Biogeography

natural & cultural

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Preface

This book is intended specifically for undergraduate students of geography, and in particular for those involved with biogeography for the first time at anything other than the patchy treatment given in most schools; I realize that such people may not have taken much biology either. My aim here is to give an overview of much of the content of the field as seen from within geography and is deliberately planned as a 'once over lightly' treatment. The subject matter is therefore rather wider (it includes animals, for instance) than has been the case with most books of this kind written by geographers recently, though such was not the case with the biologist N. Polunin's *Introduction to Plant Geography* (1960). Inevitably, selection for breadth has meant sacrifices of depth of detail and explanation and some readers may therefore find the general level of treatment too superficial: they ought to go directly to more specialized material. My hope is that it will be read by the users rather than copiously noted, and that the students, aided by their teachers, will follow up some of the topics in greater depth. To that end I have buttressed the text with rather more references than is usual in books at this level, with a small selection of them at the end of each chapter. Apart from a few references to the late Mesolithic period in upland Britain, all the material has been culled from other people's work and I have doubtless misunderstood some of it, so that I shall be glad to have the errors pointed out; some Latin binominals may have been changed since the source in which I read about them was printed and again I should be pleased to be corrected by any systematist who happens to come across the book.

The background to the present work can be seen as a set of stages. I was fortunate to be taught as an undergraduate by a number of outstanding lecturers in the Plant Geography course of the University of London, and they strengthened an interest in the natural world which stemmed from parts of my childhood. So Palmer Newbould, David Harris, Francis Rose and Stanley Woodell introduced me to some of the material and attitudes of ecological and biogeographical thinking in Britain during the post-war years, a tradition into which my Ph.D. thesis on the ecological history of Dartmoor fitted quite well. A year at the University of California's Berkeley campus showed me another type of biogeography, which I found strange in its emphasis on human culture in an almost ethnographic sense as it related to particular groups of plants and animals. Its value, though, was made convincing to me in the course of conversations and field trips with men like Jim Parsons and the late Carl Sauer. So this book is an outcome of having been in contact with two traditions although it is not to be considered as an attempt at a synthesis with methodological intent. In more recent years, concern over environmental issues and the future of threatened species has become a concern of many students with biological interests and this view too will be apparent in this book. Lastly, I agree with David Watts that a humanistically-oriented biogeography might well be in the vanguard of a resurgence of the man-environment relations tradition in geography and it seems to me that this view, bringing together both the natural and the cultural systems of the world, might now be something which our discipline can offer mankind in its search for a *modus vivendi* with nature. The way I have tried to weave all these strands into one book is explained in the section entitled 'Framework' beginning on page one.

I have had a great deal of help in the preparation of this work. Michael Tooley took part in many discussions about format and content when we were both colleagues together at Durham. My wife Carol prepared much of the material for Part I and I have benefited greatly from her experience as a biology teacher. My thanks are due to the unknown Dr X who commented on a draft of Part II, and to Sarah Ayling and Annie Berry who helped with the rather boring tasks of checking and compilation. Part II especially was improved during a spell in the Berkeley library in 1976, and I am grateful to the Department of Geography there for lending me a desk, and to Lois and Dan Luten for their always generous hospitality; Dan's personal library yielded a fair amount of material, too, including his unpublished diagram which appears here as Fig 11.2. Early drafts were typed by the secretarial staff at Durham and the final version here in Bristol by Mrs D. Macey. My secretary, Mrs Mary Southcott, helped in very many ways and especially by re-typing tables, captions and other bits at short notice. Much of Part II was written while I was at Durham University and the time in which to do it was made possible by the generosity and flexibility of my colleagues there (and especially the Head of Department, Professor W. B. Fisher) in not insisting that I always gave particular courses; Part I was written after moving to Bristol University early in 1978 and here I am grateful to Professor Peter Haggett and his colleagues for not loading me too heavily with new courses and administrative duties.

Catherine and David are the dedicatees of this book: in small recompense for all the times the study door has been firmly shut.

I. G. SIMMONS
Bristol, June 1979

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*Figure numbers refer to this book. Detailed citations may be found by consulting captions and bibliography.

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Framework

Students of geography are usually introduced to the study of the plant life (and, less often, the animals) of the world and the environmental factors which control their distribution; frequently their work includes a consideration of how human activities have affected the distribution and growth of the organisms. This sub-field of the subject is usually called biogeography: this is a term which is not wholly satisfactory since the word is already in use by biologists to whom (either as 'biogeography' or its subdivisions 'phytogeography' and 'zoogeography', dealing with plants and animals respectively) it has a rather specialized meaning. In biology it is used for the study of the distributions of plants and animals as a key to their long-term evolution, and for looking at the effects of large-scale environmental factors such as continental land-form, continental-scale climate and world soil groups. Much of the material normally used by geographers would be considered as 'ecology' rather than 'biogeography' although the boundary is not rigid and biologists as a group are not particularly demarcation-minded. But terms like 'ecological geography', 'geographical ecology' and 'geoecology' have not found common acceptance and so, for all its problems, within geography the term 'biogeography' has stayed firmly put to describe our study of the biosphere and of man's effects on its plants and animals and the ecological systems of which they are a part.

