Article 165

ENVIRONMENTAL FACTORS AFFECTING ATTACHED MACRO-ORGANISMS, PATUXENT RIVER ESTUARY, MARYLAND

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Abstract.—Periodic measurements of water temperature, salinity, and dissolved oxygen content were made at various depths during the period October through December 1962. Temperature was found to be the most significant variable affecting the growth of the organisms. Four principal organisms attached during October and November; growth was rapid in October but slight during the other months.

An algal-tubeworm association, in which a yellow-green alga thrived on the waste from tubeworms, was noted and may prove useful as an indicatoı of organic pollution.

A large steam-generating plant at Chalk Point, Md., on the Patuxent River, will begin operation in the spring of 1964. The plant is expected to discharge large amounts of heated water into the estuary which at times may be equal to or greater than the total fresh-water inflow. To establish a basis for the future understanding of the effect of the heated water on the biota, the State of Maryland has initiated a comprehensive study of the entire river. Presently over 40 investigators representing State, Federal, and private organizations are studying a wide variety of problems.

Although the estuary is close to a highly urbanized area, there has been little urban development along its shores. The value of oysters, fish, and crabs taken from the estuary annually is about half a million dollars, and the estuary is known as one of the best oyster-growing areas of the Chesapeake Bay.

It is believed that any changes occuring in the estuary due to the heated water will be reflected in attached macro-organisms (chiefly barnacles, bryozoans, tube-building amphipods, and tubeworms) and marine borers (none were observed during the period reported on here). Study of these two types of organisms offers certain advantages because a dozen or more species representing at least eight phyla can be studied qualitatively and quantitatively at one time. Most of the mature organisms are fixed or only slightly mobile, so they are at the mercy of their immediate environment. They can be collected from uniform substrates, measured areas, and over known lengths of time, thus ruling out some of the questionable factors inherent in other quantitative biological studies. Preliminary results of the Geological Survey investigation, based on observations from October 1962 through March 1963, are reported here.

Two types of test panels, wood, for marine borers, and asbestos-cement are to be exposed for periods of 1 month, 3 months, 1 year, and for the duration of the study before and after plant operation begins. The wood panels are 260 sq cm in area and the asbestos-cement panels are 290 sq cm. At each point of observation one of each type is exposed for the periods indicated. The panels are collected and preserved in alcohol, then analyzed in the laboratory.

Monthly and quarterly panels have been set out and collected from the surface, middepth, and bottom (7 meters) at the center of Benedict Bridge; from middepth (2 meters) at the west end of Benedict Bridge; and from middepth (1 meter) at the end of the pier of the Chesapeake Biological Laboratory at Solomons Island, Md. (fig. 165.1). The Benedict Bridge sampling site is in the region of expected high temperatures. The Solomons Island site was chosen as a control because it will be beyond the effect of unnatural heating.

Accumulations of marine macro-organisms on the monthly panels for October and November and on the quarterly panels for October through December 1962 were measured and are reported in table 165.3. No attachment occurred during the cold months of December, January, and February, hence no accumulations are reported.

ENVIRONMENTAL CHARACTERISTICS

Water-quality data collected once a month at the Benedict Bridge site [1] indicate that temperature was

[1] Data furnished by the State of Maryland Water Pollution Control Commission. Samples were taken at the center of the bridge.

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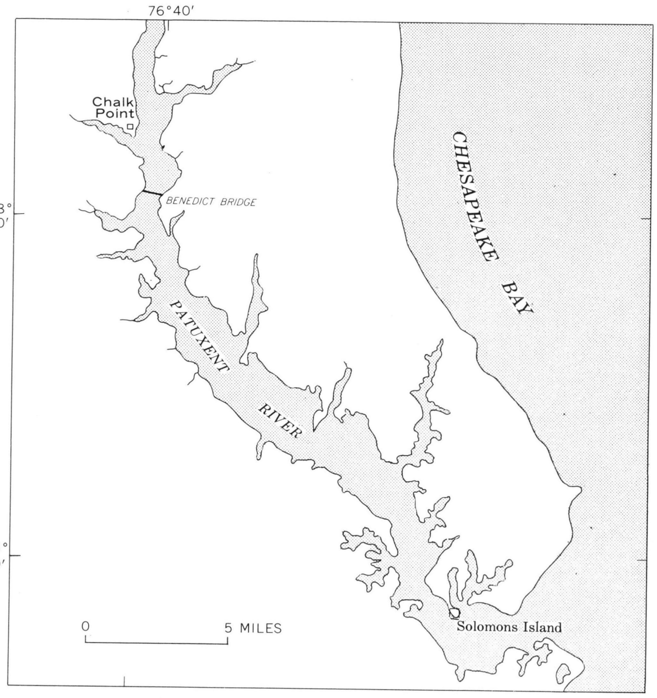

FIGURE 165.1.—Index map of Patuxent River estuary.

