INTERNATIONAL BIOLOGICAL PROGRAMME 3

Photosynthesis and productivity in different environments

EDITED BY

J. P. Cooper

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Foreword

In view of the need to find answers to urgent problems of environmental management, ecologists are nowadays exposed to a stress as well as a temptation to formulate and solve their problems rapidly and in rather broad terms. It is obvious that such an approach is based on rather broadly defined assumptions and can lead to conclusions which are of general and qualitative or only semi-quantitative character. Such conclusions may not stand the test of practical application. In spite of all good intentions, ecology may thus lose rather than gain the confidence of the lay public.

The IBP Production Process section, together with its Photosynthesis subsection, and later also the intersectional Photosynthesis Liaison Group, have been aware of this danger, and have been emphasising the value of the fundamental 'processes approach' to ecology. This approach stresses the importance of the study of physiological processes underlying the functioning and behaviour of ecological systems.

Primary production tends to be taken for granted by some ecologists, as if the plants acted as mere accumulators of energy and matter which they acquire from their environment. Ecological relationships, in this interpretation, become complex only during the further transfers and transformations of this matter and energy in the ecosystem. But things are by no means so simple; the primary producers operate differently in different ecosystems although, at the same time, the general principles of the process are common. The study of these common principles, as well as of the most important differences, should assist us in determining the minimum useful diversity which we must understand if we wish to analyse and predict the functioning of photosynthetic systems in different environments. The reactions and adaptation of the photosynthesising plants to the varied environmental factors can only be understood when we intensify our investigations from the ecosystem and community levels to most of the lower levels of biological organisation, and then extrapolate our results back to the higher and more complex levels.

The present concluding operations of the IBP consist largely of the synthesis of the great amount of unique data and ideas that have resulted from investigations of plant photosynthetic production pursued in a number of countries. How can ecology make use of these results? In order to understand the role played by photosynthesis and plant productivity in various ecosystems and biomes, the data on photosynthesis should be related to other ecosystem characteristics, such as the origin of the constituent taxa, the structure of the ecosystem and that of the populations present there, and the variation of these structures with time, habitat, and human influence. Also of importance is the relationship between photosynthesis and the genetic and morphological features of the taxa. When investigating these relationships we are analysing the variation in time of the photosynthetic function, particularly during successions taking place in ecosystems affected by man.

An analysis of the spatial variation of the photosynthetic function is also of great importance. It is meaningful to pursue comparative studies of the photosynthesis of taxa which occur both within one biome and in different biomes. Investigations of photosynthesis under controlled conditions represent an extremely useful tool for clarifying the dependence of photosynthesis on irradiation density, temperature, and water potential as well as on other important environmental factors. In such studies, we can also link the processes of gas exchange with the anatomical structure of the assimilatory organs, with the ultrastructure of the chloroplasts, and with the metabolism of the plant. Intensive work will undoubtedly be pursued along these lines in the post-IBP period also.

Finally, a few comments on the mathematical modelling of processes taking place in the leaf, plant, ecosystem, and biome. Apart from its usefulness as a method of clearly defining the objectives of our research, a fascinating aspect of mathematical modelling is the possibility of predicting changes in the processes, which will occur as a result of various kinds of environmental or other influences. Moreover, mathematical modelling has made it possible to investigate new characteristics, hitherto not studied, that are important for rightly understanding the photosynthetic function, e.g. the role which the spatial orientation of the leaves plays in the attenuation of photosynthetically active radiation. As a result of the recent rapid development of systems ecology, all of us seem to be at present under a 'stress' of mathematical modelling. With due respect to the outstanding advantages of mathematical modelling, its use should always be based on a critical and careful analysis of the data employed. The level of resolution of the model is determined both by the complexity of the system studied and by the actual level of our knowledge of that system. If the system is very complicated and our knowledge is comparatively little, the model inevitably contains many 'holes' each having a different significance for the quality of the model. Bearing in mind their 'hierarchy', the numbers of these 'holes' should be reduced by further carefully planned experiments and observations.

The present IBP volume concludes one period of international collaboration in investigations of plant production processes. This is an opportunity to thank all those whose enthusiasm and mutual understanding in carrying the burden of international collaboration – however rewarding it has been – have brought the Photosynthesis subsection as well as the intersectional Photosynthesis Liaison Group to our present situation. Among those few to be named, out of many others, Professor E. C. Wassink is to be thanked first of all. As Deputy Convener, he has always emphasised the fundamental and experimental approach to the study of plant photosynthetic production. Together with his work, that of all the members and corresponding members of the PP Photosynthesis subcommittee deserves high appreciation, the more so when we recall the hesitations and doubts about the subsection's programme in the early phases of the IBP. The idea of organising the Aberystwyth IBP technical meeting, on whose proceedings this volume is based, was first put forward by the Photosynthesis Liaison Group, and the Group has been most active in putting this idea into practice. Dr P. Gaastra deserves the credit for maintaining the activity of the Liaison Group for nearly four years, while Professors J. P. Cooper, and G. E. Blackman, FRS, and all the other British organisers are to be thanked for having enabled the meeting to take place in the United Kingdom, particularly in the hospitable environment of the University College of Wales at Aberystwyth. Last but not least, all the encouragement and assistance received from SCIBP, UNESCO and IUBS are gratefully acknowledged. The representatives of the MAB programme of UNESCO have also often expressed their interest in our activities; all of us would like to regard this as a guarantee that the results presented here will be fully used and further developed by the MAB programme. Dr F. E. Eckardt has been particularly active in promoting the contacts with UNESCO. We are also grateful for the assistance of the Royal Society towards this meeting, as well as for the various national supports given to the participants at Aberystwyth and the authors of this IBP volume.

It is with confidence, as always, that we look forward to future international collaboration in the study of photosynthesis and other plant processes essential for ecosystem functioning. We shall carry on with our effort aimed at breaking through both the national and interdisciplinary barriers separating us one from another. The role IBP has played in this most desirable development has not been in vain. We believe that our plant will continue to grow, flourish and bear fruit even now, after the IBP has served its term and handed over to other more and more complex programmes, because ours is a vigorous living plant!

Prague and Leningrad
June 1973

IVAN MÁLEK
IBP/PP Convener

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IBP/PP – Photosynthesis Deputy Convener

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