First Annual

OYSTER MORTALITY CONFERENCE
January 20-22, 1959

RUTGERS, THE STATE UNIVERSITY
NEW BRUNSWICK, NEW JERSEY

In cooperation with
Branch of Commercial Fisheries
U. S. Fish & Wildlife Service.

SUMMARY OF CONFERENCE

Enclosure: 1 - Topics for Discussion
2 - Attendance

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Rutgers, The State University
New Brunswick, New Jersey

TOPICS FOR DISCUSSION

I. PATTERNS OF OYSTER MORTALITY:

A.	57-Spring Mortality-Delaware Bay	Staff. N.J.O.R.L. including McDermott
B.	58-Fall Mortality-Delaware Bay Intensity, scope, timing, sampling	
C.	Mortalities in Delaware Waters	Shuster
D.	Mortalities in Long Island Sound	Nelson
E.	Canadian Mortalities	Logie
F.	Mortalities in Chincoteague Area	Sieling-Carver-Engle
G.	Mortalities in Chesapeake Bay	Andrews-Beaven

II. CAUSATIVE AGENTS:

A.	Dermocystidium	Andrews-Kunkle-Myrhe
B.	Examinations for parasites Hexamita, Nematopsis, Ciliate	Stauber
C.	Bacterial Studies	Logie-Adelson
D.	The "new organism"	Stauber-Nelson-Haskin
	1. Description of stages, Demonstrations	
	2. Inoculation experiments	Feng-Canzonier
	3. Culture observations	Myrhe-Logie
	4. Tray studies-Cape Shore	Haskin

III. WORK TO BE DONE:

A. With Agents:
   Identification, culture, limiting factors
B. With Host:
   Transfer of infections
   Resistance studies
C. With Industry:
   Development of Resistant Strains
   Importation Policy

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PATTERNS OF OYSTER MORTALITY

A. Delaware Bay 1957-58. Haskin and Staff New Jersey Oyster Research Laboratory

In the six-week period from mid-April to late May 1957, oysters died rapidly in extensive areas of the New Jersey planted oyster grounds. June sampling indicated that the kill was centered on the "Shoal Sand Bar and upper Deepwater grounds with generally decreasing intensity of kill as distance from this center increased. One Bar ground had 85% kill and several had about 70% kill. The kill dropped off to 35% in the Ledge, Southwest Line and Lower Deepwater areas. No appreciable mortalities occurred on Miah Maull grounds or in Section A - the easternmost portion of the planted areas - nor on the Natural Seed Beds.

On the planted grounds at this time were oysters from a variety of sources. Approximately half a million bushels of seed oysters from the Natural Beds had been planted in May 1956. According to the best information available there was probably a much larger quantity of James River stock on the grounds, replanted from Lower Chesapeake Bay grounds. Few grounds of Virginia "brush" (oyster from the Virginia seaside) were planted. There was no apparent difference in susceptibilitv of these various stocks. James Rivers and Native Bays on adjoining grounds were equally hard hit. There was a suggestion that the Virginia "brush" was less hard hit, but there were not enough grounds of "brush" to be sure of this.

Various grounds were sampled periodically following this spring mortality, providing some evidence for additional kill in the fall of 1957 and spring of 1958. Stocks of oysters were low however, and virtually all grounds were "run" by the planters in the 1957-58 market season. Apparently the survivors of the 1957 kill and the winter of 1958-58 suffered an additional 30-40% loss in the spring of 1958.

In May 1958 approximately 450 thousand bushels of seed oysters from the Natural Beds were again planted. By September these were showing an unusual death rate, little or no shell growth and apparently were not feeding as indicated by stomach examinations and lack of style. By December total mortalities on the 1958 plants ranged from 40-60%. Excluding drill-kill, deaths from unknown causes, presumably an epidenic disease, ranged from 25-40%.

The 1958-fall mortality differed from the 1957-spring kill in that, in the former, the kill was more uniform over the entire planted grounds and extended to the Natural Seed Beds, as far up Bay as the Middle (above Ship John). Assuming that an infectious agent caused both, it would appear that the infection started in the Bar-Shoal Sand areas of heaviest oyster plantings and then spread rapidly to uniform infection over the entireplanted area and lower Natural Seed Beds.