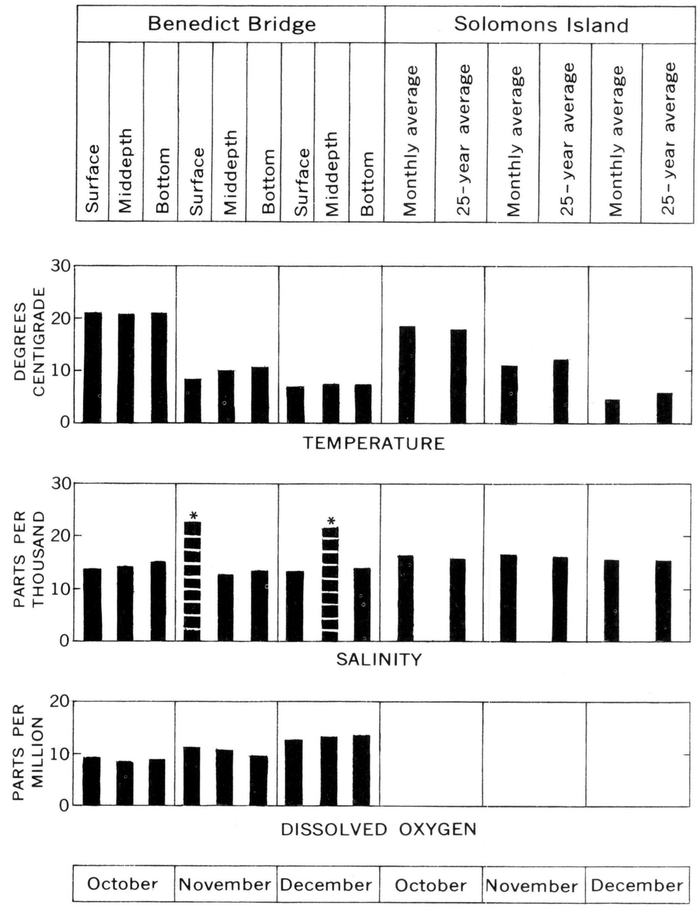

FIGURE 165.2.—Monthly temperature, salinity, and dissolved oxygen content of water of Patuxent River estuary at Solomons Island and Benedict Bridge, October–December, 1962. *Data questionable.

the most significant variable during the period of observations (October 1962 through February 1963). Temperatures decreased from a high of about 21.5°C in October 1962 (fig. 165.2) to a low of 0°C in January 1963. Salinity at the bridge was generally between 12 and 17 parts per thousand, and vertical variations were slight. However, the sampling program does not take into account the short-term variations caused by local weather changes and daily tidal fluctuations. Dissolved oxygen gradually increased as the temperature decreased and was high enough to support aquatic life throughout the period.

Continuous recordings of temperature and daily salinity readings have been taken since 1938 at the laboratory pier at Solomons Island.[2] During the study reported here, the mean daily surface temperatures gradually decreased from a high of 21°C in October 1962 to a low of 0.5°C when the quarterly panels were collected. Salinity ranged from 14.8 to 17.3 ppt during the same period.

DISTRIBUTION OF ORGANISMS

The density of the principal attached macro-organisms is shown in figure 165.3. Note, however, that the number of bryozoan colonies, rather than individuals, is shown, and that the number of organisms does not indicate the total mass contributed by each group. Microscopic organisms also covered much of the surface of the panels. These forms added little to the total mass but are important in forming microscopic substrates, which often precede attachment of the larger forms.

Attachment by marine macro-organisms occurred only during October and November—no macro-organisms attached to monthly test panels during December, January, or February. During October, barnacles, tubeworms, tube-building amphipods, and colonial bryozoans dominated the complex. At Benedict Bridge, barnacles were the dominant form during October and increased during November (fig. 165.3). At Solomons Island mud tubeworms were dominant in October and bryozoans in November. At Benedict Bridge, where test panels were placed at three depths, the populations varied with depth (fig. 165.3).

The quarterly panels (October–December) for Benedict Bridge showed about the same organisms as the October panels, but those at Solomons Island did not have tubeworms and amphipods, which were attached to the October panels. Bryozoans were prominent and covered large areas of the panels, although the number of colonies was small. They were the dominant form

[2] Data furnished by the Chesapeake Biological Laboratory, Solomons Island, Md.

