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Ecology in the university first year?

W. H. DOWDESWELL
School of Education, University of Bath, Bath BA2 7AY
I. C. POTTER
School of Biological Sciences, University of Bath, Bath BA2 7AY

Abstract

The inclusion of ecology in first-year university biology courses presents considerable difficulties. The new course being evolved at Bath centres round three main themes—spatial distribution, the flow of energy, and the gene as an element of continuity. Practical work presents particular problems on account of the large number of students and a lack of time. The difficulty can be overcome to some extent by the use of simulation experiments which aim to reproduce in miniature within the laboratory certain restricted aspects of the real environment. Bearing in mind that, at most, only one visit to a natural habitat will be possible, it is important that full use should be made of good visual aids such as films and slides. Facilities must also be provided for students to check their own progress through problems derived from second-hand sources such as research papers.

1. Introduction

In the School of Biological Sciences at the University of Bath, we are currently attempting to produce a course suitable for the teaching of ecology to students entering a first year that is common to botanists, zoologists and microbiologists. There are, however, those who claim that the complexities of the subject, and some of its associated teaching problems, make this task virtually impossible or even undesirable (Lambert & Goodman, 1967). Yet, it can be argued that ecology should occupy an important part in any introductory biology course, not only as a subject in its own right, but also because of its relevance to other subject areas, such as physiology, behaviour and genetics, and to contemporary problems, such as conservation and pollution.

As we have pointed out previously (Dowdeswell & Potter, 1974), the teaching of ecology probably poses more problems than any other area of biology. This is particularly true at the first year level where large student numbers and the siting of many universities in urban surroundings make it difficult to carry out field excursions or courses. This problem is accentuated in multi-disciplinary courses where limitations imposed by time-tabling frequently add an additional restriction to the use of field work as a basis for practical experience. At Bath, and in other universities with courses where the summer period each year is spent in industry, the situation is further complicated by the fact that such teaching has to be restricted to the winter months and cannot be supplemented by out-of-term field studies. Another factor influencing the nature of an introductory course is the heterogeneity of background knowledge possessed by the students, even when they all have a respectable pass in biology at General Certificate of Education, Advanced level. In view of the great public interest now being shown in such topics as conservation and pollution, this heterogeneity of knowledge is often further enhanced through marked differences in the amount of extracurricular reading and practical experience

2. Aims of an introductory ecology course

There has been a tendency in some universities for each subject discipline to treat ecology as a separate subject. While this may be acceptable, and even obligatory in more advanced courses, it could have deleterious consequences at an introductory level. A highly biased view of the subject might be acquired by the student, especially where this is his or her only experience of this area of biology. It is therefore important that an introductory course should emphasise the interdependence of micro-organisms, plants and animals.

Another generalisation having some validity is that ecology is often taught in isolation from other areas of biology. Here again this might not be too detrimental at a more advanced level, but the same cannot be said for a first-year course

where a broad but integrated view of the subject is surely essential. In fact, ecology can be regarded as the ideal subject for tying together the various components of a course through emphasising its close relationship with such features as behavioural patterns, physiological adaptations and genetic polymorphisms.

An introductory course is thus envisaged as embodying two major principles, namely, to show the interrelationship existing between the various areas of ecology and also between the different aspects of biology. Having established these principles, an attempt can be made to isolate specific areas of the subject for further emphasis. It should be noted, however, that the choice of emphasis is important since for many students the short introductory course may remain their only experience of ecology at the university level.

3. Approaches to the lecture programme

When introducing a new subject, particularly at an elementary level, it is important that it should make a strong initial impact. A good short film, such as one of the BBC 'Web of Life' series, can achieve this purpose admirably, not only in providing information on a particular ecosystem but also in provoking questions of a more general kind. Later in the course, a description of some relevant aspects of one's own research can provide not only new material but also give a personal note to the lecture programme. In this context, sampling has proved a particularly suitable topic, since an account from first-hand experience can help to explain vividly the problems involved and ways in which these have been surmounted. We have also found that the use of a case history, involving a description of man's effect on some particular ecosystem or geographical region, is a suitable end to a programme of lectures and provides the students with at least one applied illustration of the way in which ecology is important in a contemporary context. Although the emphasis in the above examples is placed on exposure of the students to new material and a variety of approaches, it is essential that this should not be done to the exclusion of important and more traditional topics.

In an attempt to integrate the various components of such a diverse subject as ecology, we have suggested that, at an elementary level, the lecture programme can be centred around three main themes.

(i) The spatial distribution of organisms.
(ii) The flow of energy in ecosystems.
(iii) The gene as an element of continuity in populations.

Although we certainly don't regard this as a rigid format, we have found that a consideration of ecological principles within a flexible framework centred on this grouping has helped us in emphasising the interrelationships between the various areas of ecology. That alternative approaches are possible has been well illustrated by Cox (1970) who recognises for teaching three levels of integration in ecological systems, namely, the organism, the population and the ecosystem.

4. Approaches to practical work

Ideally, all ecology courses should be based on natural habitats since there can be no substitute for the real thing. However, as has been pointed out above, the peculiar circumstances pertaining in many first-year courses can exercise severe constraints on field excursions. This raises the important question of whether to jettison the practical aspects of ecology in the first year or to try some new approach.

At Bath, the provision of a good foundation course is considered so important that alternative teaching approaches and materials must be found to achieve the desired ends. The length of the course we are evolving resembles that of many other universities in that it comprises ten one-hour lectures and five three-hour practicals. We assume that, at the most, only one field trip to a natural habitat will be possible.