B. Mortalities in State of Delaware Waters. Shuster

The mortality data reported here are based on spot checks. In 1956-57 the State planted 8-10 thousand bushels of oysters on the Ridge (a seed bed) as a spawning stock. When checked in August 1957 they were living well. In

March 1958 the Delaware Shellfish Commission reported these as "100% dead." Fresh-water kill was suspected, but this seems unlikely since no appreciable fresh-water kill occurred at this time on New Jersey seed beds in much fresher waters. The Delaware Industry first publicly reported extensive kills in late summer and in September 1958. Four inspection trips were then made by the Delaware Marine Laboratory. Two of these to Rehoboth Bay - Indian River area (10,000 acres) indicated that Cape Shore set planted here in 1957 was about 70% dead. Reports of 30-90% mortality were investigated on two trips to Delaware Bay beds off Bowers Beach; on soft-bottom beds with much hydroid and boring sponge, mortality averaged 70%. Virginia "brush" planted in spring of 1958 in the Mispillion River area was living well; in the Murderhill River area it was 40% dead.

This year's production of oysters was estimated at not over 70,000 bushels in contrast to 800,000 bushels for last year.

C. Mortalities in Lond Island Sound Areas.

In the absence of Dr. Loosanoff, Dr. Nelson reported on the fragmentary information available on recent Long Island Sound mortalities. In November of 1950 J. R. Nelson reported a loss of about three-quarters of his oysters following the "hurricane" which moved oysters in depths of water up to 60 feet. In late summer of 1953, 80% of the oysters on Fireplace ground in Gardeners' Bay died suddenly. This mortality has never been explained. At this point Dr. Nelson emphasized the importance of considering possible multiplicity of factors in such mortalities. For example it may be an oversimplification to think of a causative agent without considering factors which at the same time lower host resistance, such as poor food conditions, smothering by storm-moved sediments etc.

Also about 1953 Frank M. Flowers & Sons reported unexplained heavy mortalities of market stocks in Oyster Bay. These mortalities followed shortly planting of oysters from the lower Hudson River.

D. Canadian Oyster Mortalities. Logie

Dr. Logie first reviewed the operations of the industry in the St. Lawrence areas, pointing out that oyster production is generally limited to the warm inner circle around Prince Edward Island. Peak production is about 150,000 bushels of seed stock for the entire area with relative production for Nova Scotia, Prince Edward Island and New Brunswick in the proportions of 1: 2: 2½. The oyster-producing waters are ice covered from about mid-November to sometime in May. Setting is irregular because of low summer temperatures. Silt depostions in the rives is another critical problem and limits oyster culture to the mouths of estuaries.

In 1915 heavy mortalities occurred on oyster grounds in Malpeque Bay on P.E.I. These were not investigated until Dr. Needler arrived on the ground about 1929. Reports of events of the intervening 14-years are based therefore on accounts of growers. In 1914 some oysters from Connecticut were planted in Malpeque Bay by the Blue Points Company. The mortalities began in 1915 and fanned out from the areas of this planting. Eventually mortalities of 90-95% occurred in all oyster populations on the Island. All transfers of

oysters to the mainland were embargoed and no mainland outbreaks occurred until 1955.

Dr. Needler, starting in 1929, gathered together surviving oysters and studied the resistance to disease of these and their spat. In Malpeque Bay, spat survival appeared normal by 1929. The fishery recovered by 1935. After outbreak of the disease in the Charlottetown Area in 1936, resistant Malpeque stock was imported. In this area, porduction reached pre-disease levels by 1947. This looks promising for an assisted-recovery. In the current mainland outbreaks in Nova Scotia, the Canadian government is moving large numbers of resistant oysters to the epidemic areas, in an attempt to speed recovery of the industry. It has so far been shown that the transplanted, resistant stock will spawn in the new areas. Whether the spat is resistant is not yet known.

Causing concern at present are unusual unexplained mortalities in the heart of Malpeque Bay over the past three winters. Oysters have died at an approximately constant rate of 30% per winter.

