The effects of an increased organic load on tidal sediments with special attention to *Glycera dibranchiata*

by

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Introduction:

Soft-bottom studies were conducted in Montsweag Bay along the central Maine coast to determine the effect organic content has on the productivity of the bloodworm, Glycera dibranchiata. The relationship between organic content of the sediment and the abundance of bloodworms is not well defined but a positive correlation is often referred to by worm diggers although any available data is anecdotal. From their experiences, diggers generally find a higher relative abundance of worms in areas of high organic matter. These areas include streambeds where logging has occurred in the past, i.e. sawdust, and where Mytilus and Ulva have been turned into the sediments from past digging efforts. The basis for this study was to determine if there is an optimal level of organic matter that would be conducive to increased numbers of bloodworms. The area chosen was accessible during ebb tide and closed to commercial harvesting.

Distribution of benthic organisms is dependent on substrate type (Levinton 1982). Areas that are composed of fine silts and clays can not support organisms with high density ratios; therefore, are classified as physically unstable environments (Thayer 1975). The study site contained a large number of bivalves and from this it can be deduced that the sediment structure is stable. If it were unstable, bivalves and other benthic organisms would sink below the oxidized layer into the reduced layer where these organisms would suffer high mortalities (Thayer 1975). The Redox Potential Discontinuity layer (RPD), the dividing line between anaerobic and aerobic conditions in the sediment, can be found from just millimeters below the surface to many centimeters down. The depth of the RPD layer is dependent on the amount of bioturbation, population densities, organic matter, and sediment composition. Microbiota that have adapted themselves to live below the RPD layer decompose organic matter by fermentation or by dissolved sulfates, nitrates, carbonates and water (Levinton 1982). The bacterial biomass produced is important to the food web because many benthic organisms may feed below the RPD layer (Levinton 1982).

Materials and Methods

Field experiments were conducted to examine the effects organic content have on mudflat productivity particularly on the abundance of *Glycera dibranchiata*. This study was conducted from May thru August of 1984. Ten 1 m^2 plots were used; five plots on the southern side and five on the northern side of a 30 m^2 area of Montsweag Bay which is a protected estuarine environment located along the mid-Maine coast ($44^{o}55'$, $69^{o}44'$). Plots were situated 1 m apart and ran east to west (Fig. 1). Initially, all plots were dug to remove any bloodworms present, however none were encountered. The first plot, on the northwestern corner received four buckets of a horse manure/hay mixture which were worked in the upper 6-10 inches of the sediment. The same was done to the other four plots except the amount of organic matter was decreased by one bucket, leaving the last plot at the northeastern end with no organics added. This pattern was reversed for plots on the southern side. All plots were allowed to season one month. At the end of this time four tagged Glycera dibranchiata were released in each plot. Tag numbers corresponded to the amount of manure added thereby identifying each set of worms with a particular plot. Worms were tagged with binary coded microwire tags made of magnetic biologically unreactive type 302 stainless steel wire (Joule 1983). Microwire tags are 1.07 mm in length and 0.25 mm in diameter. Tags were injected into the worms coelomic cavity with a 24 gauge hypodermic needle syringe. Once the tags were implanted they could be detected with a magnetometer. All plots and surrounding areas were dug vigorously after a one month time period. Worm recoveries were noted in relation to their position to the plots. Analysis of certain physical, chemical and biological parameters of this mud flat were performed. These include interstitial salinity, pH, biota, organic content and particle size which were taken at the time the worms were released.

Interstitial salinity: Two hundred g of mud were taken from outside the plots and centrifuged at 9000 Rpm and 20^{o}C to remove the interstitial water. The water was drained off and a measurement of salinity was run four times to give an average number.

pH: The pH was measured by using pH strips of the surface water left by ebb tide.

Biota: Quarter meter samples were taken from the shore and sea side of the area. The samples were sieved through a 500 μ mesh sieve. The remaining sample was stained with Rose Bengal and preserved in 5% formalin solution. The biota were classified to genus.

