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Sigmund S. Socransky, Anne D. Haffajee

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Periodontal microbial ecology

SIGMUND S. SOCRANSKY & ANNE D. HAFFAJEE

The authors have taken the liberty of presenting this manuscript in two parts. The first is a brief 'primer' on microbial ecology, because, although the importance of microbial ecology in periodontal diseases is widely recognized, most of us do not know precisely what is meant by the term. The second section is a rather extensive overview of current studies of oral microbial ecology based almost entirely on recent *in vivo* studies.

Principles of microbial ecology

Microbial ecology is concerned with the interrelationships between microorganisms and their environments. Habitat ecologists, including periodontal microbiologists, examine the microorganisms of a particular habitat and attempt to analyze the effects of the microorganisms on their environment and the influence of the habitat on its residents. Many of the principles of microbial ecology were outlined in a superb monograph by Alexander (2) and will be briefly described below along with some periodontally relevant examples to highlight some of the points.

The ecosystem

A key concept in microbial ecology is the ecosystem. An ecosystem is the complex of organisms in a specified environment and the nonmicrobial surroundings with which the organisms are associated. The ecosystem includes the assemblage of species and the organic and inorganic constituents characterizing that particular site. Each ecosystem has a collection of organisms and nonmicrobial components unique to it and it alone. The organisms inhabiting a given site constitute a community. The assemblage of organisms constituting a community contains populations of individual microbial species. This leads to a hierarchy from ecosystem to community to population to the single cell. One of the goals of this issue of *Periodontology 2000* will be to define the assemblage of species in the periodontal habitat, to determine how changes in the habitat affect the community and how the community affects its habitat.

Habitat and niches

The habitat is the site at which a population or community grows, reproduces or survives. The role of an organism in a habitat is its niche. Niche does not connote location but rather function. A species can have one niche in one habitat and a different niche in another habitat.

Microbial succession

In a developing ecosystem, certain species termed pioneer organisms colonize first. These species are often replaced by other species after they have altered the habitat, making it suitable for colonization by other species. There are two kinds of microbial succession. In autogenic succession, the sequence of species is brought about because the resident populations alter their surroundings in such a manner that they are replaced by species better suited to the modified habitat. In allogenic succession, one type of community is replaced by another because the habitat is altered by nonmicrobial factors such as changes in the physical or chemical properties of the region or changes in the host. Factors contributing to succession are:

- provision by one community of a nutrient that confers an ecologic advantage to the species in the next stage of succession;
- the making available by one population of a constituent present in insufficient supply to allow for growth of a later population;
- alteration in concentration of an inorganic nutrient;
- modification of heterogeneous substrates such as animal tissue;
- an autointoxication effect;