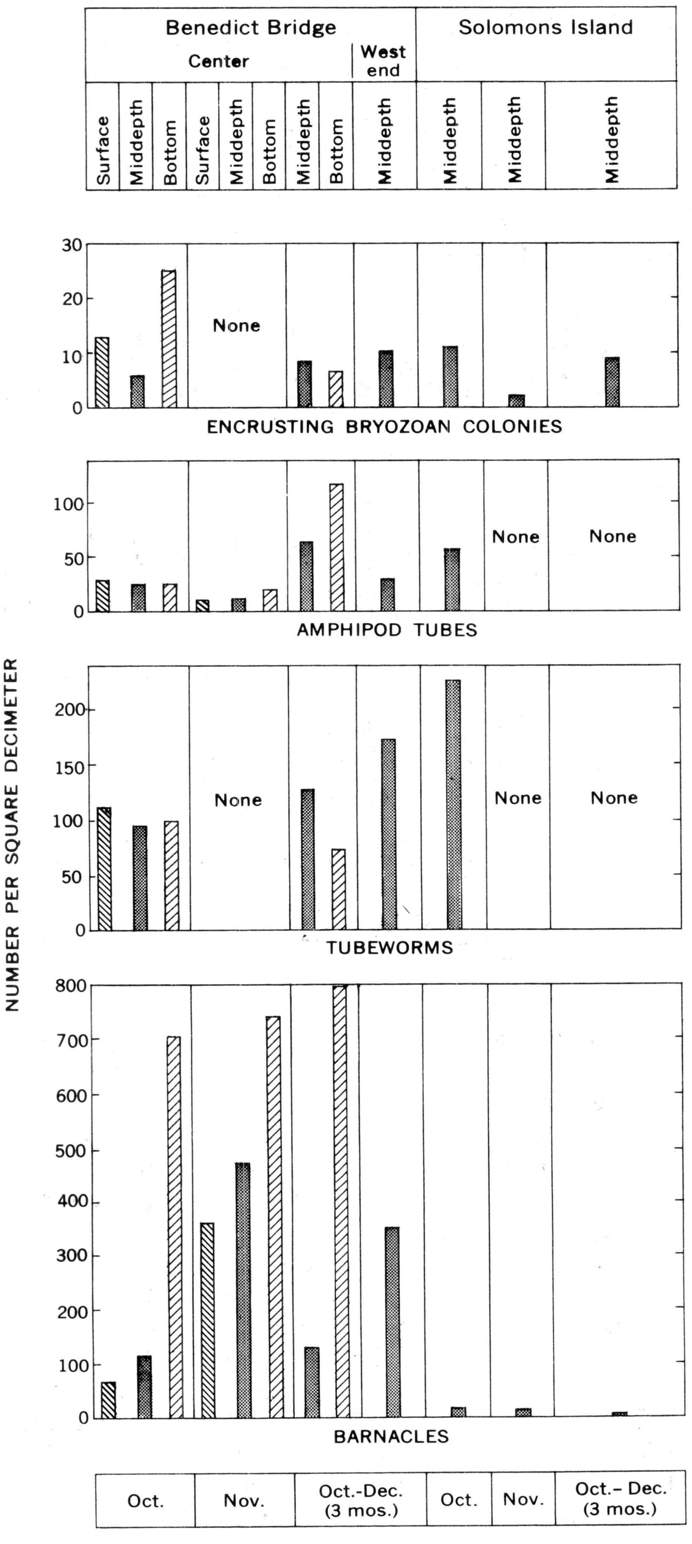

FIGURE 165.3.—Density of principal attachment organisms collected on test panels at Benedict Bridge and Solomons Island, October–December, 1962.

at Solomons Island, where a single colony covered an area of 961 square millimeters. Many young barnacles were overgrown and killed by these bryozoan encrustations.

GROWTH

Even though attachment of new individuals ceased after November, the quarterly panels indicate that total accumulations of the organisms continued. Gravid tubeworms and their eggs were present, amphipods were active on freshly collected panels, and new growth by the bryozoan colonies could be observed—evidence that all of these forms were still quite active when the panels were collected.

Measurements of barnacle basal areas on the monthly panels show that growth of individuals was vigorous during October, diminished greatly in November, and was negligible the remainder of the winter. The growth varied both with depth and location. (See table 165.1.) Maximum sizes were attained at Solomons Island.

