Suggestions for the Teaching of Ecology

RALPH W. DEXTER
Kent State University, Kent, Ohio

In recent years increasing interest in the science of ecology has been shown in the development of new teaching programs, curricula, and textbooks. In some instances emphasis has been placed upon the role of ecology in its relation to the whole field of biology as it has never been given before. More and more the new textbooks are giving stress to ecology, and several weave the thread of ecology throughout the text. There is need on the part of teachers to become more familiar with the teaching methods of this subject and to give more emphasis to an ecological point of view. In this paper the writer will briefly describe techniques which he has found successful over a period of twelve years in teaching ecology courses. While my experience has been at the college level, the techniques herein outlined can be modified and used successfully at a wide range of educational levels. Ecology is now a part of biological education from nature study in the elementary grades through each successive level to graduate school. The writer has already shown in the pages of this journal the unification of the natural sciences through the study of ecology, and has outlined the various phases of this science (Dexter 1945a, 1946a). This paper will continue the earlier discussions with the presentation of specific teaching methods.

I. Field Studies

All studies in ecology are based upon field work, either directly or indirectly. Without question the actual field observation is the essence of this science. Guidance for planning and conducting field trips is given in detail by Adams (1942), and a general discussion on conducting field trips has been published by the writer (Dexter 1943a) in which the aims, objectives, and general procedures of conducting field trips are outlined. Topics for specific studies are suggested here.

The most obvious problem which is first met in the field is that of community composition and structure. Whether one is observing a coniferous forest, deciduous forest, grassland, desert, or some other type of community, it becomes clear at once that it has a distinctive composition of plants and animals and has a definite structure which may be analyzed. The first step is to measure the physical factors of the environment in which the community is existing: temperature, humidity, and pH, are among the factors which can be measured easily and quickly. Others can be included if more complicated instruments are available. The plant and animal constituents and their stratification can be determined by sampling techniques. With the information on physical measurements, which may be supplemented with weather station data, geological and soil maps, as well as general observations, correlations may be made between environmental factors and the stratification of the plants and animals. Ecology offers an excellent opportunity for the integration of the physical and biological sciences. In addition to the macro-communities, similar studies may be made upon microhabitats and their communities such as those of fallen logs and temporary pools.

Following the study of community composition and structure, its relationship to the process of succession should

be determined. Wide experience in a given region will soon make clear the climax type for that region, and observations will disclose the general relationship of a particular community to the successional series. Many field trips can be organized around a successional sequence such as open bog lake, closed bog, bog forest, and climax forest to trace a hydrosere as well as to study the structure of specific types of communities. Secondary successions such as found in abandoned pastures and fields with concentric zones of open field vegetation, tall weeds, blackberry brambles, sumac shrubs, aspen-sassafras grove, and hardwood forest are easy to find and illustrate the principles of succession fully as well as the primary seres which are not always available within a reasonable travel distance.

Seasonal aspection excites much interest when field trips are made at different times of the year. With the seasonal change of environment and community structures such topics as the life cycles of plants and animals with emphasis upon flower and seed production, bird migration, animal hibernation, and other adaptations to seasonal change may be brought out. One seasonal phenomenon successfully used by the writer has been that of tracing the life histories of the sporadic fairy shrimps (Dexter 1943b).

The study of community dynamics can best center around observations on food habits and food cycles. Observations can be made directly in the field, and material can be collected for laboratory studies and analyses mentioned below.

Special and detailed observations may be made upon the vegetation or on the population of birds, mammals, fishes, mollusks, insects, etc. Surveys of vegetation and cover-type mapping can be made on field excursions. Competition, fluctuation, and survival of animal populations can be studied over a period of time with periodic quantitative samples. Bird study is particularly suitable and valuable. The more advanced students may assist in bird-banding programs and special censuses such as the Breeding Bird Census and Christmas Bird Count sponsored by the National Audubon Society. Special advantages and methods of bird study are discussed in a paper by the writer (Dexter 1945b). A license is required for bird-banding, mammal trapping, and fish seining, but these are usually available to qualified teachers for educational purposes from the conservation authorities of their states. At certain times of the year, such as after a freshly fallen snow, animal tracking is a fascinating sport.

II. Laboratory Studies

Many ecological problems can be brought into the laboratory for further study and for analysis of the field observations. The establishment and maintenance of aquaria and terraria are common practices which need no further mention here. However, it is well to point out that they should not be mere ornaments but should serve a definite purpose such as studying a microcosm or balanced aquarium, or studying animal behavior and food habits.

