damage during autoclaving with glucose. The vitamins required in the medium (B complex) contain nitrogenous moieties which might conceivably react with glucose similarly to amino acids. Inactivation of nutrients was minimized by using sucrose instead of glucose in the medium (Curve S), as previously described by the authors (*1*).

Reference

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Effect of Suspended Silt and Other Substances on Rate of Feeding of Oysters

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Our recent studies on the feeding of oysters (*Ostrea virginica*) with cultures of *Chlorella* sp., *Nitzschia closterium*, *Euglena viridis*, and other forms have shown that they feed most efficiently when the numbers of food microorganisms in the water are relatively small (*2, 3*). These conclusions are in agreement with the theoretical discussions of Kellogg (*1*) and Yonge (*5*). We found that both the filtrate of the cultures containing metabolic products of the cells and the cells themselves affected the rate of oyster feeding.

In continuing our studies on the feeding of oysters we substituted for living cells various turbidity-creating substances, such as fine silt collected from the tidal flats of Milford Harbor, a clay-like substance—kaolin (aluminum silicate), powdered chalk, and Fuller's earth. All these substances may sometimes be found under natural conditions in suspension in inshore waters. Silt, which is a mixture of organic and inorganic substances, is, of course, very common and always present in varying quantities in inshore waters inhabited by oysters.

The methods employed were virtually the same as those used in our earlier studies on the effect of different concentrations of microorganisms upon oysters (*3*). They consisted chiefly in recording, on the kymograph under normal conditions and when water was rendered turbid in various degrees, the rate at which the oysters pumped water through the gills and the changes in their shell movements. The concentrations ranged from 0.1 to 4.0 gm of turbidity-creating substances/l of water, except in the case of Fuller's earth, where only one concentration of 0.5 gm/l was used.

In the first series of experiments the water was made turbid by the addition of silt. Even when small quantities, such as 0.1 gm/l, were added, the type of oyster shell movement changed and the rate of pumping considerably decreased. The reduction averaged 57% (Fig. 1), but in some individuals the rate of pumping was decreased 87%.

A sharp decrease in the rate of pumping was always noticed when concentrations of 0.25, 0.5, 1.0, 2.0, and 4.0 gm/l of sea water were made. In concentrations of 1.0 gm of silt/l, the average rate of pumping decreased more than 80%, reaching a decrease of about 94% in concentrations of 3 and 4 gm/l. Although such heavy concentrations seldom occur in nature, they may, nevertheless, arise during heavy floods or be created in areas where the bottom deposits are artificially disturbed, as happens in the case of channel dredging.

The results of the experiments with kaolin and chalk were similar to those obtained with silt (Fig. 1). The addition of even such small quantities of these substances as 0.1 gm/l noticeably decreased the rate of pumping. This became more evident as the concentrations were increased. Nevertheless, even in high concentrations, the majority of the oysters kept their shells open most of the time and pumped some water. Fuller's earth was used only in one concentration, 0.5 gm/l, reducing the rate of pumping by 60%.

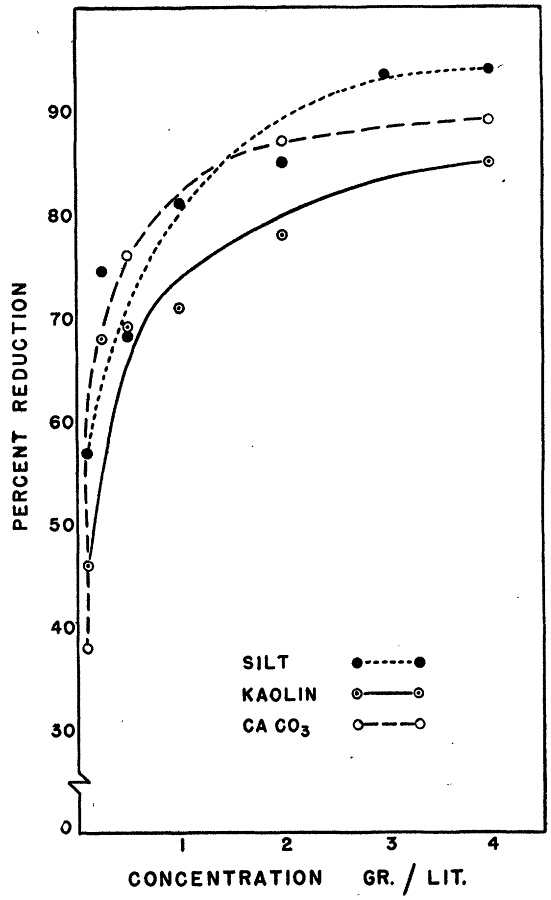

Fig. 1. Per cent reduction in pumping rate of oysters subjected to different concentrations of turbidity-creating substances.

