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The purpose of these summaries is to demonstrate that a high level of genetic resistance to MSX has been acquired in lab-bred oysters in Virginia waters. The brood stocks were selected from survivors of James River seed oysters that were 90% killed in the early 1960's on private beds in Mobjack Bay. Only data from the years 1976 to 1980 are given in this summary, although comparable data have been accumulated since 1964 when laboratory breeding began.

All oysters were monitored in large, legged trays holding about one bushel of oysters when full. The monitoring station at Gloucester Point is about one-half mile above the York River Bridge in 12 to 15 feet of water. It is an abandoned oyster bed with shells and a few oysters on the bottom. The tray prevents smothering and eliminates predator mortalities because handling every 2 to 3 weeks allows thorough cleaning of oysters and trays from a boat. The operation is planned and operated to eliminate most causes of deaths except diseases of which Dermo and MSX are the primary ones. Trays are located beside stakes that are spaced about 50 ft. apart to minimize the spread of Dermo which is very contagious when oysters are in close proximity to each other. Once a tray of oysters is infected by Dermo, the disease spreads rapidly and kills many oysters. It is necessary to isolate infected lots or begin with new disease-free groups every 3 to 4 years at least.

Twenty-two years of experience with MSX-killed gapers and prevalences of MSX in live-oyster samples has demonstrated that in trays, where Dermo and other natural causes of deaths are controlled or eliminated, MSX causes 90% of deaths (Andrews 1966 and Andrews and Wood 1967). The only period when the ratio is lower occurs in winter when a large proportion of dying oysters are recovered as gapers for testing. About 50% of deaths in winter are caused by MSX. However, in annual compilations of gaper diagnoses, winter recoveries are dominant and they distort the ratios of MSX-infected oysters. On natural beds, the ratio of deaths caused by MSX is lower and variable, but it is still the dominant cause of deaths that keeps half of Virginia's private oyster grounds from being planted with oysters.

Over the past year, there has been much discussion about saving the fast-growing, MSX-resistant brood stocks built up over a 16-year period. I have proposed that representative resistant-oyster populations be bred for setting on shells. These shells may be planted around stakes on barren, hard bottoms inshore of Wreck Shoal in the James River. There is considerable risk in this, but the alternative of tray culture off the bottom in York River is labor intensive and not adequately financed now.

The youngest oysters in tray-grown resistant broodstock are now 3 years old. Most lots are five or more years old and Dermo is active. At a recent MSX conference at VIMS, I found Dr. Kranz receptive to trying to breed some of the brood stocks for us and for his own purposes. He now has a geneticist at Horn Point Laboratories and could check out progeny and parents for isozyme distributions.

I have prepared summaries of the lots that were taken back to Maryland on 16 June 1981, to aid in planning and interpreting crosses. Most lots have been outcrossed for two generations after several generations of inbreeding. Most are derived from James River stocks and maintenance of separate inbred lines is not important.

Four tables have been prepared to demonstrate the characteristics of these lab-bred stocks for breeding of superior strains of brood stocks. First, the mortality records of susceptible James River oysters at the Gloucester Point station are given in Table 1 to show that MSX has been highly selective of oysters for resistance in recent years.

Each year, two or three trays of susceptible oysters are imported from James River to Gloucester Point in March. In most years, late-summer importations of susceptible oysters were made also. In Table 1, 13 lots of tray oysters are listed for annual mortalities by calendar years. Experimental lots were usually held for at least 2 years, but in 1980 it was decided that my monitoring operation would be closed out for lack of money and personnel, therefore the trays of susceptible oysters were discarded. Then the 1980-81 drought necessitated reinstating the monitoring program.

Horsehead oysters exhibited a 56% first-year mortality and a 48% second-year kill. By the third year, the mortality rate was 40% (only 1978 represented). When Rainbow Rock oysters from further down the James River are included in averages the rates drop to 50% and 42%, respectively, for 1st and 2nd years. The accumulative totals for 2 and 3 years of mortality average 75%. It takes very drastic kills to push the rates much above 80%. Fall importations had almost no deaths the remaining part of the first year, but averaged 59% for the second year. In Virginia, infections after 1 August rarely kill oysters before June-July of the next year.

Table 2 gives the accumulative mortalities for up to 5 years in lab-bred oysters selected for resistance to MSX. Deaths were very light the first year after setting and it is rare to find MSX infections in these oysters from late-summer exposure. The spat were usually taken to Ames Pond, a small culvert-fed swimming pond that appears not to permit MSX infections at any age. After natural setting had ceased in York River about 1 October each year, the new batches of spat were placed in mesh-lined trays at Gloucester Point in the York River. In effect, the spat were only exposed to MSX for part of the month of October the first year. Some lots were not counted until spring but they were examined regularly to clean off sea squirts and were observed to have very little mortality.

Table 2 shows that most tray oysters had less than 10% mortality after 3 years of monitoring in the York River. By the 4th and 5th years, Dermo had appeared in the trays and mortalities increased.

Where Dermo was kept out, mortalities actually declined in later years, presumably reflecting resistance of survivors to MSX.

Table 3 provides a subjective evaluation of the relative merits of various tray groups for broodstocks. All groups are considered to have adequate resistance to MSX for satisfactory culture in lower Chesapeake Bay. I find only low levels of MSX infections (< 10% usually) in these resistant oysters and I do not find the chronic infections that are reported from Delaware Bay. Always the largest, best-shaped oysters were chosen for breeding--first by progeny lots and then by individuals in the chosen lots. Shape evaluation consisted primarily of choosing wide, deep-cupped oysters and avoiding elongate, irregular-shell features in lots of oysters. Uniformity of shape and size and presence of few runts were important factors. Mortality rates, more often than prevalences of MSX, were used as evidences of resistance in later years. As trays became crowded, groups were subdivided and small, runty oysters were discarded. This usually occurred after 2 years of monitoring, but in later years, large spat were selected early for monitoring at the time of transfer from the pond.

