of time produce a somewhat dehydrated product. Observations after several months of shrimp frozen in cans, showed no dehydration. The author did not feel that utilization of deveining machines would alter prices to the consumer.

The Emphasis in Oyster Research in Past Years

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Eight papers were presented to the morning session of the shellfisheries session of the Institute. This meeting was guided by Chairman William W. Anderson of the Fish and Wildlife Service. Summaries of the papers by the authors (with two exceptions) were presented in the abstracts section. Discussion was deferred until the afternoon panel session, when the papers were examined in considerable detail. It should be noted that there were two substitutions for authors in presentations of the morning session. First, Mr. George Gehres presented the paper by Richard P. Hardison which discussed bacteriological standards for oysters under conditions of a semi-tropical climate. Second, Chairman Anderson presented the paper by Phillip A. Butler which contained data on the importance of local environment in control of growth in oysters. Otherwise all papers were presented by the authors.

In the absence of A. E. Hopkins of the Gulf Research Laboratory of Mississippi, Dr. Paul Galtsoff consented to serve on the afternoon discussion panel. With Mr. J. N. McConnell of Louisiana and the authors of the various papers completing the panel.

Papers were discussed in the order in which they were read, with the exception of the first. Mr. Gehres was detained but since the contents of Mr. Hardisons' paper is of very considerable importance to the oyster industry some remarks concerning certain portions of it may not be amiss.

The paper did not attempt to present research data, but raised certain questions concerning the applicability of bacteriological standards developed for a more northern climate, to the semi-tropical Caribbean and Gulf coasts. Among other points made it was suggested that studies be made on several phases of the problem. These were (1) effect of temperature on the death rate of coliforms, (2) the effect of salinity on death rates under subtropical conditions, (3) determine whether or not development of coliforms takes place in oysters, and (4) studies to determine whether or not obsolete methods are being used. It is clear that such studies must be of primary importance, due to the fact that health agencies are bound by law to close to oystering those areas not meeting standards as now set up. If, as suggested, the standards themselves do not fit the climate, or have become obsolete, the oyster industry may be taking unnecessary penalties under the closure laws.

Philip A. Butler, Director of the Pensacola, Florida Station described in his paper, which was presented by William H. Anderson, difference in mortality and growth in oysters placed on opposite sides of the island on which the Pensacola Station stands. These stations were substantially equal as regards such factors as salinity, temperature, depth, turbidity, etc. Growth of local oysters at the two stations was substantially different, and the difference was

greater than the difference between "local" oysters and stocks shipped from the Chesapeake and kept at the same stations.

Although there were no obvious differences between the two local environments, the observations point to the existence of environmental conditions, which were unknown to the author but which are nevertheless, important in oyster growth.

Dr. Butler concludes from his studies that "greater differences exist in the environment at two adjacent stations (at Pensacola) than exist between stations over 700 miles apart". It should be pointed out that the statement is not necessarily true, since Dr. Butler was not comparing oysters in the Chesapeake with oysters at Pensacola. The fact that part of the oysters originated in the Chesapeake does not alter the fact that, during the eighteen months of the study, they were subjected to the conditions at Pensacola, not those in the Chesapeake. What Dr. Butler's study does show is that the origin of oysters has little to do with their growth and mortality in a new locality, within the distribution range of the species, barring injury in transportation. Also it points up the fact that perhaps undue stress has in the past been given to measurements of temperature and salinity when in fact other unknown or obscure factors are more important to oyster growth.

Robert M. Ingle, of the Appalachicola Laboratory described studies designed to measure the effect of shell dredging on fish and shellfish. The studies were carried on in Mobile Bay, at the site of the shell dredging operations to the northwest of Great Point Clear. Mr. Ingle decided from his studies that "damage to fishery animals due to dredging is frequently overrated" and pointed out that his studies led him to the same conclusions as arrived at by Robert Lunz in his studies of dredging operations in oyster producing sections of South Carolina. They also parallel those of Wilson in Texas. Ingle decided that the greatest possible distance that changes in bottom could occur was 400 yards from the operations.

Mr. A. J. Wegmann, in discussion, raised the question whether dredging operations could contribute to distribution of pollution, referring to sewage pollution from the city of Mobile. He also raised the question as to whether a combination of dredging and pollution could produce a large area (2 to 5 miles in diameter) of pollution. The concensus of opinion of the meeting seemed to be that, in the absence of any data bearing on the matter, the probability is that the two could not be linked. Mr. Wegmann also inquired as to the possibility that sewage pollution emanating from Mobile could be responsible for certain fouling of the shells of oysters in the lower Bay which was taking place at the time of the meeting. It was brought out that at the time, oyster beds in Mobile Bay were not polluted and had not been for some time. A connection between a non-existent pollution and a presently current fouling is highly problematical.