It is possible that in the case of chalk the depression of the rate of flow was in part due to the chemical action of that substance. This possibility is now being investigated, and the results will be reported in the final article.

The oysters expelled, in the form of pseudo-feces, large quantities of suspended materials. Nevertheless, some particles passed through the gills, and some were found in the stomachs and intestines. In other words, although their efficiency of feeding was greatly depressed, the oysters could ingest small quantities of particles even while surrounded by very turbid water. However, some oysters, while kept in heavy concentrations, stopped feeding entirely although their shells remained open and moving. We agree, therefore, with Nelson (*4*) that oysters can feed in turbid waters, but wish to emphasize the point (not mentioned by him) that an increase in turbidity usually causes a decrease in the rate of pumping and, therefore, feeding.

behavior of oysters in turbid waters, regardless of whether this turbidity was caused by a large number of microorganisms or by inanimate matter.

In our experiments the oysters were kept in turbid water for comparatively short periods, rarely exceeding 6 hrs. Nevertheless, on the basis of our observations we may conclude that oysters are very sensitive to the presence of suspended silt and other substances, and that there is a correlation between the increase in the concentration of such substances and the decrease in the rate of pumping. In strong concentrations oysters may cease pumping entirely.

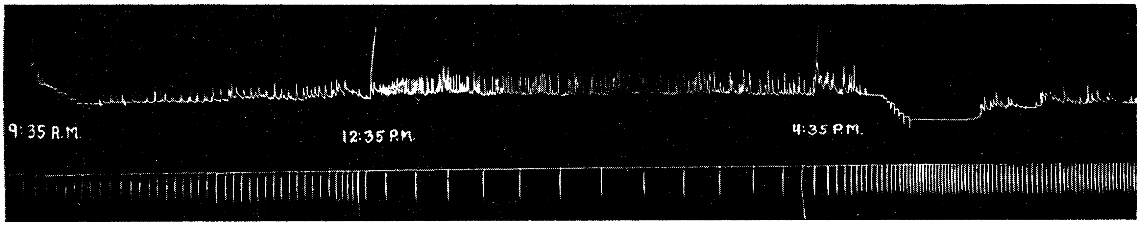

FIG. 2. Section of kymograph record showing effect caused by 2 gm of kaolin/l of sea water upon the shell movement (upper line) and rate of pumping (lower line) of an oyster. Each short vertical mark of the lower line designates emptying of dumping vessel of 275-cc capacity filled with water pumped by the oyster. The oyster remained in turbid water between 12:35 P.M. and 4:35 P.M.

The shell movements of the oysters in turbid water usually became of greater amplitude and their type was different than that observed under normal conditions (Fig. 2). This was especially well demonstrated in stronger concentrations. This type of shell movement was associated with the ejection at frequent intervals of large quantities of material accumulating on the gills. It closely resembled that observed in our experiments, where the oysters were exposed to large quantities of microorganisms (*2, 3*).

When the flow of turbid water was replaced with regular sea water, the oysters usually quickly recovered. Their shell movement soon became normal, and the pumping increased to the normal rate or even exceeded it. Such a behavior was also noted in our earlier experiments on the feeding of oysters and was usually associated with the change from water rich in microorganisms to normal conditions. In general, the results of our earlier (*2, 3*) and present studies showed a definite similarity in the

Our studies were made only with Long Island Sound oysters which were accustomed to living in comparatively clear water. We know, however, that in other places oysters live and propagate in water carrying large quantities of silt and clay. Although no explanation for this discrepancy is offered at present, it may be possible that we are dealing with physiologically different races of oysters, some of which have developed a greater tolerance to turbidity. A comparison of the behavior of oysters from widely different ecological environments is the next step in these studies.

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