Organic content: Each of the ten plots was sampled for organic content after one month. Carbonates were removed by adding 10% hydrochloric acid. The acid was evaporated, the samples were weighed and placed in a muffle furnace at 500°C for 24 hours to remove organics. The samples were then re-weighed and the percentage organic material was calculated by $\frac{\text{(original-final x 100)}}{\text{original}}$.

Particle size: A sonic sifter was used to analyze the distribution of particle sizes. Dried mud samples that were treated to remove any organics and carbonates were ground with a mortar and pestle. Samples were processed through a series of U.S. graded sieves in the sonic sifter and classed according to the Wentworth scale.

Results

The recovery rate for tagged G. dibranchiata was 7.5%. All Glycera were recovered from areas low in organic content (Table 2 and 3). These areas contained from 0 to 1 bucket of manure. Areas high in organics had an RPD layer at or near the surface and appeared to present an uninviting environment. Five untagged worms were recovered of which three were of commercial size. Initially, no G.

dibranchiata were found when the area was dug. Benthic organisms from the area samples were predominately bivalves and gastropods (Table 1). Nereis was the only polychaete observed when initially turning the mud, however upon closer observation large numbers of Heteromastis were encountered. Competition was high in this area due to the large numbers of the bivalves Mya and Macoma. Nassarius, a gastropod, was also extremely abundant but not considered a direct competitor for space since they are surface dwellers.

The areas which received no added organics varied considerably in their percent organic matter (Table 3). Plot #10, located next to the shore, had an organic content of 20% while plot #5, located on the sea side, had a 10% organic content.

An interstitial salinity taken from the center of the study site in mid-July was 17.7‰. Area pH readings were 7.1 and particles from this flat fell in the silt/clay fraction.

Discussion

From these data we can conclude that G. dibranchiata occurred more frequently in areas with a low organic content. Areas high in organics provided an anoxic environment that is generally unfavorable for this species and others. With so few tagged recoveries one can not speculate as to an optimal level of organic matter. What happened to the other tagged worms is an unanswerable question.

There are two likely possibilities: a.) mortality, b.) migration. An increased number of worm and clam diggers were noted in the vicinity during the latter part of this study. Glycera may have been moving closer to the shore zone due to the increased harvesting pressures. If this is true than this may be an explanation for the presence of the untagged worms.

Salinity, pH and composition of the sediments do not appear to be a controlling factor on this flat, however, the absence of a suitable food source could be. Competition for space is high due to the abundant numbers of bivalves. The absence of significant numbers of G. dibranchiata from this area could be due to competition for space coupled with adverse environmental factors. More extensive field analysis should be conducted to compare areas with large numbers of Glycera and the levels of organic materials. The data from this study are generally inconclusive.

