of treatment that was used. This treatment killed half the flies exposed to it and rendered still others useless for breeding.

Sixty-nine fertile matings were made with treated males. Ten C1B daughters from each male were mated in individual cultures, making 690 matings producing 100,000 flies which were observed for lethal mutations. In no case where large numbers of progeny were produced were any lethal mutations observed. Three matings showed no males, but each of these produced only two or three females, hence showed nothing significant.

Thus far the results are of such a nature as to indicate that very probably mutations can not be produced by the use of electricity, at least of the particular kinds used in these experiments.

W. R. HORLACHER
AGRICULTURAL AND MECHANICAL
COLLEGE OF TEXAS

THE FECUNDITY OF THE OYSTER[1]

IT is a well-known fact that many marine invertebrates, especially those that discharge the eggs into the water where fertilization outside of the organism occurs, produce large numbers of sex cells during a spawning season. The estimation of the total number of eggs developed in a single female is of certain scientific interest, but unfortunately it presents considerable difficulties. In the case of the oyster, which is known to be extremely prolific, the attempts to determine the number of eggs produced by one adult female were made by Möbius[2] in 1883 and Brooks[3] in 1880. Möbius's method consisted in weighing first the whole mass of the embryos which were scraped by means of a small brush from the gills of the female, then in weighing and counting the number of embryos in a small portion of it. He estimated that the average number of embryos in each of five full-grown *Ostrea edulis* from Schleswig-Holstein was 1,012,955. This figure is less than that given by Eyton,[4] whose estimate was 1,800,000. Brooks estimated the number of eggs in the American oyster, *Ostrea virginica*, by determining the total volume of eggs washed out of the ovary and by measuring the dimensions of eggs. He arrived at the conclusion that an oyster of average size developed more than 9,000,000 eggs. An unusually large oyster, according to his computation, would possibly produce 60,000,000 eggs in one summer. Nelson[5] thinks that a large oyster, "if fat the preceding spring, undoubtedly would mature from 50,000,000 to 60,000,000 eggs in a season."

During the course of the experiments on the spawning of oysters in which the writer was engaged during last summer and fall opportunity presented itself to enumerate the eggs laid by *O. virginica* and *O. gigas*. Experiments with the American oysters were carried out at Woods Hole; those with the Japanese species (*O. gigas*) were made at the Hopkins Marine Station, Pacific Grove, California. Japanese oysters were shipped from Samish Bay, Puget Sound, to Pacific Grove where they were kept for about a month in the laboratory tanks. *Ostrea gigas* grows very well in Samish Bay, but in spite of good development of the gonads, fails to spawn there.

Female oysters, placed in twenty-liter glass tanks filled with sea water, were stimulated to spawn, and kymograph tracings of the spawning reaction, which is characterized by the rhythmical contraction of the adductor muscle, were obtained. After the reaction was over, the water in the tank was stirred with a powerful electric stirrer and a 100 cc sample was taken. Eggs, killed by addition of a few drops of 1 per cent. osmic acid, were counted, using the Sedgwick

NUMBER OF EGGS DISCHARGED AND DURATION OF SPAWNING REACTION OF *O. virginica* AND *O. gigas*

Oyster No.	Length cms	Width cms	Date 1929	Temp. ° C.	Duration of reaction, minutes	Number of contractions	Average number of eggs per contraction, millions	Total number of eggs discharged in one spawning period, millions
O. virginica			July					
292	13.3	10.5	23	22.5	61	56	1.26	70.3
295	9.2	7.0	24	24.0	36	57	0.53	30.3
299	11.2	8.0	24	23.0	70	75	0.20	15.0
302	9.4	6.6	25	25.0	70	135	0.85	114.8
O. gigas			Oct.					
J–2	15.2	6.9	2	25.0	23	31	1.34	41.5
J–2	15.2	6.9	9	30.0	23	47	0.83	39.0
J–2	15.2	6.9	19	30.0	19	44	0.26	11.4
J–16	9.5	6.1	20	27.5	15	.....	.....	30.4
J–20–1*	11.6	6.8			59	121		
J–20–2*	10.9	6.2						
J–20–3*	11.2	6.8	22	25.3				55.8**
J–20–4*	12.0	4.8						
J–20–5*	10.8	7.4						

* Five females were kept together; kymograph tracing obtained from one oyster only.

** Average per female; total number discharged by five oysters, 278.8 millions.

[1] Published by permission of the U. S. Commissioner of Fisheries.

[2] K. Möbius, "The Oyster and Oyster Culture," Appendix H to the Report of the Commissioner of Fisheries for 1880, pp. 681–747, 1883.

[3] W. K. Brooks, "Development of the American Oyster," Johns Hopkins University, Studies from the Biological Laboratory, No. IV, p. 81, 1880.