Mr. Ingle's studies pointed up the fact that wherever critical studies on dredging operations have been carried out, the results are approximately the same, namely that no measurable effects result from the operations if they are a reasonable distance from oyster beds. Mr. Ingle's conception of a safe distance is certainly conservative enough. Since silting is assumed to be the detrimental factor, it is obvious that the true problem is to determine how far are extraordinary suspensions of silt carried from the dredging operations.

By "extraordinary" suspensions is meant turbidities exceeding those naturally produced by wind and rainfall (not of storm proportions). Suspensions produced by these agencies occasionally attain 500 ppm in estuaries of the Gulf. Calculations based on a round number of 100 ppm which is commonly recorded, in a water body averaging 5 feet in depth shows that a nautical square mile of water will contain about 575 tons of suspended silt. On the exceptional days when wind velocity is high and sustained there may be as much as 2875 tons of suspended silt per square mile of water of 5 feet in depth. The whole of Mobile Bay on a day with 100 ppm of turbidity would have about 288,000 tons of suspended material in the water assuming an average depth of 10 feet and an area of 250 square miles. The absurdity of becoming agitated over the comparatively minute turbidities produced by a single dredge in 250 square miles of water is apparent.

Mr. Ingle pointed out that his paper had been published as a bulletin of the Florida State Board of Conservation.

A. F. Chestnut and W. E. Fahy of the Institute of Fisheries Research presented considerable data on the vertical distribution of setting of oyster larvae. They were particularly concerned with those areas where oyster production is completely intertidal as it is in parts of Virginia, the Carolinas and Georgia.

They reviewed the literature bearing on the subject, pointing out that few papers actually measured vertical distribution of setting. Some papers measured the set on culch placed on the bottom from points above low tide to points below, which does not actually measure vertical distribution since (1) the culch was all on the bottom, and (2) no two levels were measured at the same place. In other studies observations were made at such wide intervals of time that the factor of predation obscured the true conditions of setting.

Their own studies showed that setting occurred at all levels, and was often heavy at considerable depths below low tide level, in areas where adult oysters do not survive below low tide level at all, and where production is exclusively intertidal. They pointed to drill predation as the probable most potent agency in destruction of set of oysters below low tide.

As was inevitable, it was indicated in discussion, that predation by drills could not account for all losses of spat below low tide (in South Carolina). Thus, while it seems quite probable that drill predation below low tide accounts for the greater part of destruction of spat in some areas where production is entirely intertidal, in other large areas there must be other agencies of death. Probably the most enlightening one piece of information oyster biologists could work out is the answer to this puzzle. It is so commonplace that few have even realized that it is a problem. In those areas where oyster production has had its greatest decline, losses began in deeper water, and the last to disappear were the intertidal oysters. In Australia, when the industry based on deep water production completely failed, it was revived and made vigorous by moving the operation to the intertidal flats.

Robert Lunz and Francis Beaven collaborated in a study of costs and mortality factors in transportation of very young spat from South Carolina to the upper Chesapeake. The problem of obtaining seed is often acute in the upper Chesapeake and areas north, while from South Carolina south and around the Gulf Coast there is an embarrassing richness of set. How this excess of young

oysters in the south can best be utilized in the north is a primary problem of the industry.

Lunz and Beaven experimented with wire bags of shells in taking the set of spat. These bags held ½ bushel of shell and picked up several thousand young oysters each. These are trucked to the north without removal of the shell from the bags. There was little mortality from shipment in periods up to six days. The total cost per bag, not including shipment, was 21¢. Transportation costs are 3.5¢ per bag. Three hundred thousand bushels are available annually in South Carolina, the estimate based on available shell. Transportation and planting in summer was superior in survival to that in winter. Such "shell plants" make 3 to 4 bushels of adult oysters per bushel planted, when utilized in proper Maryand waters.

There was considerable discussion during which it developed that restrictive taxation on movement of the spat out of South Carolina constituted the greatest stumbling block to utilization of southern seed in northern waters.

The most interesting factor coming out of the study was that month-old spat can be shipped with much less mortality than can one-year-old seed, and much more economically. It would appear that industry can take up from this point.

