Studies on the Ecology of West Australian Actinomycetes: Factors Which Influence the Diversity and Types of Actinomycetes in Australian Soils

D. Keast, P. Rowe, B. Bowra, L. Sanfelieu, Edward O. Stapley, and H. Boyd Woodruff

Department of Microbiology, University of Western Australia, Nedlands, Western Australia; and Merck Sharp & Dohme Research Laboratories, Rahway, New Jersey, USA

Abstract. A statistical technique has been employed to study the effects of various environmental factors in altering the actinomycete populations of soils located in the western part of Australia. Over 12,000 actinomycetes obtained at 28 different locations were included in the evaluation. Among factors that had a significant influence were the geographic area at which the sample was taken, the nature of plant rhizosphere, and a rainstorm. Seasonal changes in population did occur, but there was considerable stability of population with time. Although marked differences occurred in types of actinomycetes present among different geographic locations, multiple samples taken within a location at distances of 30 cm or greater showed marked similarity in populations. There were varied degrees of diversity among the populations studied. The population that developed after a rainstorm was low in diversity, whereas the populations of root rhizospheres were as diverse as those of plant-free soil-litter areas. In assessing the ecology of soil actinomycetes, it is important to consider the degree of change in population induced by an environmental factor and also its effect on diversity, since the effects may be complementary or may be opposite in nature.

Introduction

Soil is the common habitat of aerobic filamentous bacteria of the order Actinomycetales. Members of the genus Streptomyces, which as mature organisms produce chains of spores attached to aerial hyphae, are especially numerous.

Problems are encountered in measuring the numbers of actinomycetes present in soils. Especially, the significance of colony counts as a means for counting filamentous organisms has been questioned. There is high probability that a single streptomycete organism present in soil will yield multiple colonies on agar dilution plates. The multiple colonies can be derived from individual spores or from fragmented mycelial elements which become separated one from the other during the dilution and plating steps.

* Present address: 797 Valley Road, Watchung, New Jersey 07060.
Despite uncertainties arising from the enumeration techniques, there is little doubt that *Streptomyces* spp. and other members of the Actinomycetales are biologically active components of soil populations. Cholodny slides buried in soil can be used to obtain qualitative assessments of active members of soil populations. Microscopic examinations of such slides show many fine actinomycete filaments growing out from the soil particles. Furthermore, the strong odor of freshly cultivated soils, a characteristic property of compounds typically produced by streptomycetes, provides additional evidence that the streptomycetes present are in a physiologically active state. In addition, laboratory studies have shown that streptomycetes are able to metabolize various complex organic materials which are found in soils. Such studies attest to active metabolic activity by filamentous bacteria present in soils.

In spite of the emphasis given to study of actinomycetes by researchers specializing in soil microbiology, relatively few approaches have been made to the elucidation of the specific factors that influence the actinomycete populations of soils, either the species encountered or the diversity of the types present.

An opportunity to address the issue arose when large numbers of actinomycetes were isolated from soils in Australia during a screen for antibiotic production. To obtain information of fundamental significance to the field of soil microbiology, care was taken in the design of the program to obtain data concerning cultural characteristics and sources of cultures that could be submitted to statistical analyses.

Materials and Methods

*Site Selection*

The major soil sampling sites were located within a 500 km radius of Perth, Western Australia. They included an exceptionally diverse range of soil types, extending from sand dunes of the Indian Ocean coastal areas to areas at the rear of a coastal escarpment which receives little impact from activities of man. Areas evaluated on a replicate basis were a jarrah forest on laterite soil, a relatively fertile area of krasnogenic soil, a jarrah forest subject to a wilt disease caused by *Phytophthora cinnamomi* [12], cleared jarrah-pine farmland on laterite soil, and a native scrub sand-dune area. In addition, samples were taken at 20 other sites in the Perth area ranging from sandy coastal areas, lake shores, high-saline soils, bauxite-rich soils, highly leached soils, marsh lands, forested areas, and farm lands. Also, 3 samplings were made in the northwestern tropical areas of Australia in the Ord River basin.

To provide for assessment of influence of ground cover on actinomycete populations, samples were taken from soils covered with forest litter but containing few active roots, and from the rhizospheres of plants located nearby. The plant rhizosphere samples included the genera *Acacia, Banksia, Dryandra*, *Melaleuca, Anthoceris, Juncus, Templetonia, Tetragonia, Spinifex, Arctotheca, Lemna* and *Pinus*. Because *Acacia* spp. are common in Australia, a rhizosphere from an *Acacia* spp. could be collected at every geographic site sampled. Rhizospheres of other genera were collected at only single sites.

*Soil Sampling and Plating*

As a standard procedure, 5 g quantities of soil from root-free, forest-litter-covered areas were collected at 1–4 cm below surface level after removing the litter. Rhizosphere samples were collected