Table 4 gives the prevalences of MSX and Dermo in live oysters and gapers. After many years of sampling, I relied on low mortalities in resistant-progeny groups to indicate low MSX prevalences. Consequently, reliance has been placed mostly on mortality rates to indicate resistance of a group, and few live-oyster samples were taken for diagnoses. Also, low death rates meant that few gapers were recovered for testing for diseases.

Table 1. Annual mortalities of James River (Horsehead) Oysters at Gloucester Point, Va., York River.

Tray Nos.	Date of Import	Annual Mortalities by Calendar Years 1st Yr	2nd Yr	3rd Yr	Totals (accumulative)
Y97	24 Mar 1978	55	40	38	83
Y98	24 Mar 1978	44	40	—	66
Y99*	29 Mar 1978	23	37	41	71
Y100*	17 Mar 1978	27	33	39	70
Y101*	29 Aug 1978	0	43	15[a]	—
Y102[b]	Native York set 1974 (trayed 15 Sep 1978)	3	8	4[c]	—
Y103	20 Mar 1979	57	56	—	81
Y104	20 Mar 1979	61	—	—	—
Y105	20 Mar 1979	54	56	—	80
Y106	6 Aug 1979	5	63	—	65
Y107	26 Sep 1979	1	70	—	71
Y108[d]	20 Mar 1980	58	—	—	—
Y109[d]	20 Mar 1980	58	—	—	—
Y110[d]	20 Mar 1980	62	—	—	—
Averages - spring imports		49.9	42.0	39.3	75.2
Averages - fall imports		2.0	58.7	—	68.0

* Rainbow Rock seed oysters from below Horsehead Rock

[a] to 26 June 1980 only

[b] trayed at market size and 4 yrs. of age - excluded from averages

[c] to 26 June 1980

[d] anaerobic freshwater kill of April 1980 excluded

Table 2. Mortality Records of MSX-Resistant Oysters Selected for Broodstocks.

		Accumulative Mortalities* - Percentages				
		Age of Oysters				
Tray No.	Yearclass**	12	24	36	48	60
P176	1976	3.4	7.3	10.4	20.3[D]	36.6[D]
P179	1976	0	2.5	4.8	7.8	29.6[D]
P181	1976	- nc	5.6	9.4	11.1	25.7[D]
P186	1976	- nc	4.5	8.6	15.6	35.6[D]
P190	1976	- nc	- nc	3.7	3.7[a]	10.9
P196	1978	- nc	1.0	20.4	-	-
P197	1978	- nc	0.7	8.3	-	-
	Averages		3.6	9.4	11.7	27.7

* Calculated from 1 Jun to 1 Jun by approximate ages of 1, 2, 3, 4, etc. years.

** no spat produced in 1977 and 1979 despite attempts - hatchery failure

D probable Dermo kills

nc not counted until spring - but no selections by MSX because no mortality

a none died for 1 yr., held at VIMS pier until Aug 1978, therefore exposed to Dermo as spat

Table 3. List of Brood Oyster Lots Sent to Dr. Kranz at the Horn Point Lab in Maryland.

Tray No.	Parentage	Yearclass	Description[E]
P176	XLA2* X P151	1976	MSX-resistant - excellent growth - good to V-good shape - good mort. - V-low
P179	XLAB* X P99	1976	MSX-resistant - excellent growth - excellent, large shape - wide, a little thin mort. - V-low
P181	P141 X P99	1976	MSX-resistance - excellent growth - superior shape - wide, large, uniform mort. - V-low
P186	P159 X P100	Aug 1976	MSX-resistance - excellent growth - V-good shape - OK, a little irregular mort. - V-low
P190	P141 X P99 & P141 X XYNAA*	1976	mixed at pond by accident MSX-resistance - excellent growth - V-good shape - wide, but thin mort. - V-low
P196	P141 X P172	1978	MSX-resistance - good growth - good shape - a bit thin mort. - low
P197	P141 X P182	1978	MSX-resistance - excellent growth - V-good shape - OK mort. - V-low

* Delaware Bay lab-bred stock - Haskins

E excellent MSX-resistance - less than 15% mortality in 3 year's exposure

Table 4. Live Oyster Samples and Gapers Collected for Disease Prevalences.

MSX in Live Oysters and Gapers

Tray No.	Date	No. Oysters	Prevalences (cases) MSX	Dermo* (1980) (gapers)
P176	5 Oct 1977	21	0	no summer gapers
P179	3 Aug 1977	25	0	1M, 1L, 1N
	22 May 1980	25	0	
	gapers	5	0	
P181	1 Aug 1977	25	1	2N
	9 Nov 1979	25	1	
	14 May 1980	25	0	
P186	3 Aug 1977	25	1	3H, 1R, 1N
	4 Sep 1979	25	3	
	gapers	5	1	
P190	25 Jun 1980	not processed		2N
P196	2 Oct 1979	25	0	4N
P197	2 Oct 1979	25	0	no gapers
Totals		256	7	(2.7% prevalence)

* No live-oyster thioglycollate tests for Dermo in these lots. None found in stained slides of live oysters.