Model epidemics set up with susceptible stocks in epidemic waters have established a consistant pattern of mortality for the "Malpeque disease," as follows: Seed oysters first exposed in spring may or may not die on the first winter. In the following summer, mortalities continuing to the fall-freeze-up will kill 40-45%; in the second winter and spring another 40-45% die and by late summer total mortalities will be about 90%. In following years mortalities continue until only 1-5% of the oysters survive. In summary, approximate annual and cumulative mortalities are:

	ANNUAL	CUMULATIVE
1 st year	5%	5%
2 nd year	40-45%	45%
3 rd year	80%	90%
4 th year	60-65%	95%
5 th year	40% (?)	
6 th year	25% (?)	

This indicates the peak mortality in the 3rd year after exposure.

In the discussion Dr. Logie brought out the point that there has been no single definite symptom of Malpeque disease. Specifically, yellow pustules are not characteristic.

E. Chincoteague Mortalities. Engle, Sieling, Carver.

Engle - introduced this section, pointing out the role of the U. S. Fish & Wildlife Service in arranging for the collection of samples from areas of oyster mortality in 1958 and their shipment to New Jersey for examination.

Sieling - reviewed the recent history of the Chincoteague area with respect to oyster mortalities as follows:

1945-46 Summer mortalities associated with decomposition of heavy blanket of algae-probably Agardhiella.

1952 - Another summer loss-following excessive algae.

1958 - Heavy algae growths were carried out of Bay by a June "northeaster." As an example of mortalities, 2 beds planted with Virginia salts in 1957 had 80% kill by late summer of 1958 (not drilled). One bed of 1958 plants had 50% dead by late summer. It is estimated that 1958 mortalities in lower Chincoteague average about 50%. Some Chesapeake transplants (late winter 57-58) also died. Two

groups of oysters brought up from Oyster, Virginia were compared:

1. Planted in Sinepuxent Bay: By fall was 40=50% dead and survivors were poor.
2. Planted in Assawoman Bay (Isle of Wright) are healthy and living well.

By way of correlations it was pointed out that years 1945, 1946, 1952, and 1958 were all wet years with excessive rainfall. For example, salinities in the center of Chincoteague Bay this year were 18-19% as compared with the usual 25 o/oo. The Chincoteague watershed is small (about 110 square miles) but is intensively farmed. There is a small native oyster population along the marsh banks in the lower part of the Bay.

One would expect normally up to 10% annual mortality due to unexplained causes.

Carver: who has been working cooperatively with Sieling in the lower Chincoteague area pointed out that in the Queen's Sound area mortalities were about 50% with about 5% due to drills. The kill is very spotty, however, as shown by 2 adjoining beds, one with 11% and the second with about 50% kill. As of 16 December, examination of beds indicated that the kill was dropping off.

F. Chesapeake Bay Mortalities.

1. Maryland - Beaven

Maryland has no real drill problem except in Tangier Sound where drills can kill up to 100% of the oysters.

Various mortalities were reviewed as follows:

1916 - on Western shore of Bay-up to 80% mortalities; no explanation.
1932 - Little Choptank River - investigated by Truitt and Beaven in early August. Hauls showed mortalities from 40-100%. Beaven recalls that up to 50% of the recently dead oysters still had meats in the shell. Death occurred on the shallow bars indicating that it was probably not due to oxygen lack. This area required 8 years for the bars to come back into production.
1957 - to date: The last two winter-kills have been about 15% instead of the usual 5%. Watermen ascribe this to the harder winters. In 1957 - Pocomoke Sound, with a high Dermocystidium incidence, had a 30-35% kill of oysters. In 1958 - during August and September high kills occurred on deep bars - attributed to the low oxygen levels which existed for at least 2 weeks while temperatures were at 25°C or more.

In the Maryland portion of Pocomoke Sound the oystermen catch their own spat locally. In the Virginia portions of the Sound, James River Seed are planted.

2. Virginia - Andrews

Andrews discussed patterns of mortality in the lower Chesapeake based largely on tray studies and mostly in terms of Dermocystidium kills. At a 20°C transtional temperature, this area has 5 warm months, from 1 june to 1

November, and 7 cold months. By 1 July temperatures usually reach 25°C.