Sammy Ray, J. G. Mackin, and James Boswell studied the effect of the fungus disease caused by *Dermocystidium marinum* on weights of oysters in Louisiana using a method which established a normal relation between meat weights and shell capacity, and compared the normal relation with the relation in heavily diseased oysters. A careful mathematical analysis was prepared by R. O. Reid. In general, drastic loss of meat weights by diseased oysters was demonstrated by the authors, especially in summer months, thus explaining in part the extremely poor summer condition of most Louisiana oysters.

Discussion of this paper centered around distribution of the disease, effects of transportation into new areas, and means of transmission of the parasitic fungus cells. Known normal distribution is from Virginia to Texas, environment controls the development of the disease in any area and introduction of infective elements is not calculated to increase incidence in an area not normally subject to high incidence, and the parasites are water-borne.

A very interesting paper was presented by Don Pritchard, Director of the Chesapeake Bay Institute. Study of the movement of water in the James River estuary in Virginia showed that inflow of deep water (below ten feet) exceeds the ebb flow. This provides a mechanism by which oyster larvae produced in the lower estuary may be carried upstream to the upper reefs. Indications are that larvae tend to aggregate due to some unknown biological factor, which would enhance the chances of mass movement upstream utilizing the deep water movement. Time elements as checked by studies on the set of spat at various levels in the James estuary tend to support the hypothesis that larvae utilize the deep layers in moving upstream. Abnormal water movements, for example movements caused by flood conditions, might result in upset of normal water movement and loss of spat by being carried out of the estuary.

David H. Wallace, Director of the Oyster Institute of America, presented the closing paper of the morning session. He made several points of importance. The main thesis was that in general the oyster industry based on *Crassostrea virginica* has suffered a decline roughly of 50 per cent in fifty years.

During that time extensive research on oysters has failed to stem the downward trend in production. Mr. Wallace, in an analysis of major research fields listed those dealing with (1) set of spat, (2) effects of predators and parasites in mortality, (3) feeding and fattening (4) studies on environmental factors affecting production, and (5) selective breeding. In spite of the extensive researches, little practical utilization of results has been achieved.

Extended discussion resulted from this paper. Dr. Galtsoff ably defended the biological studies on oysters of the past century. His most telling point was that much of the failure of the great producing center of the east coast, meaning Virginia and Maryland, is caused by political factors which prevent the development of public grounds. These public grounds, very extensive in area, are the best natural producing areas. In spite of the fact that they disintegrate through lack of development, private enterprise is prohibited from using them, and is forced to utilize marginal areas. State resources are entirely inadequate for development of the State-owned grounds, so that the attitude of the State in prohibiting private development by private enterprise amounts to a dog-in-the-manger performance.

Additionally, it is obvious that researchers are handicapped further by inadequate funds for experimental studies. There is not now, and never has been, a State or Federal agency designed for oyster research which was provided with adequate funds to provide necessary equipment and personnel. Technical personnel are often supervised by non-technical personnel who insist on limiting researches to the so-called "practical" studies, which in the long run often are far from practical.

Mr. Baughman, Chief Marine Biologist, Texas Game and Fish Commission, stated it as his opinion that oyster biologists should be able to tell industry where and when to plant oysters in order to achieve a profit, and attributed a part of the decreased production to failure on the part of oyster biologists. The inference was that college-trained biologists are academic and impractical, and that a practical man could do better.

Mr. Wallace, in summarizing what could be done to relieve the situation of declining production, mentioned four things. First he advocated surveys for high-setting areas. He was evidently not thinking of the Gulf of Mexico when he mentioned this as a profitable study, since approximately all Gulf areas produce an overabundance of spat. Secondly, he advocated studies of transportation of seed, certainly an overdue study. Thirdly, he advocated studies of control of pests and predators, a field which should be highly profitable in some cases (*e.g., Thais*). Fourth, he suggested removal of "political interference" in development of the industry, which field, not being of scientific nature need not be commented on here.

Mr. Wallace's paper points up the fact that we are long overdue an assessment of our position as regards research in the field of oyster production. It seems evident that certain lines of research, long since proved sterile, are still followed through sheer inertia. Other fields obviously of primary importance, are neglected. It is suggested that an assessment of position should be divided into several headings as follows:

1. Critical analysis of research of the past 75 years along the lines of
   a. Measurement of emphasis placed on various lines of research.
   b. Tracing of changing trends in research.

c. Analysis of accomplishment and delineation of areas in which we are lacking in knowledge.

2. Enumeration of the most profitable fields of research and establishment of plainly stated objectives for future research.
3. Assessment of the research facilities in terms of personnel and material and the organization of the research agencies into a co-operative organization.