LITERATURE CITED

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A Criticism of Oyster Measurements

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THERE ARE SURPRISINGLY FEW PAPERS among the vast amount of oyster literature which give measurements on oysters. Among those which do give measurements a high proportion report length of oysters in tenths of a millimeter. An article in a Bureau of Fisheries publication, one in the American Naturalist, one in a Canadian publication, and two fairly recent articles in Science, give the length measurements of oysters in tenths of a millimeter. Further, within the year, two manuscripts have been submitted to the writer for criticism in which comparative growth rates of oysters have been given, with the length measured in tenths of a millimeter. Such measurements are really too "accurate" to be accurate.

Measuring the length of oysters to a tenth of a millimeter should not be attempted because of the very nature of oyster growth, because of the limitations of the instruments used in making the measurements, and because of a time-growth element which should enter into the measurements.

Those familiar with the rapidly growing oysters of the Gulf and South Atlantic coasts realize that, in time of rapid growth, the bill of the oyster may consist of as much as three to five millimeters of extremely thin, britle, yet pliable chitin-like shell. In gathering specimens for measurements, injury is likely to occur to this thin bill. It is extremely difficult to determine by ordinary observation whether or not small parts of this fast growing oyster bill have been broken off. Assuming that the specimens for measurement can be and have been hand-collected, this very flexibility of a fast growing oyster bill makes it readily subject to distortion if even only a small amount of pressure is applied when the length of the oyster is measured with a vernier caliper. Accuracy of measurement to a tenth of a millimeter seems somewhat dubious under these circumstances.

A measurement or a weight can be only as accurate as the instruments used to weigh or measure. If the measurements of oyster lengths were made by use of an ocular micrometer in a binocular low power microscope, measurements down to one-tenth of a millimeter certainly would be accurate. Undoubtedly, however, the vast majority of oyster length measurements are made with a standard vernier caliper. It is extremely doubtful that any of these have been standardized by the U. S. Bureau of Standards. Although their accuracy is probably relatively good, two such calipers bought from the same company, but at different times, were compared recently at Bears Bluff Laboratories. One of these calipers is inaccurate to one-tenth of a millimeter. While this inaccuracy is small, nonetheless it is sufficient to influence oyster measurements which are given in tenths of a millimeter.

Robert Ingle's publication in Science (Vol. 112 No. 2908, pp 338-339) on the "Summer Growth of the American Oyster in Florida Waters" surprised

some oyster biologists who were familiar only with growth rates of oysters in the colder North Atlantic waters. Although we in South Carolina have no long series of oyster growth measurements exactly comparable to those given by Ingle, we have some measurements (admittedly our best) which virtually confirm Ingle's records. Averaging our best measurements a growth rate of 0.56 millimeter in a day has been found. An average of Ingle's figures gives a mathematical growth of 0.688 millimeter in a day. Assuming (erroneously to be sure) the growth rate is continuous and constant during the day, from the above figures, the conclusions reached are that Bears Bluff Laboratories' oysters grow at the rate of 0.023 millimeter per hour and that Ingle's oysters grew at a rate of 0.028 millimeter per hour. This seems to be mathematically accurate even though it is extremely doubtful that it occurs thus in nature. Now suppose that a series of oysters are taken for measurements beginning in the morning at 8 o'clock. Sampling continues periodically through the day until the last oyster taken for measurement is secured at 1 o'clock. These oysters are held out of water until they can be measured. For absolute accuracy it would be necessary to record the time at which the various specimens are taken. Since, mathematically and theoretically they are growing at the rate of almost a 0.03 millimeter per hour, the oysters taken at 1 o'clock would have had an opportunity of growing more than a tenth of a millimeter in the interval of time between the taking of the first oyster at 8 o'clock and the last oyster at 1 o'clock. Thus a time-growth element should be taken into consideration if measurements are given to an accuracy of a tenth of a millimeter.

Growth Rates and Movements of Hard Clams, Venus mercenaria

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AMONG THE NUMEROUS OBSERVATIONS that have been made of the growth rates of various species of pelecypods there are but few references to growth studies of hard clams, *Venus mercenaria*. These references are limited to studies in the northern range of *Venus*, from New Jersey northward. Kellog (1903) made some preliminary studies at Cold Spring, New York with small clams 2.8 to 4.4 centimeters in length. Unfortunately his experiments were continued for only six months from June to December, but the results clearly demonstrated the rapidity of growth in *Venus* with an increase, in some cases, of 225 percent in volume. The extensive plantings made by Belding (1912) in Massachusetts were followed for four years. The growing season in Massachusetts was found to extend from May to November when water temperatures were above 45°F. Various ecological factors such as current tides, depth of water, salinity, type of soil and temperature were found to influence the growth rate. Under favorable conditions Belding recorded clams growing two inches in length in two and one-half years from time of setting, to two and one-half inches in three and one-half years. He estimated that sixteen years would be required to produce a clam four inches in length. Haskin (1949) concluded after one growing season that the results in Delaware Bay, New Jersey checked almost exactly with those of Belding at Wellfleet, Massachusetts, The present study was undertaken to