94. *On the Sex-change of the Japanese Common Oyster, *Ostrea gigas* Thunberg.*

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The various species of oysters can be grouped into two categories (Amemiya,¹⁾ Orton²⁾). They show in many respects different characters from each other. Their spawning and breeding habit, the nature of their eggs and sperm or sexual processes in general are the main points to distinguish the two categories.

One of the representatives of one category is the European oyster, *Ostrea edulis*, and that of the other is the Portuguese oyster, *O. angulata*, or the American species, *O. virginica*. With respect to sexuality our common oyster, *O. gigas*, belongs to the latter class or the type of the Portuguese oyster.

Fairly much has been studied on the sex physiology of the European oyster, but comparatively few works have been done upon that of those belonging to the other category.

It has been believed that the sexes of the type of the Portuguese oyster are strictly separated, although the condition in which ova and sperm were found in the same individual and in the same gonad was reported by a few authors only in a limited number of cases in the Portuguese (Amemiya),¹⁾ the American (Kellogg)³⁾ and the Japanese (Amemiya)⁴⁾ oysters. Such cases are considered rather abnormal or exceptional instances, as the monoecious condition which occurs abnormally in a sex-separated animal is not rare, especially in a bottom-living and sessile creature.

In fact, sexes of our common oyster are well separated. According to my former investigation,⁴⁾ only at most 0,35% of individuals were in such condition as having ova and sperm in the same gonad, so that it may reasonably be said that sexes of the species are separated.

My former work⁴⁾ on the sex ratio of the present species showed an interesting result. At ground A, number of males per 100 females

1) Amemiya, I. 1926. Proc. Roy. Phys. Soc., Vol. XXI, Part 2.

2) Orton, J. H. 1928. Nature, Vol. 121, No. 3044.

3) Kellogg, V. L. 1892. B.U.S.F.C., Vol. XII.

4) Amemiya, I. 1928. Journ. Jap. Zool., Vol. II, No. 1.

was 94,99 in one-winter oysters and 73,15 in two-winter ones, while at ground B, number of males per 100 females was 116,06 in the one-winter group and 155,16 in the two-winter ones. As the spawning lasts fairly long and the spatting takes place from spring to autumn, we cannot say exactly how old oysters are. We can only know with certainty the number of the winter or the winters they have passed.

Judging from the result, it is easy to expect that in the present oyster, unless preponderous death occurs either in the side of the female or the male, (1) the genetic sex-determining mechanism would not be all-powerful, and (2) the sex-change of the individual would occur at a stage in which new reproductive element differentiates towards either the female or the male, so that the same individual spawns as either the female or the male sex which may be opposite to the sex of the preceding season.

To prove whether the sex-change actually occurs or not, I undertook an experimental study of which the result will be given.

The material I used were one-winter oysters, that is, they had been born and spatting in the preceding year and had passed one full winter. The sexes of individuals were determined just prior to the spawning season by microscopically examining a part of the gonad taken out through a hole drilled in the shell. It seems that the wound thus inflicted is not severe, as the skillfully operated specimen showed no unhealthy symptom, recovering the wound very soon and closing the hole in the shell by the secreted nacreous layer in a week or ten days after the operation.

Individuals of different sexes were put separately in cages and sent back to the culture bed. They were kept there for full one year during which they spawned, grew, fattened and then entered on the spawning season of the following year.

Although the number of dead individuals during the time of relaying in the bed was fairly high, yet the surviving specimens showed their growth and had their full-developed gonads of the second season when their sexes were again examined.

The result of the experiment and sex-examination is shown in the following table.

Table.

Batch		I		II	
1928		Female 119	Male 58	Female 209	Male 145
1929	Female	82	<u>32</u>	85	<u>48</u>
	Male	<u>20</u>	18	<u>34</u>	39
	Ova and sperm in the same gonad	0	0	1	0
	No gonad	4	0	8	1
	Survival	106	50	128	88
	Dead	13	8	81	57

The figures underlined denote the numbers of individuals of the sex-change.

Thus, it is rather needless to make any further remarks on the sex-change of the oyster, and it is surprising that so great a number of individuals actually changed their sex.

As every one knows, the species has one spawning season in a year, and at the end of the season the animal is entirely exhausted. After the season is over, it regains its active growth and deposits its nutritive reserve material in the body for the formation of the new gonad of the next year. It is probable that at the beginning of every new spawning season the sex differentiates independently to the sex of the preceding season, so that the sex-change, if it appears, occurs only once in the season or in a year at the very stage when the gonad differentiates sexually. Thus, if only a single spawning season is taken into consideration, the circumstances make us believe that the sexes of the species are separated.

As will easily be thought from perusal of the above result of my former investigation, such phenomenon as protandry does not seem to exist. And moreover, there are in the one-winter oysters many individuals which are very young and small and whose ripe gonads are so minute that they can hardly be discernible by naked eyes. Still, such gonads show clearly the peculiarity either of ovary having ova or the testis having sperm.