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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 these 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

Foreword

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

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IBP/PP Convener

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Contents

<i>List of contributors</i>	<i>page</i> xvii
<i>Foreword: I. Málek & O. V. Zalensky</i>	xxi
1 Introduction <i>J. P. Cooper</i>	1
Part I. Primary production in terrestrial ecosystems	
2 Primary production of forests <i>T. Kira</i>	5
3 Primary production of grazing lands <i>M. M. Caldwell</i>	41
4 Primary production of tundra <i>F. E. Wielgolaski</i>	75
5 Primary production of deserts <i>E.-D. Schulze & L. Kappen</i>	107
5.1 Physiological basis of primary production of perennial higher plants in the Negev desert <i>E.-D. Schulze, O. L. Lange, L. Kappen, M. Evenari & U. Buschbom</i>	107
5.2 The biomass production of some higher plants in Near-Eastern and American deserts <i>M. Evenari, S. Bamberg, E.-D. Schulze, L. Kappen, O. L. Lange & U. Buschbom</i>	121
5.3 Potential photosynthesis of Central Asian desert plants <i>O. V. Zalensky</i>	129
5.4 Primary production of lower plants (lichens) in the desert and its physiological basis <i>L. Kappen, O. L. Lange, E.-D. Schulze, M. Evenari & U. Buschbom</i>	133
6 Productivity of agricultural ecosystems <i>R. S. Loomis & P. A. Gerakis</i>	145
7 Functioning of the biosphere at the primary production level - objectives and achievements <i>F. E. Eckardt</i>	173

Contents

Part II. Primary production in aquatic ecosystems

8	Primary production of freshwater macrophytes <i>D. F. Westlake</i>	page 189
9	Primary production of marine macrophytes <i>K. H. Mann & A. R. O. Chapman</i>	207
10	Primary production of freshwater microphytes <i>J. F. Talling</i>	225
11	Primary production of marine microphytes <i>T. Platt & D. V. Subba Rao</i>	249
12	Primary production of aquatic plants – conclusions <i>J. F. Talling</i>	281

Part III. Distribution of radiant energy and CO₂ in relation to community structure and stratification

13	Distribution of radiant energy and CO ₂ in terrestrial communities <i>T. Saeki</i>	297
14	The roles of nutrient cycling and radiant energy in aquatic communities <i>D. W. Schindler & E. J. Fee</i>	323
15	Solar radiation and carbon dioxide in plant communities – conclusions <i>Margaret C. Anderson</i>	345

Part IV. Photosynthetic activity of individual plants and tissues

16	Photosynthetic mechanisms in higher plants <i>J. H. Troughton</i>	357
17	Photosynthesis in mosses and lichens <i>P. Kallio & L. Kärenlampi</i>	393
18	Photosynthetic systems – conclusions <i>Ph. Chartier & J. Čatský</i>	425

Part V. Use of assimilates for maintenance, growth and development

19	Biochemical pathways in unicellular plants <i>G. E. Fogg</i>	437
20	Use of assimilates in higher plants <i>F. W. T. Penning de Vries</i>	459

- 21 Source-sink relations and the partition of assimilates in the plant
P. F. Wareing & J. Patrick page 481
- 22 Beyond photosynthesis – the role of respiration, translocation and growth potential in determining productivity
L. T. Evans 501

Part VI. Influence of stress factors and the use of assimilates

- 23 Water stress, photosynthesis and the use of photosynthates
B. Slavík 511
- 24 Influence of mineral nutrition on photosynthesis and the use of assimilates
L. Nátr 537
- 25 Influence of temperature stress on CO₂-gas exchange
H. Bauer, W. Larcher & R. B. Walker 557
- 26 Effects of environmental stress on photosynthesis – conclusions
D. Koller 587

Part VII. Actual and potential production in photosynthetic systems

- 27 Control of photosynthetic production in terrestrial systems
J. P. Cooper 593
- 28 Crop simulation and experimental evaluation – a case study
H. van Keulen, W. Louwerse, L. Sibma & Th. Alberda 623
- 29 Control of photosynthetic production in aquatic ecosystems
E. Stengel & C. J. Soeder 645
- 30 Actual and potential photosynthetic production – conclusions
W. R. Stern 661

Part VIII. Conclusions

- 31 Photosynthesis and productivity in different environments
E. C. Wassink 675
- List of supplementary papers submitted at the IBP Aberystwyth Meeting, April 1973* 689
- Index* 695

Table des matières

<i>Auteurs</i>	page xvii
<i>Préface. I Málek & O. V. Zalensky</i>	xxi
1 Introduction	
<i>J. P. Cooper</i>	1

