Nitrogen Fixation

Nitrogen Fixation:
Achievements and Objectives

Proceedings of the 8th International
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Edited by
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Preface

We are witnessing an increased awareness of the earth's environment. Examples are easily seen in the rise of 'Green Parties' across Europe, North America, Australasia, and lately Eastern Europe. The public outcry following industrial mishaps in Alaska, Chernobyl, Basel, and Bhopal, as well as the renewed legislative activity, such as the Clean Air Act in the USA and the European Community directive to member nation concerning the control of release of genetically engineered organisms are further examples of the general interest in the biosphere.

The 'Ozone hole', 'Greenhouse gases', and 'Genetically engineered Microorganisms' have gained public profiles, and are discussed widely in newspapers, magazines and the electronic media. A recent educational survey of nations, belonging to the Organisation for Economic Co-operation and Development (OECD) showed that school children are more literate with ecological terms (as listed above) than with 'pure' scientific terms, like 'phloem', 'mitosis', 'proton', or 'Jurasic period'.

Perhaps the increase in awareness is cyclical, being fed by non-scientific, sociological and economic advances. The late 1960s/early 1970s saw a major increase in environmental consciousness. Anti-pollution groups were founded, healthfood shops and naturopathy became acceptable as did recycling, the use of lead-free gasoline, and the reduced usage of environmental toxins, like DDT and PCB. For example, Monsanto Chemical Company instigated a self-imposed halt to the manufacture of PCB in the mid-seventies. Chemical companies started to look at biodegradable herbicides, slow release fertilizers, and specifically targeted pesticides. Slowly the concept of low input and sustainable agriculture developed. Renewable resources became an attractive concept beyond its use as an alliteration.

The 1973/74 oil price adjustment came right in the midst of this development and resulted in an upsurge in biological nitrogen fixation research. Significant momentum was gained by the realization of the large energy inputs required for industrially produced nitrogenous fertilizer. At the start of the last decade of this century, we can look at the results of this international focus on biological nitrogen fixation. What information has been provided so that we can approach the agronomic problems in a meaningful way? What have been our achievements and what are our objectives?

Not surprisingly, the 'young science' of nitrogen-fixation research has produced no major agronomic result. We do not have superior legumes or inocula. We do not have molecules that convert nitrogen gas directly into ammonia under the action of solar light. We do not have a hydrogen-based fuel economy, eliminating the demand for fossil fuel. What we have is a lot of valuable information and a recognition of the problems at hand. It becomes clear from the analysis of other technologies (electric, electronic, transportation, metallurgic, etc), that there is a distinct lag period between the development of the critical technology (e.g. the invention of the transistor or the airplane) and broad application (PCs and Boeing 747s, respectively). It would have been silly to ask the *Escherichia coli* geneticists of the late 1950s, having discovered the operon, Hfr

strains and bacteriophages, to put their information to practical use, yet today we use these technologies to clone and express human insulin and pharmaceuticals.

The new decade is faced with a new set of problems, arising before the old ones are solved. Many nations are faced with trade deficits and internal economic problems. East European nations are changing to market-driven economies and democratic societies. Global food demand has exceeded the food supply for the first time in a decade. The time 'bought' by the Green Revolution is wearing thin. Population increases in the developing world continue to outstrip local productivity. The developed world progressively sees value in the quality of life as more people grow older and birth rates decline.

Thus biological nitrogen fixation research has renewed impetus and applicability. The old applications of our research are still to be fulfilled. The world needs better agricultural systems with plants, technologies, and microorganisms that are adapted to modern agricultural needs. The factors that influenced the evolution of the mechanisms underlying nitrogen fixation may not be critical factors in the broad acreage, high yield demand situation experienced today. We need to lower our demand for nitrogen fertilizer and make legume (and non-legume) crops, pastures and trees (!) more attractive to the grower. It seems essential to distinguish between our human role as manipulator versus participant in our biosphere. Difficult problems indeed!

Nitrogen fixation research does provide more than the above focus. The recent discoveries in all areas covered in this book permit one to recognize other benefits of our activity. Our primary product clearly is information, which in turn can help us to understand other biological processes. Only then will we, as a species, know how to interact, control, or be controlled by the biosphere of this planet.

The study of the signal exchange and regulatory circuits between the symbiotic partners and within the symbionts themselves relates to other plant-microbe interactions. The molecular mechanisms of nitrogenase function relate to electron transfer, metallo-enzymes, and cofactor chemistry. Evolutionary concepts dealing with divergence and redundancy of genetic systems show that gene duplication and/or convergent evolution led to functional duplication in all organisms involved in nitrogen fixation (e.g., alternative nitrogenases, multiple *nod, ala,* and *nif* genes, multiple nodulation controls, and multigene families involved in nodulin function). Our research into nodulation processes promises to accelerate plant biology in general through the elucidation of developmental cassettes and new signal compounds.

The 8th International Congress on Nitrogen Fixation took this global view as reflected by the stated theme, its program, and the title of this book. The cover design of the graphics on the first and second circulars and the abstract book images the sun, the green biosphere and water. Nitrogen fixation is linked to all of these. Coincidentally, the design may also be interpreted to represent the beautiful East Tennessean countryside experienced during the Congress by the over 600 registrants from 51 different countries

The large proportion of young and enthusiastic scientists, the high calibre of the oral and poster presentations, and the vigorous discussions, research planning, development of future collaborations, and exchange of materials during the Congress showed clearly that nitrogen-fixation research is significant and necessary and that synergism of researchers working at different levels of organizational complexity is fruitful.

In closing, we want to express our deepest thanks to our co-organizers Paul Giordano and Owen Livingston; the local and international committees that helped shaping the program, the UT Conference Department (especially Lea Anne Law, Nissa Dahlin-Brown and Robert Gibbs, and the rest of the 'Nitro' group); our sponsors around the world (see separate listing); our postdoctoral, graduate, and technical staff; Greg Payne; and the general staff of UT for making the Congress so successful. Special thanks must go to Janice Crockett for her untiring assistance in the execution of the planning of the Congress, Lorraine Coffey for excellent help with the abstract book, and Vicky Newton for the effort (a repeat performance (!)) of putting this volume together.

Finally, we want to thank our close families for putting up with us throughout this exciting period of bringing our colleagues and friends to Knoxville.

Knoxville May 1990

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