation of maturation for female oysters rather then for male ones. The low salinity of the Western Baltic had no effect on maturation and sex ratio.

Introduction

The German oyster fishery vanished completely in the first half of this century due to overexploitation of the former flourishing oyster grounds which have been inhabited by the flat oyster Ostrea edulis. Later trials to restock the old oyster beds with imported half-grown oysters from the same species as well as Portuguese oysters from France gave no good results. These oysters were not suited for the hard winters of our Wadden-Sea coast.

But since hatchery-reared cultchless spat of the Japanese oyster (C. gigas) from an oyster hatchery in Scotland became available in 1971 a new attempt was made (MEIXNER, 1973). The young oysters were not only placed in the Wadden-Sea but due to their known greater salinity tolerance also into the Western Baltic. Growth rates and survival during the winter months (MEIXNER, 1974) were

so promising that new spat was bought throughout the following years.

In summer 1975 some of these oysters were examined for the first time to find out whether they would reach sexual maturity (MEIXNER, R. and GERDENER, Ch., 1976).

Mature oysters of both sexes as well as hermaphrodites could be found and the sex products were successfully fertilised.

Basing on these results a routine procedure for sex determination was developped in 1976. Following this procedure, oysters of all existing year classes have been investigated throughout 1977 to find out the seasonal changes of maturation under the specific conditions of the Flensburg Fjord.

This was necessary as there is a permanent demand for mature oysters of both sexes for reproduction purposes for bio assays as well as for future commercial approaches.

Material and Methods

Investigated Oysters

All oysters were imported as small cultchless hatchery reared spat at a size of 0.6-1.4 cm from Scottish Sea Farms near Oban, Scotland. They were sent by air to Hamburg and then brought to the field station Langballigau at the Flensburg Fjord where they were grown on in plastic trays suspended from rafts roughly 1 m below the water surface. During winter when ice became hazardous to the rafts the oysters where transferred into containers which then were lowered to the bottom of the Fjord which is 2-7 m deep at the research site.

Oysters and plastic trays where cleaned at regular intervals to prevent fouling (MEIXNER, 1973, 1974, 1975).

1977 the following numbers of oysters of different year classes were available at the Baltic Sea site:

year class	n	year class	n	year class	n
1972	550	1974	1220	1976	13000
1973	780	1975	13000		

Hydrographic conditions

As basic information for all running investigations data on the meteorological situation, oxygen content and water temperature at the surface and at 6 m depth were recorded daily. Since 1977 also water samples were taken to determine the salinity by the araeometric method. Only surface temperature and salinity will be given in this paper.

Standard procedure for sex-determination

After taking the oysters from the sea they always had to be brought to the Hamburg laboratory. There they were cleaned from all fouling organisms and silt as good as possible by brushing them off. For later identification purposes numbered tags were attached (NEUDECKER, 1977).

After this a small hole was drilled at the dorsal edge between the two valves. Through this hole a small sample out of the right gonadal lobe was taken by a syringe. The sample was placed on a slide and the smare observed under a phase-contrast mikroscope.

Four catagories were made to line up the results:

1 male (spermatozoa)
2 female (ripe eggs)
3 hermaphrodite (spermatozoa and ripe eggs)
o no sex (i.e. determination not possible or unripe males and females with spermatids or small unripe eggs)

Results

Salinity

The salinity at the research site varied considerably throughout the year 1977. The weekly mean values are shown in figure II A.

The yearly average was 17.45°/oo S. During the summer period from May to September the salinity was usually below this average while it exceeded it during spring, autum and winter. The minimum was 12.81°/oo S on 25.05.1977, the maximum 24.07°/oo S on 22.11.1977.

Temperature

The mean weekly temperature is given in figure II B. It was very low in spring, not reaching the 10° C level before the first half of May. The highest values measured in the summer months of June, July and August were 20.0°C, 19.5° C and 18.9° C respectively. The temperature then gradually declined to undergo the 5° C line already in November. So 1977 has to be considered as a fairly cool year (average year temperature 9.01° C)compared with the foregoing years which all had higher maxima and average temperatures.