Peak mortalities occur in August and September in trays. Field mortalities are usually about 1/3 less. Levels and pattern of mortality are influenced by source and ages of oysters. Infections build up slowly in uninfected seed oysters and in the first 2 years kills are low at 5-10%. The kill builds up in the 3rd year and reaches a peak in the 4th year.

The levels of kill in trays over the last 8 years are given below. These were all with three and four year-old oysters.

1951 - 25%	1955 - 33%
1952 - 22%	1956 - 20%
1953 - 33%	1957 - 35%
1954 - 53%	1958 - 22%

On the bottom there is a 15-20% mortality not occurring in trays. In interpretation of the tray mortalities one must remember that density of planting is important. That oysters pick up infections from gapers nearby is shown by a 5% death rate in one experimental group, compared with a 25% rate in comparable trays but with infected oysters mixed in.

Older kills:

1930-Mobjack Bay: Dunnuntt report shows that this was a late winter-early spring kill with high mortalities on some grounds. Rumors indicate that this kill was more widespread than just in Mobjack Bay.
1949-Rappahanoch River kill-associated with heavy fresh water run-off. Bottom blackened in May, oysters appeared OK in June but were dead by August 1.
1955-Rappahanoch Kill-assosicated with the hurricanes of that summer.
1958-Brown shoal in James River had a 15-20% end-of-winter kill.

On the Eastern Shore--Andrews had hearsay reports only:

During 1958 there were several complaints of unusual mortalities from the Seaside but few on the Bay side. Prior to this past season, reports of mortality have been isolated and sporadic. In 1957 no complaints reached the VFL. In 1956 one grower in Hog Island Bay (Nat Perry) reported heavy loss of oysters-verified by Sieling at 25-30% mortality. This was market stock in 8-10 feet of water; a fall loss. Dredges on this ground-filled with sea urchins.

CAUSATIVE AGENTS

A. Dermocystidium. Andrews, Myrhe, McDermott

Andrew's discussion of Chesapeake Bay mortalities above was largely concerned with Dermocystidium and included the patterns of D. marinum kill. McDermott summarized D. marinum data for Delaware Bay. Since 1955 the New Jersey Oyster Research Laboratory has been studying the incidence and distribution of this fungus on New Jersey oyster grounds. The distribution closely approximates the distribution of peak mortalities in the 1957-spring kill but the peak incidence, as shown by the thioglycollate method of Ray, is in September and early October. Different intensities of infection from 1955-59 were correlated with summer temperatures-with the highest peaks occurring after the hottest

summers. Based on experience with D. marinum in other areas Dr. J. L. Mackin has estimated that at our level of incidence, in the fall of 1958 he would not expect over a 5% monthly mortality (for a 2-month period) attributable to this fungus. It was pointed out that the distribution of D. marinum in Delaware Bay corresponds closely to the pattern of planting of imported oysters in this decade.

B. Various Parasites. Stauber

In seeking explanations for the unexplained mortalities, the most obvious one is that a new etiological agent is involved. It is also obvious that, at least theoretically, this might be viral, spirochetal, bacterial, fungal, rickettsial or protozoan in nature. The position taken was that in an unexplained mortality no possibility can be overlooked.

Several lines of investigation, underway to explore these possibilities, were presented. Following the spring of 1957 mortality, organisms like Nematopsis, Dermocystidium and the ancistrocomid--like ciliate were sought for both in fresh oysters and in tissue sections of them, and an attempt was made to evaluate their possible role in the mortalities. There is no evidence, that any of these is importantly involved in the present mortalities.

C. Bacteria.

Attempts to isolate and characterize bacteria from healthy and dying oysters by Adelson in the fall of 1958 were described. Only two types of bacteria consistently appeared in culture of material (gapers and healthy oysters) taken from high mortality grounds in contrast to the large numbers of bacteria reported by Logie and earlier by Fraser. Bio-chemical studies with these bacteria are in progress. In addition, the fate of pure cultures of various organisms injected into the oyster's blood stream was described. While most such organisms, of those already tested, are readily destroyed in the oyster, it is noteworthy that one bacterial associate was able to maintain itself in the oyster for a considerable period of time. While none of these organisms can be incriminated in the present outbreak, or definitely associated with oyster disease, the possibiltity should not yet be discarded. Because of deficiency of methods no attempts have been made yet to find intracellular parasites like viruses and rickettsiae.

