Preface

The fifth meeting of scientists working with *Frankia* and actinorhizal plants was held at Montmorency Forest of Laval University in Québec from August 6–8, 1984. Results of research presented at the meeting are included in this special volume of *Plant and Soil.* The understanding and use of actinorhizal systems continue to increase, though workshops and discussions at this and similar meetings make it evident that this important subject remains open for fruitful investigation at all levels.

Some important 'firsts' were reported at this meeting. The first extensive survey of *Frankiae* and their host specificity ranges from Asia was presented. This is of significance since Asia is a center of diversity for many actinorhizal host plant genera. A report that protoplasts of *Frankia* have been produced and regenerated for the first time improves the possibility for genetic manipulation of *Frankia.* It is also important to note the first report herein of successful mass inoculation of actinorhizal plants commercially for stabilization and reclamation of disturbed soils around hydroelectric power projects in Québec. This heralds the transfer of actinorhizal technology to private and public users.

The bacterial genus *Frankia* is easily recognized both *in vivo* and *in vitro*, and isolation of this organism has become routine. But, as yet, there are not sufficient biochemical, morphological, or anatomical criteria for establishing species.

Although isolation of *Frankia* has become routine for many actinorhizal associations, there are no isolates reported for about half of the known actinorhizal genera and some *Frankia* isolates cannot be manipulated so as to successfully reinfect the host plant from which they were obtained.

The analysis of DNA from *Frankia* and its host plants, and the genetic analysis of *Frankia* plasmids, are emerging as tools for understanding and manipulating actinorhizal symbioses. There is a need to find useful markers for distinguishing functions of genetic material from *Frankia* and its host plants. Investigations of metabolism are yielding pathways and barriers for biochemical transformations of *Frankia.*

Improved methods for researching actinorhizal partners reported at this meeting include freeze substitution of *Frankia* for electron microscopy, the use of microbeads for precision placement of *Frankia* colonies near root surfaces, and tissue culture of host plants for studies of interactions between host and endophyte.

Unusual spore-like structures similar to chlamydospores were reported to occur on an isolate from *Casuarina* nodules at this meeting. Vesicles of *Frankia* have been purified and *Frankia* protoplasts have

been produced for improved studies of organismal functions. Exploration of the events, preceeding and associated with the infection process continues, with extensive serial sectioning and ultrastructural examination of actinorhizal associates. Isolates from diverse geographic sources are now available, and cross-inoculation patterns continue to emerge.

Physiological and ecological studies of actinorhizal organisms are revealing relationships among respiration, growth, nitrogenase activity, nodulation, temperature, oxygen tension, water stress, mineral nutrition, allelochemicals, and other properties of actinorhizal organisms and their environment. Methods to optimize operations for inoculation of actinorhizal plants are also being developed.

Results of studies of pure and mixed plantations of *Alnus* and *Populus* trees illustrate the complexities of nitrogen fixation and movement in actinorhizal ecosystems. The effects of planting mixture, planting density, soil type, site, time, different actinorhizal plants, interplanted species, allelochemicals, weather, and other factors are important in determining plantation performance.

Future research needs include more *Frankia* isolations for taxonomic and practical use. It is also possible that there are more actinorhizal plants to be found, since *Frankia* has proven to be a very promiscuous nitrogen-fixing symbiont. Detailed study of the infection process is also needed. Such studies may lead to increased host susceptibility and the spread of symbiotic nitrogen fixation capabilities to additional host plant taxons. Recent advances in the understanding of manipulation of microbial genes have been spectacular. More emphasis and effort are needed in order to realize similar progress with *Frankia.* Much needs to be done in order to obtain a clearer picture of the physiology and biochemistry of *Frankia* and its host plants.

The need for information on actinorhizal systems seems to be particularly critical in developing countries where demand for fuelwood, improved soil nitrogen fertility, and building materials can be better met with more effective use of actinorhizal plants. Furthermore, the ubiquitous occurrence of actinorhizal plants in temperate ecosystems where they are often overlooked, suggest that research is needed to quantify current benefits so that we can better appreciate and improve our use of actinorhizal plants.

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