Oysters investigated

Oysters of all year classes available from 1972 to 1976 have been investigated for the sexual status on 46 dates at irregular intervals. The results have been summarized to 17 half monthly periods of the year 1977. The total number of individuals was 1473. Table 1 gives the numbers of individuals belonging to each year class.

Maturation

Mature oysters could be found in all age groups from one to five years.

The age groups 2 to 5 have been investigated from January onwards while age group 1 was investigated for the first time in the second half of June. As the percentage of mature oysters of age group 1 during summer was similar to all the others, it is-

assumed that the maturation of this age group (one year old oysters) follows the line which is given by the results of all other age groups (Fig. 1).

The percentage of mature individuals increases sharply from June to July and has its maximum in August, and is decreasing gradually till the end of the year.

Sex ratio (Compare Table 1)

The sex ratio was found to be as follows:

$♀ : ♂ : ☿ : o^x = 1 : 0.54 : 0.08 : 1.54$

o^x = undiff. + unripe

Males

Male oysters have been found in most samples throughout the year although there were slight differences between the five year classes. The highest percentage found in a sample of 26 individuals was 38.46% in the 1974 year class during the first half of July (Fig. II C). The yearly average of all oysters was 17.11% (Table 1).

Females

Generally for all year classes female oysters were only found from summer to late autumn. In some cases very few mature females could be found even in December. The first ripe females occured at the very end of April. Then in June the percentage increased sharply. The highest values for July and August were 84.62% (year class '76) and 85.71% (year class 1975) respectively. Then the percentage decreased (Fig II C). The yearly average was 31.64% (Table 1).

Hermaphrodites

Individuals showing ripe eggs as well as activ spermatozoa occured in all year classes. They were only found during summer from June to October and in one case at the beginning of November in the year class 1972. Although the average percentage was 2.51% for the whole year, in the second half of August an extreme high amount of 53.84% hermaphrodites out of a sample of 26 oysters in the 1972 year class was observed.

No sex

Contrary to the diagramm given in Fig. 1 the amount of undifferenciated and immature oysters is very high in the first half of the year and drops down to zero in most year classes during August. Then it gradually increases again till the end of the year. The yearly average of oysters in an undifferenciated or immature stage was 48.74% (Table 1).

Discussion

The results show a clear connection between rising temperatures and maturation of C. gigas in the Flensburg Fjord. Similar results have been found by other authors (KATANSKY and SPARKS, 1966). It was obvious that female oysters of all ages have the same seasonality in maturation. Minor differences were due to partial spawning of '72, '74, '75 year class oysters induced by higher temperatures in July and August. But from the fact that mature oysters occured during the whole summer period of 1977 in high percentages it can be concluded, that no general spawning took place in that year. This is also likely as the temperature hardly reached 20° C, the normal minimum spawning temperature. Another observation also parallels the findings of KATANSKY and SPARKS for oysters of the same species introduced to Washington State waters.
A strong tendency towards the female phase in all year classes was found in the Baltic Sea as well, although the oysters have been kept crowded in trays which favours development to males at least in C. virginica populations (KATANSKY and SPARKS, 1966).

It is known from other authors that gonadal material is resorbed with decreasing temperatures in autumn and winter. This is obviously true for the Baltic Sea oysters as well, although male oysters seem to be an exception. Their maturation is not by far so much influenced by the season.

In the Baltic Sea the mean percentage of hermaphrodites is with 2.51% in the same range of that one found by KATANSKY and SPARKS. The reason for the high percentage of hermaphrodites reported

for the 1972 year class in August is unknown. Further data may give a conclusion.

Results are very similar to those from KATANSKY and SPARKS, who have worked in quite higher salinities. This means, that hydrographic conditions of the Baltic Sea site especially its low salinity had obviously no influence on the maturation and sex ratio of this species.

Current research will prove whether similar results can be obtained for the German Wadden Sea coast. Investigations on the mechanism of sex reversal reported by other workers will be done in addition.

Acknowledgements

This work was supported by the German Federal Ministry of Research and Technology. Thanks are due to Mr. W. Clausen who takes care of the oysters at the research site off the Baltic Sea coast and to the laboratory staff, Miss v. Holt and Miss Willführ, who have been involved with the technical work.

