Long-Term Variability in the Structure of Subtidal Benthic Communities in Puget Sound, Washington, USA

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Abstract

Data on benthic infauna from 4 permanent stations in Puget Sound off Seattle, USA, collected during 1963--1964, 1967, and 1969, revealed considerable stability in numbers of species and specimens and in diversity within stations among sampling dates. The species composition of the faunal assemblages also remained rather constant during the period of investigation, but the relative dominance among the numerically important species varied somewhat. Biomass data did not differ significantly in 1964 and 1969, but the 1967 data were considerably lower at all stations.

Introduction

The concept of stability of communities or ecosystems receives considerable attention among ecologists, but as there are different definitions of stability, there is ample ground for confusion (Margalef, 1968). The most common definition of stability of communities is constancy of numbers, i.e., communities evolve in the direction of small numerical variability in habitats with constant external conditions. Small numerical variability is characteristic of tropic communities (Dunbar, 1960), in which the species diversity is typically high. Hence, a relationship between species diversity and community stability has been suggested (Dunbar, 1960). MacArthur (1955) stated that the higher the number of pathways for energy flow, i.e., the higher the species diversity at each trophic level, the more stable would be the energy flow through the community. In recent literature, there is experimental evidence questioning the universal validity of MacArthur's hypothesis (Hirston et al., 1968, Hurd et al., 1971).

Sanders (1968, 1969) postulated a stability-time hypothesis to explain observed patterns of diversity in the sea. This hypothesis states that, in physically highly fluctuating or unfavourable environments, species diversity is mainly controlled by the physical environment, and the resulting diversity is low. Conversely, in habitats of physical stability, species diversity is primarily biologically controlled, i.e., through species interactions and the resulting niche-specialization, the number of species per unit indivi-

dual (species diversity) increases with time towards a maximum. Slobodkin and Sanders (1969) stated that it was the degree of predictability of the environmental fluctuations rather than their absolute magnitude that was of importance for species diversity.

Above, the term "stability" refers to constancy of numbers, energy flow, or physical environment, but there is a fourth definition of stability that needs to be discussed: the stability in species composition of a community. Constancy of specimen numbers or diversity in a community could be maintained even if drastic changes in the relative importance of a species took place. In the present paper, an attempt is made to follow the species composition of benthic communities in Puget Sound with time and subsequent changes in numbers and species diversity.

There are few long-term investigations of benthic infauna that are directly comparable to the present study. Results from extensive investigations, such as those by Petersen (1913, 1918) in Danish waters and by Ziegelmeier (1963) in the German Bight, refer to general areas of investigation rather than to exact locations of individual stations as in the present study.

The present paper is based on material collected during 3 periods of investigation, 1963--1964, 1967, and 1969. Since 1966, about 45 metric tons of digested sewage-sludge per day has been discharged into Puget Sound at the West Point treatment-plant (Pamatmat, 1971). It is one of the aims of the present paper to investigate possible quantitative or qualitative changes in the bottom fauna that could be attributed to the sewage discharge.

Material and Methods

The 4 stations included in the present study (Fig. 1) are Stations 1--4 in Lie (1968) or A--D in Lie (1969 a). They are located on a section across Puget Sound off Seattle; their distances from the sewage outlet at West Point were 4.5, 6.0, 10.5 and 12.0 km, respectively. There were no navigational problems in locating Stations 1, 3, and 4, as they were close to the beaches. Station 2 was more difficult to locate accurately, but
the bottom topography is less variable at that station and, therefore, less heterogeneity in the fauna may be expected. According to Lie (1968), depths and sediment types at the stations are, Station 1: 23 m, mixed sandy bottom; Station 2: 195 m, soft mud; Station 3: 22 m, mixed sandy bottom; Station 4: 12 m, silty sand.

During 1963—1964, the benthic infauna was collected with a 0.1 m$^3$ van Veen grab in 5 to 10 replicate samples every 3 months. In August, 1967,