But there is not much doubt that within geography, the biogeography teaching has lacked any crystallizing focus. Instead there has been something of a supermarket approach: according to the interests of the teacher a number of packages have been brought off the shelves and put in the course trolley. The major world soil-climate vegetation units; soils; the 'natural' vegetation units of a region or country; some vegetation history; and the consideration of energy and chemical element flows through ecological systems, have been put together and presented as 'biogeography' at the check-out point of the examination paper. This writer is not about to suggest that such an approach is 'wrong', but for those teachers and students who would prefer to have a stronger conceptual framework for their learning, then it is suggested that one can be found. The source, unaccountably neglected by many recent authors in this field, is the North American geographer of distinction, Pierre Dansereau, in his book *Biogeography* (1957). His concepts are, simply, that man creates new **genotypes** and man creates new **ecosystems.** To expand slightly, man changes the genetic makeup of plants and animals so that they pass on the alterations to future generations. Some of this transformation is done deliberately by processes of selection in which human needs and perceptions influence the desired characteristics of the organisms, along with or instead of the 'natural' environment. Other modifications may happen by accident, as a byproduct of some other change wrought by man. As examples, consider the domestication of plants and animals by selecting for breeding those individuals which showed desired characteristics like easy harvestability and heavy yield in plants, or docility and tender meat in animals (p. 182), as a deliberate change. Inadvertently, industrial smoke selectively enhanced the survival of a black form of a normally light-coloured moth found in temperate regions, so that this darker form progressively became commoner than its lighter relatives (p. 25). Similar changes have happened to the interactive combinations of the non-living environment with plants and animals which are called ecosystems. Deliberate changes include, for example, the replacement of forests by croplands, where the complex natural ecosystems of the woodland is replaced by the relatively simple field of a single crop organism and its associated plants and animals. Inadvertent alteration might be typified by the gradual changes in the flora of a grassland during decades of grazing by domesticated beasts where the system changes gradually but not necessarily the genetic structure of the individual organisms. Another example is the effect of agricultural and industrial wastes in poisoning plankton, fish and birds.

However, in order to study the effects of the human species, it is necessary to consider nature without man, as a datum-line. Part I of this book is largely designed to do this and so it presents a distillation of a great deal of biological science. First, the individual organism is considered particularly in relation to environmental factors in its distribution at various scales (e.g. global, continental, local); this is more or less the biogeography *sensu stricto* referred to above. Initially, though, there is some basic material on classification since geography students may not have studied much biology, some schools having conceived the curious idea that a number of their pupils might be allowed to leave without a working knowledge of the biological and physical systems of the planet which keep them alive. We then move to the ecosystem idea and consider the functional relations of plants, animals and their non-living environments, hanging the study on such pegs as energy flow and the cycling of chemical elements, and ending with a brief look at how energy and matter come together as the population of a species. Lastly in Part I, the major world natural associations of climate, plants, animals and soils (usually called biomes) are discussed individually. Like all distillations, the end-product can be a bit rough, especially when new, and so this attempt to compress so much into so small a space has a lot of unsatisfactory qualities especially in the form of generalizations which are prone to large numbers of exceptions. The suggestions for Further Reading will, it is hoped, help clear up some of the inevitable questions raised by the more alert readers. In one respect, this section is particularly unsatisfactory, *viz.* in trying to separate the natural from the man-made it imposes a difficult-to-find boundary: it is not known, for example, to what extent the remaining 'primeval' forests and grasslands of the world have been affected by pre-agricultural peoples. Some investigators think that man, fire, grasslands and animal communities have all co-evolved in Africa at least since the Early Pleistocene, so that the vegetation and fauna there have not been 'natural' at any time when scientific study could have been carried out on them.

In Part II, the precepts of P. Dansereau are used as a guide, though not followed in precisely the form in which he stated them. Instead, a historical approach is followed in Chapters 4–7 in which the effects of man at various technological levels on genotypes and ecosystems is considered; we turn then to the particular consequences of modern industrialization in the creation of new patterns, both by accident (Ch. 8) and design (Ch. 9). Chapters 10 and 11 are given to the thesis that the Earth's biota are man's most important resource and so discuss some of the resource systems which are fundamentally biological in nature. Only contemporary biota are considered, so that fossil fuels *per se* are excluded, although the effects of their use are central to the themes of Chapters 7–10. The final chapter comes as a future-oriented extension of Chapters 10 and 11 and considers the possible outcome of man–biota relationships if the present trends are extrapolated, and also whether there are any alternative types of relationship which might benefit both our own species and all the rest with whom we live on this planet. A narrower focus is adopted here than would be customary in books on 'The Environment' or on population–resource–environment interactions (anybody wanting a broader treatment is quite welcome to buy a copy of the present author's (1974) book which covers that field) but the discussion is deliberately widened out beyond the scientific and biological at this point. Whatever the virtues of scientific 'objectivity', it is unreal to dismiss such phenomena as human values where the future of the world's plants and animals is concerned; consider only the differential reaction of most people to pandas and hairy spiders. Although no firm answer is attempted here, no intelligent student (or citizen for that matter) ought to avoid the question, 'how much more creation of new genotypes and new ecosystems ought we to have?'