[4] T. C. Eyton, "History of the Oyster and Oyster Fisheries," London, 1858. Quoted from Brooks, *loc. cit.*

[5] T. C. Nelson, "Aids to Successful Oyster Culture," New Jersey Agricultural Experiment Stations, 1921, Bulletin 351, p. 59, 1921.

Rafter method for enumeration of plankton organisms. Each time five samples were taken and the average was computed. The figures are accurate within ± 10 per cent. The results of the experiments are presented in the table.

An examination of the table shows that the number of eggs laid by the female *O. virginica* during one spawning period varied from 15 to 114.8 millions. Inasmuch as the author's experiments show that the female can be induced to spawn five or six times during the season it is permissible to assume that the number of eggs discharged during one spawning period represents only a fraction of their total number in the organism. It is quite probable that the maximum number of eggs in a single adult female may be close to one half of a billion. An examination made immediately after the spawning of oyster No. 302, which had discharged 114.8 millions eggs, has shown that the oyster still contained vast numbers of eggs, the thickness of the gonad layer being about 0.7 cm.

The number of eggs discharged during one spawning period by the Japanese oysters varied from 11.4 to 55.8 millions. The last figure represents the average number of eggs discharged by five oysters used in the experiment J–20. It was noticed, however, that during this experiment the four oysters which were in the tank together with the oyster No. J–20–1 contributed but a very small portion of eggs, probably not more than one fifth of their total number. Oyster No. J–2, which was induced to spawn three times on October 2, 9 and 19, discharged altogether 91.9 millions of eggs.

The results of the experiments with two species of oyster show that the actual number of eggs developed each summer by the female oyster is much greater than was previously estimated by Brooks.

PAUL S. GALTSOFF

U. S. BUREAU OF FISHERIES

THE OIL ABSORPTION OF SHELL EGGS

SHRINKAGE, due to the loss of carbon dioxide and moisture, is the greatest economic factor encountered in the cold storage of shell eggs. The following is a brief preliminary report of work done in the food research division of the Bureau of Chemistry and Soils on the problem of reducing shrinkage, by the use of mineral oils.

Eggs were dipped in oil, some at atmospheric pressure, others under a vacuum. To facilitate macroscopic observation of penetration, the mineral oils used were colored with Sudan IV, an oil-soluble dye. Penetration was particularly noticeable around the air cells.

Soxhlet ether extractions of shells and membranes were made to determine quantitatively the oil absorbed by the shells and by the membranes. The normal quantity of ether-soluble extract in unoiled shells and membranes was found to be approximately 1 per cent. The normal quantity of fat in the membranes of unoiled eggs was found to be from 3 to 4 per cent. and in the shells (freed of membranes) less than 0.1 per cent. (Percentage was based on weights of individual samples.)

Eggs dipped in oil at atmospheric pressure for 2 minutes were found to contain approximately 10 times more ether-soluble extract in the combined shells and membranes than did the untreated eggs. The quantity of ether-soluble extract in the membranes, however, was found to be only slightly greater in the treated eggs than in the untreated eggs.

No difference in the quantity of absorption was found between the shells and membranes of brown eggs and those of white eggs.

Eggs dipped under a vacuum of 50 mm for 1 minute were found to contain approximately 13 times more oil than the untreated eggs. The quantity of ether extract in the shells of these eggs was found to be about 7 times greater than in untreated eggs and approximately the same as in the shells of eggs dipped at room pressure. The quantity of ether extract in the membranes was found to be approximately 5 times greater than in the membranes of untreated eggs and 4 times greater than in those dipped at atmospheric pressure.

Unoiled eggs, as well as eggs dipped in oil both at ordinary atmospheric pressure and under vacuum, were stored at 98° F. for 10 days, and weighed at 48-hour intervals for the detection of shrinkage. The unoiled eggs lost about 13 per cent. of their total weight in 10 days. Those dipped at atmospheric pressure in plain colored oil at 100° F. for 2 minutes lost approximately 2 per cent. of their weight. Eggs dipped in 2 per cent. aluminum soap oil under 50 mm of vacuum at 100° F. for 1 minute and stored at 98° F. for 10 days lost only 0.5 per cent. Almy, Hepburn and Macomber[1] reported that eggs dipped in oil containing 2 per cent. aluminum soap and stored at 40° C. for 12 days lost 6.2 per cent. of their weight.

These studies on the oil treatment of eggs are being continued.

T. L. SWENSON

H. H. MOTTERN

FOOD RESEARCH DIVISION

BUREAU OF CHEMISTRY AND SOILS,

U. S. DEPARTMENT OF AGRICULTURE

[1] L. H. Almy, H. I. Macomber and J. S. Hepburn, "A Study of Methods of Minimizing Shrinkage in Shell Eggs During Storage," *J. Ind. Eng. Chem.*, 14: 525, 1922.