1ère Partie. Productivité primaire des écosystèmes terrestres

2 Productivité primaire des forêts	
<i>T. Kira</i>	5
3 Productivité primaire des pâturages	
<i>M. M. Caldwell</i>	41
4 Productivité primaire de la toundra	
<i>F. E. Wielgolaski</i>	75
5 Productivité primaire des déserts	
<i>E.-D. Schulze & L. Kappen</i>	107
5.1 Bases physiologiques de la productivité primaire des plantes supérieures vivaces dans le désert du Negev	
<i>E.-D. Schulze, O. L. Lange, L. Kappen, M. Evenari & U. Buschbom</i>	107
5.2 La productivité en biomasse de quelques plantes supérieures des déserts du Proche-Orient et d'Amérique	
<i>M. Evenari, S. Bamberg, E.-D. Schulze, L. Kappen, O. L. Lange & U. Buschbom</i>	121
5.3 Photosynthèse potentielle chez les plantes des déserts centrasiatiques	
<i>O. V. Zalensky</i>	129
5.4 Productivité primaire des plantes inférieures (Lichens) désertiques et ses bases physiologiques	
<i>L. Kappen, O. L. Lange, E.-D. Schulze, M. Evenari & U. Buschbom</i>	133
6 Productivité des écosystèmes agricoles	
<i>R. S. Loomis & P. A. Gerakis</i>	145
7 Fonctionnement de la biosphère au niveau de la productivité primaire: buts et résultats	
<i>F. E. Eckardt</i>	173

2e Partie. Productivité primaire des écosystèmes aquatiques

8 Productivité primaire des macrophytes d'eau douce	
<i>D. F. Westlake</i>	189
9 Productivité primaire des macrophytes marins	
<i>K. H. Mann & A. R. O. Chapman</i>	207
10 Productivité primaire des microphytes d'eau douce	
<i>J. F. Talling</i>	225

11	Productivité primaire des microphytes marins <i>T. Platt & D. V. Subba Rao</i>	page 249
12	Productivité primaire des végétaux aquatiques: conclusions <i>J. F. Talling</i>	281

3e Partie. Distribution de l'énergie de radiation et du CO₂ par rapport à la structure et à la stratification de la communauté

13	Distribution de l'énergie de radiation et du CO ₂ dans les communautés terrestres <i>T. Saeki</i>	297
14	Le rôle du cycle des substances nutritives et de l'énergie de radiation dans les communautés aquatiques <i>D. W. Schindler & E. J. Fee</i>	323
15	Radiation solaire et CO ₂ dans les communautés végétales: conclusions <i>Margaret C. Anderson</i>	345

4e Partie. Activité photosynthétique chez les individus et les tissus végétaux

16	Mécanismes de la photosynthèse chez les plantes supérieures <i>J. H. Troughton</i>	357
17	Photosynthèse chez les Mousses et les Lichens <i>P. Kallio & L. Kärenlampi</i>	393
18	Systèmes photosynthétiques: conclusions <i>Ph. Chartier & J. Čatský</i>	425

5e Partie. Emploi des assimilats dans l'entretien, la croissance et la développement

19	Circuits biochimiques chez les plantes unicellulaires <i>G. E. Fogg</i>	437
20	Utilisation des assimilats chez les plantes supérieures <i>F. W. T. Penning de Vries</i>	459
21	Relations de type 'source-réservoir' ('source-sink') et la partition des assimilats chez la plante <i>P. F. Wareing & J. Patrick</i>	481
22	Au-delà de la photosynthèse: rôle de la respiration, de la translocation et du potentiel de croissance dans la détermination de la productivité <i>L. T. Evans</i>	501

Table des matières

6e Partie. Influence des facteurs de stress et l'emploi des assimilats

23	Stress hydrique, photosynthèse et emploi des photosynthats <i>B. Slavík</i>	page 511
24	Influence de la nutrition minérale sur la photosynthèse et l'emploi des assimilats <i>L. Nátr</i>	537
25	Influence du stress thermique sur l'écharpe CO ₂ -gaz <i>H. Bauer, W. Larcher & R. B. Walker</i>	557
26	Effets du stress de l'environnement sur la photosynthèse: conclusions <i>D. Koller</i>	587

7e Partie. Productivité réelle et potentielle dans les systèmes photosynthétiques

27	Contrôle de la productivité photosynthétique dans les systèmes terrestres <i>J. P. Cooper</i>	593
28	Rendements simulés et évaluation expérimentale: un exemple <i>H. van Keulen, W. Louwerse, L. Sibma & Th. Alberda</i>	623
29	Contrôle de la productivité photosynthétique dans les écosystèmes aquatiques <i>E. Stengel & C. J. Soeder</i>	645
30	Productivité photosynthétique potentielle: conclusions <i>W. R. Stern</i>	661

8e Partie. Conclusions

31	Photosynthèse et productivité dans différents environnements <i>E. C. Wassink</i>	675
	Liste de communications supplémentaires présentées à la réunion <i>PBI d'Aberystwyth, Avril 1973</i>	689
	<i>Index</i>	695