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Table 1: Sex ratio of oysters from Flensburg Fjord, Western Baltic during the year 1977

Year class	Age in years	n	Percentages				Ratio			
			♀	♂	⚥	o^x	♀	♂	⚥	o^x
1976	1	203	45.32	12.32	2.46	39.90	1 :	0.27	0.05	0.88
1975	2	304	29.93	13.49	1.65	54.94	1 :	0.45	0.06	1.84
1974	3	345	27.25	22.32	1.74	48.69	1 :	0.82	0.06	1.79
1973	4	310	31.61	17.74	1.29	49.35	1 :	0.56	0.04	1.56
1972	5	315	25.40	16.19	5.08	53.33	1 :	0.64	0.20	2.10
total		1473	31.64	17.11	2.51	48.74	1 :	0.54	: 0.08 :	1.54

o^x = undifferentiated oysters as well as immature females and males

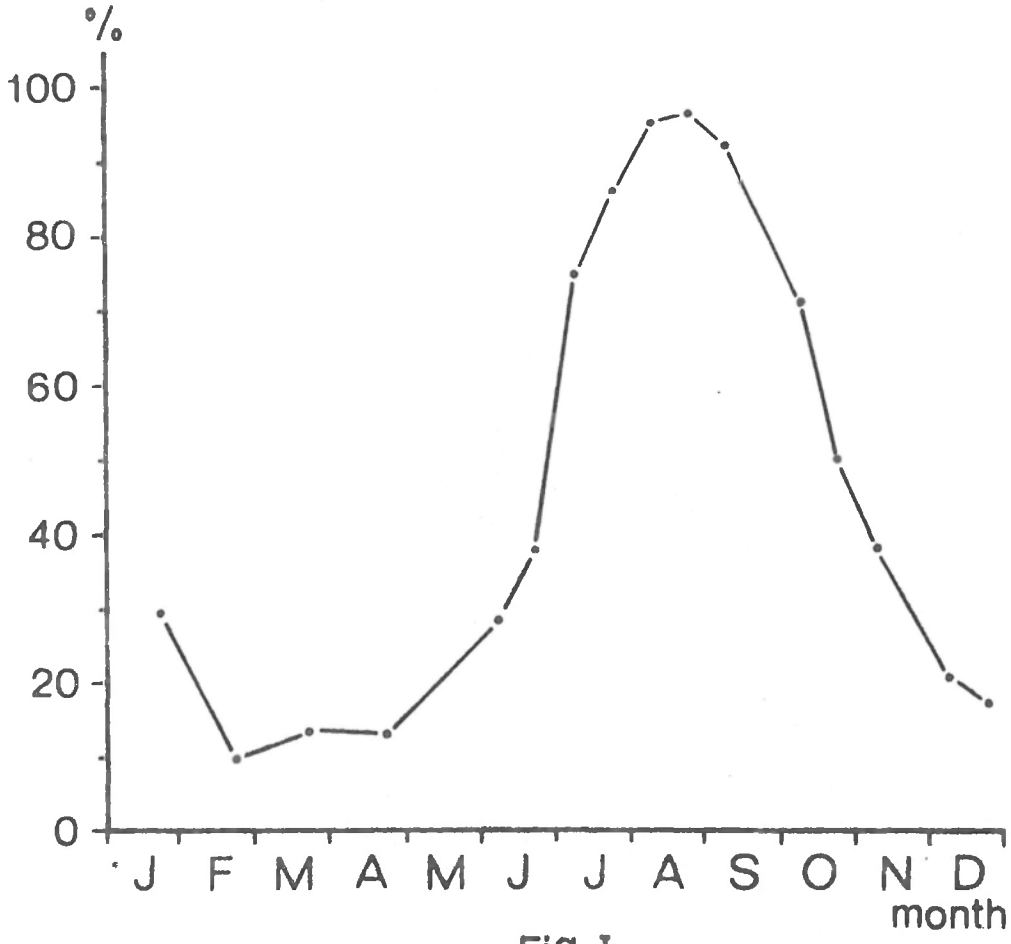

Fig. I

Percentage of mature oysters in 1977 at Langballigau, Flensburg Fjord, Western Baltic

