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no. 251
Needler, A.B.
Sex reversal in marked
oysters
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MANUSCRIPT REPORTS OF THE BIOLOGICAL STATIONS

No. *251*



Title

SEX REVERSAL IN MARKED OYSTERS

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1931-36

ABSTRACT

In 1931 and 1932 the sex was determined in a number of oysters (Ostrea virginica) by drilling small holes in the shells and extracting some of the gonad contents with a pipette. These oysters were marked so that changes of sex in individual oysters could be followed year after year until 1936. There was every variation from oysters which changed sex almost every year to those which never changed. Sex is evidently usually determined afresh each year. The high proportion of males that never changed suggests that there may be oysters which are genetically male as distinct from those which are genetically hermaphrodite.

In 1931 and 1932 the sex was determined in a number of oysters by drilling small holes in the shell and extracting a little of the gonad contents with a pipette. Some of these oysters were in clusters the outlines of which were recorded, and some were embedded in blocks of concrete in such a way that the valves could open freely. Thus it was possible to record the sex of the individual oysters year after year.

In 1931 the sex of the individual oysters was determined in a number of oysters which were two or three years old, and determined. The drill was

Sex Reversal in Marked Oysters

Alfreda Berkeley Needler

Since 1930 the writer has been engaged in a study of sex reversal in Ostrea virginica. That these oysters were capable of a change of sex either from male to female or from female to male was soon established (Needler 1932b). But it was not at first proved that any one oyster could change more than once in the course of its life. That the sex is determined in 1932. As a result of all the poor conditions... afresh every year and that many of the oysters are capable of changing sex every year over a considerable period is shown by the data given in this paper.

In 1931 and 1932 the sex was determined in a number of oysters by boring a small hole in the shell of each and extracting a little of the contents of the gonad with a pipette. Some of these oysters were in clusters the outlines of which were recorded, and some were embedded in blocks of concrete in such a way that the valves could open freely. Thus it was possible to record the sex of the individual oysters for several years.

In 1931 the sexes of two hundred and sixty oysters, mostly two or three years old, were determined. The drill used was too big so that the holes made were clumsy and apt to injure the oysters a little. Then the oysters were placed in large salt water tanks near the station. For some reason not clearly understood the conditions there were very unfavourable so that the mortality was high among all oysters placed there and very

high among the drilled specimens. The experiment was started in August and by October a great many oysters had died, none had grown, and many were ailing. They were then put in wire baskets and sunk under the water near the station. Here they suffered rather badly from silt but were obviously healthier than in the tanks. In 1932 and every spring thereafter a landing stage was built at the station. This made a convenient place to hang the baskets of oysters where they were free from silt but able to get plenty of food. Here they were very much healthier, but there is reason to believe that they never overcame their bad start enough to do as well as the oysters drilled in 1932. As a result of all the poor conditions mentioned above only forth-one of the original two hundred and sixty oysters were still alive in 1932. The changes in sex of these oysters from 1931 to 1936 are recorded in table I. In 1933 and in 1934 two or three oysters were discarded because, for some reason, it was impossible to be sure of their identity. These are entered as "dead". Where it was impossible to be sure of the sex of an oyster the sign "?" is used.

In 1932 more oysters were drilled and kept. These were nearly all two years old but a few were three years old. The drill used was a dentist's drill which made quite a small hole and the oysters were kept in wire baskets hung from the landing stage. They grew normally and most of them seemed to be quite healthy. One of the baskets containing these oysters was lost during the winter of 1934-35, but eighty-eight can be recorded. The changes in sex of these oysters from 1932 to 1936 are summarized in table II.

Consideration of these two tables shows that there is almost every variation from oysters which remain of one sex

Table I. Change of sex of oysters marked in 1931

Number of oysters	Sex from year to year					
	1931	1932	1933	1934	1935	1936
4	m	m	m	m	m	m
4	m	m	m	m	dead	
2	m	m	m	?	dead	
2	m	m	m	dead		
5	m	m	dead			
7	m	?	dead			
1	m	m	m	f	f	f
1	m	m	m	m	m	f
1	m	f	m	m	m	m
1	m	f	dead			
2	m	f	m	f	dead	
1	m	?	m	f	f	f
2	f	f	f	f	f	f
1	f	f	f	dead		
4	f	?	dead			
1	f	m	m	dead		
1	f	f	m	f	m	m
2	f	f	m	m	m	m

Table II. Change of sex of oysters marked in 1932.

Number of oysters

	1932	1933	1934	1935	1936
17	m	m	m	m	m
1	m	m	m	m	dead
3	m	m	m	dead	
3	m	m	dead		
2	m	dead			
1	m	m	m	f	f
6	m	m	m	m	f
1	m	f	?	dead	
1	m	m	m	f	m
2	m	f	dead		
1	m	f	?	m	m
1	m	f	?	f	f
2	m	f	f	f	m
1	m	f	m	m	m
3	m	f	f	m	m
1	m	f	f	?	f
1	m	?	m	m	f
1	m	f	f	f	dead
2	f	f	f	f	f
2	f	f	dead		
3	f	dead			
1	f	f	f	f	m
2	f	f	f	m	m
1	f	f	m	f	f
2	f	m	m	dead	
2	f	f	f	m	f
1	f	f	f	m	dead
3	f	m	m	f	f
1	f	m	f	f	f
1	f	m	m	m	f
5	f	m	m	m	m
3	f	m	m	m	f
1	f	m	f	f	m
1	f	m	?	f	f
1	f	?	?	dead	
1	f	m	dead		
2	f	m	m	f	m
1	f	m	f	dead	
2	f	m	m	f	dead
1	f	m	?	f	m

throughout the period to oysters which change sex almost every year. In spite of all this changing, the ratio of males to females remains fairly constant among the 1932 oysters and becomes higher among the 1931 oysters as they get older. This is a different state of affairs from that on the natural beds where the ratio of males to females becomes lower as the oysters get older. But probably none of the oysters considered above were living in quite as healthy an environment as those on the beds and the 1931 oysters started under very poor conditions. Thus the behaviour of these oysters cannot be taken as typical of natural behaviour. But it is obvious that in many of the oysters the sex is determined afresh each year and that even six and seven-year-old oysters are capable of changing sex.

It is noteworthy that there was a high proportion of males that never changed their sex. Among those drilled in 1932 over 27% of all the oysters remained male while under observation. Among those drilled in 1931 this proportion was much higher, but it is pointed out that the oysters were exposed to much poorer conditions. The proportion remaining male throughout was significantly higher than any of the other chance variations, none of which reached 10%. Since only 7 of the 1932 male oysters were three and the remainder two years old when first examined, they might already have had a breeding season as females. There is no way of proving or disproving this but it is known that less than 20% of the oysters in the neighbourhood from which these oysters were taken mature when one year old and only about 2% produce eggs (Needler 1932a, 1935). Thus it is improbable that a significant number of these consistently male oysters had ever been female.

Possibly these males have a different genetic constitution

from those that change sex at intervals. It is therefore suggested that there may be some "true" male oysters while the others are genetically hermaphrodite. Coe (1932a) has found in Ostrea lurida that, besides specimens functioning as males with the growth of ovocytes arrested (hermaphroditic males), there were some in which the growth of ovocytes of the primary gonad was inhibited and histological examination showed practically no ovocytes. He called these "true" males. Then in O. virginica he found some males with very few ovocytes (Coe 1932b, 1934) and he suggested that these might also be "true" males. A similar idea was advanced by Orton (1928) for Patella vulgata and, more recently by Coe (1933) for Teredo navalis. The above data support Coe's suggestion that there are two kinds of males in O. virginica.

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