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The Occurrence of the Nuclear Inclusion (NIX) Parasite in Oregon Razor Clams (*Siliqua patula*)

PROGRESS REPORT

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Razor clam (Siliqua patula) populations in Oregon and Washington have fluctuated substantially over the 30 to 40 year period that observations have been recorded by state agencies. Although the causes of these fluctuations are unknown, it has been speculated that they may be associated with El Nino conditions that lead to reduced ocean productivity. The lowest razor clam populations on record in Washington and Oregon were observed in 1983 (Link, 1984; Elston, 1984a). The population lows occurred in conjunction with a major El Nino - warm water anomaly, rather than in a subsequent year, and were apparently the result of a dramatic and abrupt disappearance of clams. This led to an examination of razor clams from Washington for possible lethal clam pathogens and the discovery of a previously undescribed parasite that located within the nuclei of non-ciliated branchial epitheliel cells (Elston, 1984a). The parasite is so far unclassified and has been termed nuclear inclusion X or NIX. Over 600 razor clams from Washington beaches were examined in 1983 and 1984 revealing an infection prevalence of nearly 100% and infection intensity levels in some clams that were high enough that the resulting gill damage suggested a probable fatal outcome. A very small sample of Oregon clams also contained the parasite (Elston, 1984b; 1985). These observations led to interest in the extent of NIX infection in Oregon razor clams. This report gives results of the examination of razor clams from northern and central Oregon Coastal beaches.

MATERIALS AND METHODS

Razor clams were collected approximately monthly by Oregon Department of Fish and Wildlife personnel from Clatsop Beach between Tillamook Head and the Columbia River from June, 1984 through April, 1985. Additional samples from Agate Beach near Newport, Oregon were obtained in April, May and June, 1984. Clams were sorted according to approximate age (based on shell length), removed from shells and fixed in Davidson's solution. Gill tissue was cut from preserved clams, processed for routine histological preparation, sectioned at 6 mm and stained with hematoxylin and eosin. The presence or absence of parasites (NIX organisms) was noted and the number per oil immersion (1000X) field of non-ciliated branchial epitheliel tissue (gill watertube tissue) was recorded. An index of infection intensity given by Elston (1984b) was employed to allow direct comparison with infection levels reported from Washington razor clams and to give an indication of the possible pathological significance of NIX in Oregon clams. The index developed by Elston is as follows:

Index	Significance
0-10 NIX/field	Light infection with little associated gill damage.
10-20 NIX/field	Moderate infection, gill damage evident. Presumptive compromise of respiratory infection at this level of infection and above.
Greater than 20 NIX/field	Substantial gill damage, hyperplasia of respiratory surfaces; breakout of infective organisms and secondary infections common.

RESULTS

A total of 191 razor clams from Clatsop Beach and 72 from Agate Beach were examined for NIX organisms in gill tissue. The prevalence of infection in Clatsop Beach clams was 100% and 91.7% of the Agate Beach clams were found to be infected. The prevalence and average intensity (index of infection) by month, approximate age of clam and geographic area are given in Table 1. The average index of infection per sample was always very low and did not approach levels considered either moderate or heavy. Although average index of infection levels were very low, five individuals collected Clatsop Beach between July and December were infected at moderate index levels of 10.5, 13.5, 11.0, 11.5 and 15.5. No clams infected at heavy index levels were found. The average index of infection in Agate Beach clams was lower than that in Clatsop Beach individuals and no clams with moderate or heavy index category infections were detected.

When the average infection indexes were graphed by month, levels at Clatsop Beach were found to be highest in summer and fall before falling substantially in the winter months (Figure 1). Infection levels in razor clams from Agate Beach were determined for only three spring months and were generally lower than the lowest Clatsop Beach index levels (Figure 1).

There was no detectable relationship between the average infection index and the average age of clams in monthly samples.

Other potential pathogens occasionally observed in sections of razor clam gill included ciliates in the genus <u>Trichodina</u> and various unidentified symbionts.

DISCUSSION

The unclassified nuclear inclusion (NIX) parasite was found in all clams examined from northern Oregon beaches and in most clams collected from the mid-coast area, but never occurred in high intensities such as were found in Washington razor clams in 1983 by Elston (1985). Although the infection intensities (index) in 1984 Oregon razor clams were not high, samples were not collected during the summer of 1983 when water temperatures were warmest, clam populations were low or decreasing (Link, 1984), and when infections intense enough to be lethal were observed in Washington. Infection intensities in 1984 Washington razor clams were substantially below 1983 levels at the same locations, but were still higher than those observed in Oregon at the same time. For example, the highest average infection intensity in Oregon occurred in July (Index 3.46, Figure 1) and the highest levels observed in individuals were five clams with moderate (Index 10.5-15.5) infections. Clams collected in Washington in 1984 were virtually all more heavily infected than were Oregon clams and included one beach where average infection intensity indexes of over 10 were found (Elston, 1985).

It is not known if the NIX parasite has been present in the razor clam population in previous years or if it has been recently introduced into the area. An hypothesis suggested by Elston (1984b) is that ocean temperature elevations associated with the El Nino phenomenon could have altered a normally stable host-parasite relationship in a manner favoring the parasite and resulting in potentially lethal disease. If this is true, a return to more typical ocean conditions should result in a return to a more stable, less detrimental host-parasite relationship. Results of this investigation and of the study by Elston on clams collected in 1984 suggest that this may be taking place.

The life cycle of the NIX parasite, its method of reproduction, and the means by which clams become infected are completely unknown.

LITERATURE CITED

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TABLE 1. Prevalence and Intensity of Infection in Oregon Razor Clam Gills by the Nuclear Inclusion (NIX) Parasite.

Date	Age of Clams	N	Prevalence (%)	Intensity Index
CLATSOP BEACH				
6/84	0	5	100	2.00
	1	5	100	1.80
	2	9	100	2.50
Monthly Average	1.2		100	2.20
7/84	0	5	100	3.50
	1	7	100	2.86
	2	-	-	-
	3	2	100	6.50
Monthly Average	1.0		100	3.46
9/84	2	6	100	2.25
Monthly Average	2.0		100	2.25
10/84	0	35	100	2.72
	1	3	100	4.83
	2	1	100	1.50
Monthly Average	0.10		100	2.80
11/84	0	3	100	3.67
	1	34	100	2.69
Monthly Average	0.92		100	2.77
12/84	1	25	100	3.18
Monthly Average	1.0		100	3.18
1/85	0	2	100	1.00
	1	10	100	1.00
	2	8	100	0.62
	3	3	100	1.17
Monthly Average	1.5		100	0.89

TABLE 1. Continued.

Date	Age of Clams	N	Prevalence (%)	Intensity Index
2/85	0	5	100	0.30
	1	10	100	0.75
	2	3	100	1.00
Monthly Average	0.89		100	0.67
4/85	2	10	100	1.10
Monthly Average	2.0		100	1.10
AGATE BEACH				
4/84	0	14	85.7	0.39
	1	10	90.0	0.28
Monthly Average	0.42		87.5	0.35
5/84	2	6	83.3	0.55
	3	8	100	0.28
Monthly Average	2.6		92.8	0.40
6/84	2	27	92.6	1.03
	3	7	100	0.78
Monthly Average	2.2		94.1	0.98

Figure 1. Average NIX Infection Indexes in Oregon Razor Clams