Much of the practical work is based on simulation experiments—situations which aim to reproduce and illustrate in miniature within the laboratory certain restricted aspects of the real environment. For instance, it is not difficult to set up aquatic tanks with a simple varied substratum and weed, and then introduce such animals as freshwater shrimps (*Gammarus pulex*), operculate (*Potamopyrgus jenkinsi*) and pulmonate (*Limnaea* spp.) snails and fish such as the bullhead (*Cottus gobio*) and the stickleback (*Gasterosteus aculeatus*). Although this type of association is, of course, only temporary and in no sense represents a balanced ecosystem, it can give students valuable experience of studying the spatial distribution of organisms through observation, sampling and deduction. An equally striking example of distribution is provided by the epibionts which colonise the different parts

of the body of *Gammarus pulex*, some being only superficial such as the stalked ciliate, *Carchesium*, while others like the suctorian, *Dendrocometes*, achieve a more intimate relationship with their host. Such an analysis, carried out quantitatively to show both the nature and extent of colonisation, provides a useful introduction to other kinds of association such as symbiosis and parasitism. In selecting organisms for these types of study, care must be taken to choose species that students are unlikely to have encountered in a similar ecological context at school.

Other simulation experiments illustrating topics such as succession can be followed in successive practicals and, using appropriate models, be completed within a few weeks (Odum, 1963; Vogel & Ewel, 1972). Thus the estimation of numbers in an animal population can be performed effectively by the process of capture–recapture using the flour beetle, *Tribolium*, which can be satisfactorily marked with small dots of quickly drying cellulose paint. Again, population growth in animals is studied with the vinegar eelworm, *Turbatrix aceti*, or more rapidly using micro-organisms such as *Chlorella*. Bacteria are of particular value in such studies on account of their sensitivity to physical factors in the environment, such as temperature and pH. Moreover, if introduced at this stage, a foundation is laid for considering later some of their fundamental roles in natural ecosystems such as decomposition. A full outline of our course is not included here since our purpose in this paper is to stress principles and approaches rather than to emphasise details.

One of the principal problems arising in the use of simulation methods is the extent to which they require the student to extrapolate from a micro to a macro situation. Although this is a complex matter on which a great deal more research is needed, such an intellectual jump can be greatly aided by the use of suitable 35 mm slides and short 16 mm films, which provide either an introduction to a subject or follow-up material at the end. A typical example of a film used in an introductory role is the BBC production on the River Test in the 'Web of Life' series which serves as an excellent lead-in to the study of aquatic ecosystems as well as illustrating many general ecological principles.

5. Teaching methods

In the teaching of any subject it is important that the methods used in presentation should be closely related to the aims of the course and the nature of the subject matter. This is particularly true of ecology which tends to face students with such a diversity of problems at the same time that progress can take place at greatly differing speeds. This serves to underline the role of the tutor who not only acts as expositor but as guide, consultant and stimulator of discussion. One of the advantages of simulation experiments in a laboratory by comparison with their out-of-door counterparts is that spontaneous discussion is often far easier. In particular, the use of largely open-ended problems necessitates that frequent opportunities be given for taking stock of progress and consolidation of ground covered. The process can be greatly aided if students work in small groups thereby promoting discussion among themselves and economising in the need for tutor participation.

An important adjunct to the kind of course outlined above will be a range of problems, both qualitative and quantitative, to test students' understanding of the subject. These can provide a simple self-check enabling individuals to test themselves or something more formal with which the tutor is also involved. Self-teaching methods lend themselves particularly well to this sort of use, since pictures and diagrams on 35 mm slides can be readily linked to problems presented as printed matter or on audio-tape (Dowdeswell, 1972). All that is needed is the necessary hardware—a slide viewer and tape player at most, and a room set aside for students to work on their own whenever they are free. In this way the use of second-hand evidence derived from such sources as research papers can become an integral and lively part of the course.

6. Implications of a simulation approach

In this account, emphasis has been placed on simulation methods as a possible means of aiding the teaching of ecology in the university first year. In conclusion we would emphasise that this is not the only method available. Lectures, seminars, and group discussions, for instance, all play their part. As we pointed out at the beginning, in the teaching of ecology there is no substitute for experiencing the real thing. We have been concerned here with situations when such experience is not possible. Our conclusions so far suggest that the problems we have broached are common to a considerable number of institutions of higher education both in Britain and abroad.

Clearly, there is a need for an exchange of experience in this difficult field both at national and international level.

7. Conclusion

Finally, to return to the question posed as the title to this paper—Ecology in the University first year? We consider that a good foundation course based both on lectures and practical work is not only desirable but essential. Ours rests on the following premises.

(i) It is truly interdisciplinary involving micro-organisms, plants and animals.

(ii) Ecology is presented both as a subject in its own right and as an important link with other areas of biology, such as physiology and genetics.

(iii) While frequent visits to natural habitats will generally be impossible, one such trip at least should be included so as to show students at first hand the problems posed to the ecologist in a particular ecosystem.

(iv) Laboratory work is based largely on simulation exercises imitating restricted aspects of natural ecosystems and designed to achieve the desired outcome in a session of two hours.

(v) Visual aids, such as films and slides, play a vital part in achieving initial impact and in introducing particular environments and ecological principles.

(vi) Second-hand information derived from research papers provides important follow-up material which students can work on independently. It also serves as a self-check on individual progress.

(vii) Examples from one's own research can help in introducing a personal note and to illustrate important principles such as sampling.

(viii) Case histories provide a way of illustrating man's role in the environment.

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