The mean basal-area data are somewhat misleading. For example, although the October value for the bottom at Benedict Bridge is less than at middepth and surface, this panel not only had a great many more barnacles than those at the other two depths, but many appeared to have attached a day or two before collection. This difficulty is inherent in a monthly data-collecting program and can only be resolved by more frequent observations. Also, the high mean basal area for the Solomons Island quarterly panel was based on measurement of only 10 individuals, the total number on the panel. Note the large differences between mean and maximum basal areas for the quarterly and monthly panels. A probable explanation for this is that the organisms that attach the earliest have the advantage in gathering food and utilizing space. By the end of October all available space was occupied;

TABLE 165.1.—*Basal area of barnacles*

[Rostrocarinal-lateral measurements]

Sampling site	Mean basal area (square millimeters)			Maximum basal area (square millimeters)		
	Oct.	Nov.	Oct.-Dec.	Oct.	Nov.	Oct.-Dec.
Benedict Bridge, center:						
Surface	1.25	0.22	[1]	5.28	0.38	[1]
Middepth	1.52	.31	4.92	13.81	.49	16.49
Bottom (7 meters)	.88	.44	5.18	10.11	.69	42.88
Benedict Bridge, west side (2 meters)	---	---	5.54	---	---	28.59
Solomons Island (1 meter)	1.66	.43	20.04	11.31	.94	45.43

[1] Panel scoured by ice.

therefore, the size measurements are representative of individuals that attached during that month. Barnacle growth was slight in November and December. The mean basal area of barnacles on a special panel exposed for growth studies at middepth at Benedict Bridge from November 8 to March 8 was only 0.65 square millimeters as compared to a mean basal area of 4.92 square mm for barnacles on the panel exposed from October through December (table 165.1)

Attachment and growth of the colonial bryozoans also varied with depth and location. Unlike barnacles, they grew actively in the colder winter water, and newly formed zooecia were observed on the colonies when the quarterly panels were collected. Mean and maximum areas of bryozoan colonies were considerably less at Benedict Bridge than at Solomons Island on both the monthly and quarterly panels (table 165.2). For some unknown reason, attachment and growth were less at middepth at the center of the bridge than at the surface or bottom.

TABLE 165.2.—*Area of bryozoan colonies, autum and winter, 1962*

Sampling site	Mean area (square millimeters)			Maximum area (square millimeters)		
	Oct.	Nov.	Oct.–Dec.	Oct.	Nov.	Oct.–Dec.
Benedict Bridge, center:						
Surface	6.00		181.8	31.4		282.8
Middepth	3.92		98.96	4.1		201.0
Bottom (7 meters)	6.80		182.4	21.2		282.8
Benedict Bridge, west side (2 meters)			120.6			320.5
Solomons Island (1 meter)	40.5		297.1	380.2	9.4	961.1

WEIGHT OF ORGANIC MATERIAL

The weight of organic carbon (dry, minus ash weight) produced by the attachment organisms varied with time, depth, and location (table 165.3). In order to obtain a figure to compare the standing crop at each location regardless of species, whether shelled or nonshelled, the material was scraped from the wooden panels, oven dried, weighed, ashed at 500°C, and reweighed. The weight was slight in November, compared to October, and negligible from December through February. Organic weight on the quarterly panels was highest at the bottom at Benedict Bridge and lowest at Solomons Island. Variations in organic weight undoubtedly reflect the relative abundance of the various species involved; however, measurements of single groups were not made.

TABLE 165.3.—*Comparison of dry and organic weights, autumn and winter, 1962*

Sampling site	Total dry weight	Ash		Organic matter		Exposure of panel (days)
	g/m²	g/m²	Percent	g/m²	Percent	
October						
Benedict Bridge, center:						
Surface	9.3	7.08	76.1	2.22	23.9	30
Middepth	19.7	15.22	77.4	4.48	22.6	30
Bottom (7 meters)	25.05	15.34	61.1	9.7	38.9	30
Solomons Island (1 meter)	4.72	3.17	67.1	1.55	32.9	30
November						
Benedict Bridge, center:						
Surface	2.99	2.13	71.2	0.86	28.8	30
Middepth	2.46	1.67	68.0	.79	32.0	30
Bottom (7 meters)	1.98	1.45	73.4	.53	26.6	30
Solomons Island (1 meter)	(1)	(1)	(1)	(1)	(1)	30
October–December						
Benedict Bridge, center:						
Surface	(2)	(2)	(2)	(2)	(2)	88
Middepth	117.36	91.56	78.0	25.80	22.0	88
Bottom (7 meters)	248.78	170.35	68.5	78.43	31.5	88
Benedict Bridge, west side (2 meters)	114.67	73.45	64.1	41.22	35.9	93
Solomons Island (1 meter)	49.92	31.09	62.4	18.83	37.6	88

[1] Weight negligible.
[2] Panel scoured by ice.

ALGAE AND TUBEWORM ASSOCIATION

The quarterly panel from the west side of Benedict Bridge showed an interesting association between the tubeworms and a yellow-green alga. Prominent tufts of the alga, 8–12 mm long, were scattered over the panel. Close examination revealed that these tufts were located at the anal end of the worm tubes. The algae appeared to profit from the organic enrichment of the water at this location. This relationship suggests that algae of this type may prove to be a useful indicator of other types of organic pollution.