D. The "New Organism".

Finally, the new multinucleate-sphere, organism "X", was described, distinguished from Dermocystidium, and its asssociation with the New Jersey outbreak and its possible relation to other outbreaks discussed. As a part of this, a demonstration session was conducted with displays of many of the known associates of oysters. Fresh and stained wet mounts from oysters or Dermocultures and stained sections and smears of fixed material were available for study. In addition, some special aspects of oyster histology were shown for comparative purposes.

4. Tray Studies - Cape Shore. Haskin

To determine whether or not the surviors of the 1957-spring mortality

were carrying infective agents, a tray experiment was set up on the tide flats of the Cape Shore in June 1958. Seed oysters from 3 up-Bay Natural Seed Beds and Cape Shore native yearlings were mixed in various combinations with lower-Bay 1957-kill survivors. Seed oysters alone were the controls. Mortalities were high in all trays in the September-December epidemic that swept through Delaware Bay with no appreciable difference between experimental and control trays. However, there were definite differences in the susceptibility of the various oyster stocks.

a. Seed oysters, mostly set in 1956, from Middle, Cohansey and Shell Rock natural beds showed the highest mortalities with peak monthly rates ranging from 30 to 40%.
b. Larger oysters from the planted grounds and from the lower Natural Seed Beds had monthly mortalities ranging generally between 10 and 20%.
c. Yearling Cape Shore natives had the lowest mortalities with monthly rates ranging between 5 and 15%.

All gapers from these trays have been fixed and are being processed for histological study. Virtually all examined to date show the "X Organisms" - frequently in very high concentration. Mortalities were at peak levels in September and October - corresponding with peak kills on the planted grounds. There is some indication of minimal mortality during the high temperature period of late June, July and August but this is not certain because of the late starting date for the trays.

1958 spat on the Cape Shore tide flats, fixed in late November, are already heavily infected with "X." This indicates that the yearling oysters from this area used in the tray experiments may have undergone an initial mortality and screening out of susceptibles.

WORK TO BE DONE

This portion of the conference was a general consideration of lines of work to be pursued. The New Jersey group indicated plans for work to be done and asked for comments and suggestions.

It was emphasized that the primary objective is to determine if the "X organism" is the pathogen responsible for the epidemic disease in Delaware Bay. So far all observations on distribution and intensity of infection are consistent with the hypothesis that it is indeed responsible. It is intended to continue the monthly field sampling on selected oyster grounds and the Natural Seed Beds. These samplings will provide fixed material to tie in with observed mortalities. Continued histological study, with the cooperation of Dr. J. G. Mackin and perhaps Dr. John Karling, will probably lead to the identification of "X" and more knowledge of its life cycle, and histopathology.

Mr. Scheltema at the Cape Shore Laboratory has set-up aquarium experiments with uninfected stocks mixed in with oysters from high-mortality grounds, to determine if infections can be transferred readily from oyster to oyster. It is anticipated that Dr. Mackin's techniques with Dermocystidium infections will be employed here when sea-water facilities are available. The development of reliable infection techniques with "Xorganism" may permit short-term studies on host resistance.

It is anticipated that the inoculation work of the New Brunswick group will also be continued. Although primary emphasis is on the "X organisms", the leads with 2 different bacteria are strong enough to justify some inoculation studies with these.

The members of the conference commented favorably on the proposed lines of attack in New Jersey. Maryland and Virginia representatives indicated that they would:

a. Watch carefully for further evidences of oyster mortalities in their areas and,
b. Commence at once a survey of areas and fixation of oysters to search for the "new organism" and to provide background data for future mortality studies.

It was generally agreed that any effective control measures for the causative agent in the Delaware Bay mortalities would require knowledge of its life cycle and possible limiting factors. The chief hope for the industry is that strains of oysters resistant to this agent may be selected in Delaware Bay. To facilitate the selection of such strains it was agreed that transfers of oysters into and out of the Bay should be held at a minimum.