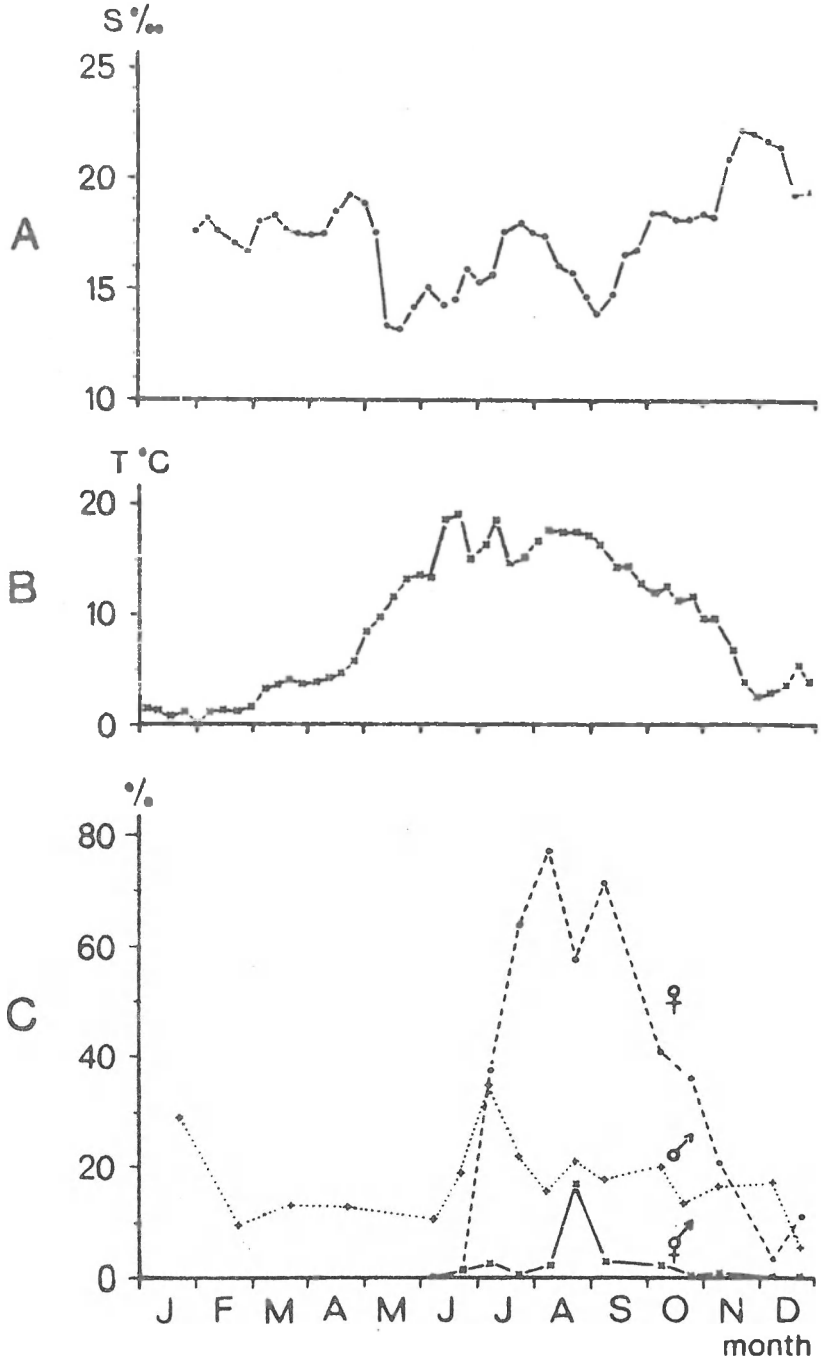

Fig. II

A = salinity (S ‰)

B = temperature (T °C)

C = percentage of ♂ (·····), ♀ (---), ♂♀ (—) oysters 1977, Langballigau, Flensburg Fjord, Western Baltic