Food habits can be studied through the analysis of stomach, pellet, and scat contents. Dead animals collected or brought to the laboratory can be used for stomach analyses in determining food habits of the larger animals. Preserved animals purchased for laboratory dissection can also be used for this purpose. Owl pellets make a very effective demonstration of predation. Scats from birds and mammals can sometimes be used in the same manner if they contain hard, undigestible materials which can be recognized. Otherwise this type of

study becomes too technical for ordinary class study.

Simple gradient experiments can be established for the study of animal reaction in gradients of temperature, light, hydrogen ion concentration, and humidity. The maximum, minimum, and optimum levels of these factors can be determined in a general way.

A simple but very effective demonstration of suspended animation can be shown by soaking in the laboratory a sample of mud from dried-out pools and ponds (Dexter 1946b).

Studies on geographical distribution can be made in the laboratory at times when field work is neither convenient nor possible. Maps of vegetation and of distribution of specific plants and animals should be studied in correlation with climatic and physiographic maps and correlations drawn between the physical environment and the distribution of plants and animals.

III. Social Studies

Recently the viewpoint of ecology has been extended into the fields of the social sciences. Man himself has been the subject of ecological investigation on the part of biologists, geographers, sociologists, and anthropologists. Man and his relationship to environmental factors forms the study of human ecology. The extension of ecological interpretation to include man and his cultural heritage has been pioneered by such men as Sears (1946). Modern man is now being investigated ecologically just as primitive groups have been studied in their relation to the environment and their utilization of natural resources which we know as ethno-ecology. Here is an opportunity for biology teachers to bridge the gap between traditional biological disciplines and the social sciences. Another human aspect of ecology is the practical field of applied ecology generally known as conservation of renewable resources. Much literature has been published on this subject so that it is not necessary to do more than mention it at this time. Finally, the application of ecological principles to problems of health, agriculture, natural resources, and human welfare should show the close interrelationship of all living things, the study of which is the very heart of ecology.

IV. Special Projects

In addition to a general and balanced consideration of ecological principles in the study of biology, advanced students with particular interests should have an opportunity to pursue in greater detail than is possible in class work special projects of an ecological nature. These projects can be an extension or an elaboration of any of the topics mentioned in this paper or especially selected topics. The background of the student, his interest and ability, the natural features available to him for study, as well as time and facilities available must be taken into consideration in organizing a special project. Each one is an individual problem in itself, and great care should be given to its selection in keeping with the total situation as mentioned and the educational ends it is designed to serve.

V. Preparation for the Teacher

As more teachers are convinced of the importance of including ecology in the biology program at all levels of instruction, there will become an increasing demand for training in this field. The need for instruction in ecology at the secondary school level and need for training of biology teachers in ecological science has been felt for some time (Riddle *et al.* 1942). Many colleges have offered courses of study in ecology only

in recent years. Many biology teachers have not received any training in this phase of biology. Summer schools, summer camps, biological stations, and individual initiative can correct this situation. (See current issue of the Turtox handbook on *Biological Field Work.*) Manuals for field and laboratory study which will give the teacher many suggestions have been published by Park, Allee, and Shelford (1939) and Gates (1949). Recent textbooks which have been very successful have been published by Oosting (1948) and Allee *et al.* (1949). These books are intended for college classes in the advanced undergraduate or graduate levels but can be used for reference and background material by the enterprising teacher at lower levels.

The writer has found in his experience that field study does not fit a predetermined pattern which can be universally applied anywhere such as is commonly true of the laboratory sciences. One has to learn to utilize the natural resources available to him to the best advantage. Student evaluation and criticism, especially of the field trips, and newly devised laboratory experiments are of great value in establishing a program of field studies. A questionnaire such as used by the writer (Dexter 1944) for a general criticism of teaching can be adapted for all levels of education and for the special needs of determining the effectiveness of field trips.

In teaching ecology one should direct his efforts toward an understanding of the principles and processes of the interrelationships of living organisms and an appreciation of nature rather than the learning of isolated facts. In developing an ecological point of view the old adage that "one should not lose sight of the forest because of the trees" is literally as well as figuratively true.

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The National Teacher Examinations, prepared and administered annually by *Educational Testing Service,* will be given throughout the United States on Saturday, February 16, 1952. Application forms, and a Bulletin of Information may be obtained from National Teacher Examinations, Educational Testing Service, P. O. Box 592, Princeton, N. J.