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Project Summary

Animal-Sediment Relationships of the Upper and Central Chesapeake Bay

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Fifty-two bottom sediment box core samples were taken in fall 1978 and summer 1979 to investigate the relationship between benthic biota and the sedimentary environment of the upper and central Chesapeake Bay.

Through an examination of the vertical distribution of the benthos and a radiographic analysis of the sediments, the degree of physical and biological activity and interaction was determined.

The benthic microfauna were characterized by opportunistic as well as equilibristic species that inhabit a wide range of salinity and substrate types. Many species increased down the estuary. Greatest species populations were found in mixed-sediment environments. The benthos were concentrated in the top 10 cm of the sediment and penetrated to 30 cm. Most sediments have a deep-dwelling faunal component, but the number of deep-penetrating individuals is greatest in the mixed-sediment environments. There are deep-dwelling representatives of all taxa except for the arthropods. Many of the deep-dwelling species are also dominant based on numerical as well as biomass determinations.

Although biological sediment mixing (bioturbation) occurs in most areas of Chesapeake Bay, the degree is substantially reduced in the upper region of the Bay because of high sedimentation rates. The prevalence of physical structures over biological features in the deep-water channel regime is due to fluid muds and periodic anoxia. The more stable mud environment is primarily inhabited by a sedentary tube and relatively permanent burrow-building community. Sands are characterized by a motile fauna. Most biogenic structures are produced by polychaetous annelids. Species population patterns and previous Pb^{210} data in Chesapeake Bay suggest that biological mixing occurs down to 30 cm and is greatest at the sediment surface.

This Project Summary was developed by EPA's Chesapeake Bay Program, Annapolis, MD, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The benthic community plays a key role in animal-sediment-chemical interactions within Chesapeake Bay. Benthic organisms facilitate the exchange of materials, including toxic compounds, within the sediments and between the sediments and water One implication of this biological activity is the retention of toxicants within the upper sediment layers, where such materials may be incorporated into the biotic system

This project was designed to highlight the degree to which physical and biological activities modify the bottom environment The vertical distribution of the benthos and sedimentary structures was examined by using a box core sampler and X-radiographic techniques Sampling occurred over a two-year period at locations in central (mesohaline zone) and upper (oligohaline zone) Chesapeake Bay. Data analysis indicated that biological processes influenced sediment texture in most of the study area. Physical processes dominated in the uppermost portion of the Bay and in deeper channels. A unique benthic community structure was associated with each sediment type. The extent of bioturbation in any sediment depended on the characteristics of the benthos. Most benthic organisms occupied the upper 10 cm of the sediment and deep-burrowing species penetrated to 30 cm.

Results indicate that the sedimentary environment in Chesapeake Bay is modified by both physical and biological forces. This study may serve as a baseline for research.

Procedure/Methodology

A total of 52 box core samples was taken in central and upper Chesapeake Bay between the latitudes 39°35' and 37°55' N. Sampling occurred from September through November, 1978, and during June and July, 1979. A modified spade box corer was used for this project. Two core samples were recovered per station, as well as data on bottom salinity and water temperature. Both core samples provided information on sedimentary features and benthic fauna. This information was illustrated in three-dimensional diagrams.

One box core was used for quantifying the benthic community. Increments were established to determine vertical population trends. All biological samples were sieved and organisms were collected for identification, enumeration, and biomass determination.

The remaining box core was used for radiographic processing. A 6-cm vertical slice was sectioned and sealed in a plexiglass tray for subsequent laboratory procedures. After refrigeration, the core sections were trimmed to 2-cm thickness and photographed with a medical X-ray unit.

Results and Conclusions

The benthic community of the upper Chesapeake Bay was characterized by endemic and colonizing species. Annelids, arthropods, and molluscs were the dominant benthic groups, represented primarily by polychaetes, crustaceans, and bivalve molluscs, respectively. Most species inhabited a wide range of salinity and habitat types. Oligochaetous annelids and arthropods were numerically dominant in the oligohaline zone, whereas polychaetous annelids were most numerous in the mesohaline zone.

Most benthic organisms were concentrated in the upper sediment layers. More than 65 percent of the benthos were sampled in the upper 5 cm, and approximately 85 percent of all benthic organisms were concentrated in the top 10 cm. However, all habitats except oligohaline sands contained deep-dwelling fauna that were found below 10 cm and penetrated to depths of 30 cm.

Annelids were the most successful deep-dwelling group and penetrated deeply into the sediment by constructing long tubes or burrows or by functioning as free burrowers. Some bivalve molluscs were deep dwelling by virtue of long siphons.

Benthic community characteristics were unique for different sediment types. Sand environments were inhabited by motile fauna, primarily free-burrowing, deep-dwelling species. Mixed-sediment environments (10 to 85 percent mud) contained the greatest species diversity and the highest benthic densities of any bottom environment. Deep-dwelling benthos were most abundant in the mixed sediment regimes. Conditions favoring the establishment of benthos in these environments included an abundance of food and suitable oxygen concentrations. Stable mud environments were inhabited by a sedentary tube and burrow-dwelling fauna. Low oxygen availability and sediment compaction were limiting factors in mud substrates, and the benthic community remained near the surface or in touch with the surface-water interface.

Bioturbation, or the modifying of sediment structure by biological activity, was observed in nearly all core samples. However, in areas where physical processes prevailed, biogenic disturbance was inconsequential. In coarse to medium sand environments found at the head of the Bay, erosion and sedimentation overwhelmed any biogenic effects. Sedimentary features of channel regions were also shaped by physical forces, since fluid muds and periodic anoxic conditions prevented long-term establishment of benthos.

In other areas of the Bay, bioturbation had a modifying effect on sediment structure. Biogenic structures which occurred in Chesapeake Bay sediments included dwelling tubes, burrows, and feeding traces. Most biological structures were produced by polychaetes.

Most of the highly bioturbated cores were located in the meso- and meso-polyhaline regimes, where a greater diversity of reworking species exists. Sediments that occurred at depths of less than 10 m usually supported benthic populations. Biogenic structural diversity was greatest in stable mud environments.

Data indicate that bioturbation of the sediment occurs in the upper portion of the substrate. Penetration in the upper Bay is greatest in mixed-sediment environments and next greatest in the muds. Toxicants are most concentrated in these regions. Sediment-adsorbed toxicants in these substrates are likely to remain in the biologically active zone of 20 to 30 cm for up to 100 years.

Results of this biological investigation serve as a baseline for research. It is expected that this information will help to explain geochemical profiles and flux rates.

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The complete report, entitled "Animal-Sediment Relationships of the Upper and Central Chesapeake Bay," (Order No. PB 83-207 738; Cost: $22.00, subject to change) will be available only from:

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