Bibliographic note; Units; Names

At the end of each chapter, 'Further reading' supplies a short list of summary sources or major works on relevant topics. These bibliographies, together with the text references, should provide a beginning for readers wanting to follow up a topic in greater depth. The items in the 'Further reading' also appear in the Bibliography, along with the bibliographic citations of the text references. A glossary of some of the scientific terms is provided at the back of the book; words defined in it are printed in **bold** when discussed in the text.

In general, the units used by an original author have been used here, with a conversion to the metric system where Imperial units were employed. Not all the units are SI, however, since quite a lot of ecological energetics is expressed in calories rather than joules. These two units are both used, therefore, rather than converting all to one system or the other. The conversion factors:

$$1 \text{ calorie} = 4{\cdot}184 \text{ joules}$$
$$1 \text{ joule} = 0{\cdot}239 \text{ calories}$$

may be useful. Sometimes productivity statistics are given in terms of grammes of carbon. To convert to the more commonly used dry-weight measurement, multiply $\times 2{\cdot}2$. This is an approximation but is widely used. Following the usage of many IBP studies on production ecology, the conventions g/m²/yr or kg/ha/yr have been used instead of the more strictly correct $\text{gm}^{-2}\ \text{yr}^{-1}$ or $\text{kg ha}^{-1}\text{yr}^{-1}$.

Latin binominals of most organisms referred to are given, except where the common name is considered an adequate identification or where groups of animals (e.g. 'hawks') or plants (e.g. 'mosses') are referred to.

Further Reading

Dansereau, P. 1957: *Biogeography. An ecological perspective*. New York: Ronald Press.

Part I

Natural Biogeography

This part of the book seeks to establish a set of datum lines about how the world of living things would be distributed and would function if man were not present. Most of our knowledge has been gained since the nineteenth century and unless there is clear evidence to the contrary we have to make the assumption that the characteristics being studied, whether for instance of physiology or ecology, have not been affected by human activity. In order to simplify the very complex set of interactions between organisms and their environment which result in the distributions and dynamics of organisms, local ecological systems, and the major world biomes, we shall study them in succession, noting that it is only in the laboratory that an organism can be seen in isolation from its non-living or abiotic environment and from other plants and animals.

1

The organism scale

All living things have in common certain characteristics. They are made up of a complex material called protoplasm which is usually divided up into units called cells. At the simplest level of organization, plants and animals consist of a single cell; at the most complex, several million, of which many will have a specialized function such as nervous tissue, hormone secretion, or hair. The functioning of both plants and animals also exhibits common characteristics: they feed, grow, reproduce, move, respire, are sensitive to their surroundings, and excrete waste substances. Differences obviously exist between these two types of life: plants make their own food from inorganic substances and solar energy and hence are called **autotrophic** ('self-feeding') whereas nearly all animals rely on food already in plant or animal form and so are called **heterotrophic** ('outside feeding'). The key difference lies in the ability of the plant to synthesize organic material from inorganic molecules, incorporating the energy from the sun which is the basis for all life. This process is called **photosynthesis** and at the simplest level of explanation involves the use of solar radiation to bind together carbon dioxide and water to make sugars and starches, with the giving off of oxygen as a concomitant. The addition of chemicals taken up by the plant from its environment makes possible the synthesis of proteins, which are the basis of the complex molecules at the heart of living matter.

Some groups of living things are not clearly either animals or plants, e.g. bacteria and fungi, and viruses show by turns that they appear to be on the border of living and non-living things. The intricacies of their classification need not be elaborated here but we need to note that the simplified systems as presented in this book are not universally agreed by all biologists.

Classification of organisms

The 'natural' system of classification, which implies some evolutionary relationship between groups, depends on arranging organisms in a series from the more simple to the more complex forms, with the latter often showing special adaptations to their mode of life, as with various types of parasite adapted to life inside another animal, or the giraffe adapted to feed off the top of savanna trees. Both plants and animals are classified according to their natural characteristics (usually morphological although biochemical are often now used), and the basic unit is the species, of which about two million are currently recognized. A definition of this classificatory or **taxonomic** unit is not easy but can perhaps be summarized as consisting of those individuals which are able to reproduce among themselves but unable to breed at all freely with members of other