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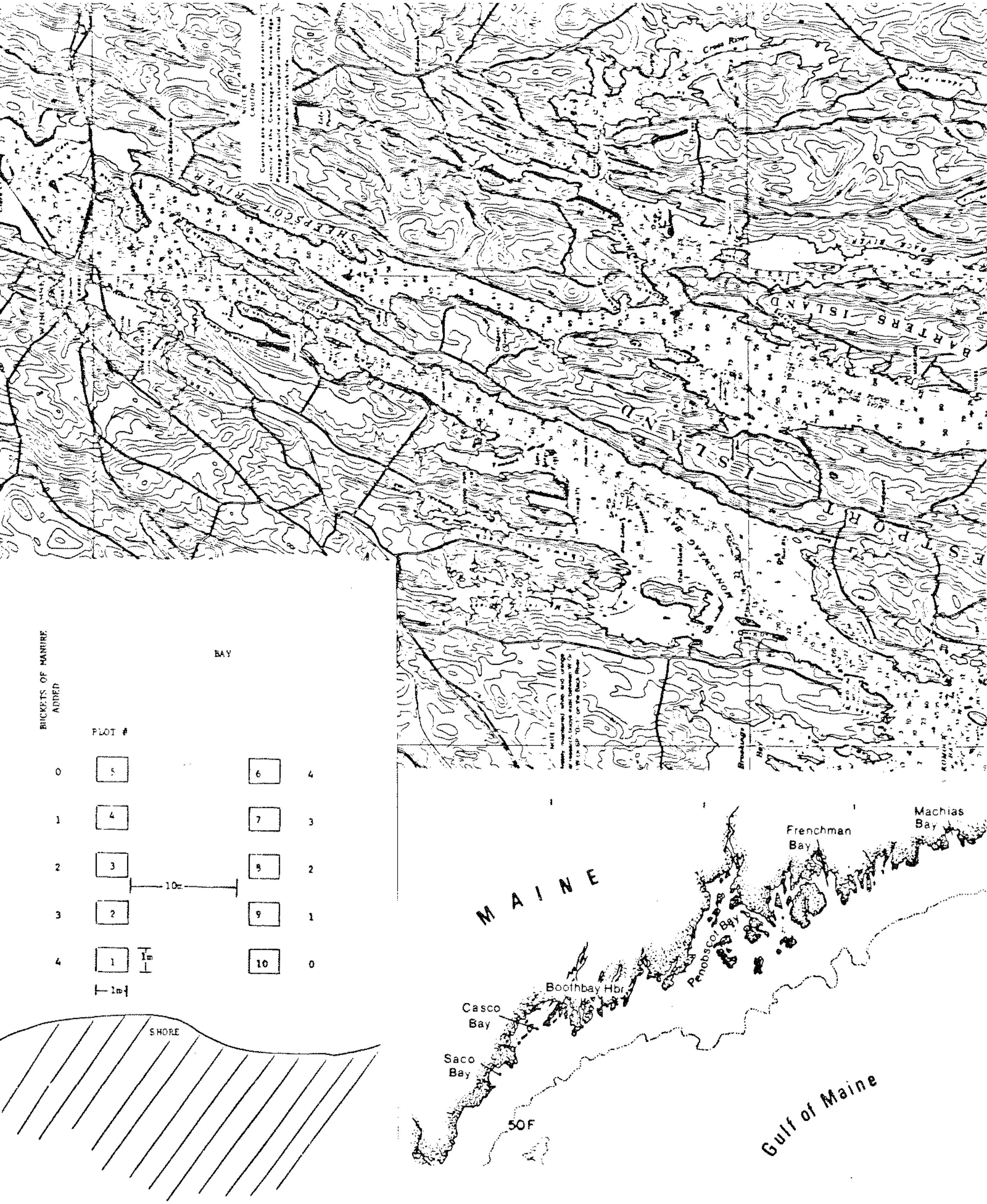
SHEEPSCOT RIVER
BARTERS ISLAND
BUCKETS OF MANURE ADDED
BAY
PLOT #
0
5
6
4
1
4
7
3
2
3
8
2
10m
3
2
9
1
4
1
1m
10
0
1m
SHORE
MAINE
Machias Bay
Frenchman Bay
Penobscot Bay
Boothbay Hbr.
Casco Bay
Saco Bay
50F
Gulf of Maine

FIGURE 1

Table 1

Genus Biota Taken from Two
Areas Within the Study Site

	Mya	*Macoma*	*Cyanthura*	*Nassarius*	*Ampelisca*	*Heteromastis*	*Nereis*	*Lunatia*	Arthropod spp.
Sea Side Area	21	331	30	1094	3	213	1	1	3
Shore Side Area	29	205	24	605	2	88	1	1	0

Table 2

Recoveries of Tagged and Untagged Worms Showing What Plots They Were Located In or Around

Tag Number	Plot	Number of Worms
24	4	2
30	10	1
N/A	10*	1
N/A	9*	1
N/A	8*	1
N/A	4*	1
N/A	3*	1

*All untagged worms were located outside the plots within one meter.

Table 3

Organic Content of
Plots at End of Experimental Period

Plot Number	Organic Content (%)	Amount Organic Added (Buckets Manure)
1	17	4
2	19	3
3	18	2
4	15	1
5	10	0
6	18	4
7	18	3
8	14	2
9	18	1
10	20	0