ZOOLOGICAL FIELD WORK IN UNIVERSITY EDUCATION

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IN these days more people seem to be "fussing" about education than ever before. The "Eleven Plus" exam is constantly being criticized in the press, the shortage of scientists in industry and the schools continually deplored. Yet some of the more fundamental problems at issue seem often to be overlooked. What is the object of higher education? A glance at the salaries offered for most of the public appointments advertised in *The Times* will speedily destroy the myth that it is to enable its recipient to earn a large income. In fact, it may even be that an advanced education is a hindrance rather than an asset in this, since it tends to restrict its possessor's choice of occupation.

It would, I think, be nearer the mark to suggest that higher education often enables people to earn their living in a more interesting and agreeable manner than would otherwise be possible. In other cases it may help them to enjoy their leisure in a constructive and satisfying way.

The academic scientist is usually quite unconcerned about the possible economic importance of his discoveries. For it is in man's nature to seek beyond the necessities and confines of everyday life. He does not live by bread alone; few great artists, scientists or explorers are impelled entirely, or even primarily, by practical and economic motives. Perhaps the last word on the subject was written by J. S. Bach: "The aim and final reason of all music is the glory of God and the recreation of the mind." And so for all the arts and sciences! The call of adventure, both physical and intellectual, is as strong today as ever, although we may not always express it so poetically.

Generally speaking, it does not seem to matter greatly what subject is studied, provided it is pursued with intelligence and determination. It is the mental exercise which is important, and this is borne out by the fact that the well-trained scientist can readily switch from one field of endeavour to another. Science is not a trick, but the application of logical and rational methods to the elucidation of the problems of the universe. The scientist restricts his attention to those phenomena that are capable of being observed by any able-bodied person, given time and sufficiently detailed instructions what to do and what to look for. The Principle of Continuity represents an article of faith to him, and for an experiment to be valid it must be capable of repetition.

Despite the higher workings of the human mind, man is, in other respects, still very much a living animal. For this reason perhaps more than any other, biology is a noble and illuminating subject for study. The zoologist is particularly fortunate in being able to select from and synthesize the best of both worlds. He employs the tools, the mental discipline of logic to unravel the physical secrets of life.

It is generally agreed that morphology is the foundation of zoology, the very backbone of the subject, and this may well be true (although I believe that a good case could be made for basing university courses primarily on comparative physiology). However, even where a satisfactory balance of both disciplines has been achieved in the laboratory, only a fringe of animal biology will have been touched upon. The living animal is more than skin, bones, muscle and biochemical reactions, and must be seen in its natural surroundings to be fully appreciated.

Wild animals live in elaborate communities. In certain areas such as rocky shores, the different zones are clearly distinct, but in others they can be delineated only by careful research. The distribution of animals is influenced not only by the physical conditions of the environment—light, temperature, moisture, wind, acidity or alkalinity, and so on—but also by its biotic factors which include plants and other animals. Every plant and animal species in a community forms part of the environment of the others on which it reacts in greater or lesser degree. And each individual animal or plant affects and is affected by every other, either directly or indirectly.

This complexity may be somewhat daunting at first, but by judicious selection of illustrations, the teacher can soon help his students to distinguish between the innumerable factors of the environment and to observe their effect upon animal populations. For instance, Juniper Hall is situated on an outcrop of chalk, the North Downs. The alkaline soil here supports an abundance and diversity of species not found in the acidic

Greensand regions nearby. The fact that not only are more species represented, but that the number of individuals is also greater on the chalk, can be demonstrated by means of counts of the macro-fauna of the litter and surface soil in comparable quadrats in the two geological areas.

Characteristic of the chalk is *Pomatias elegans*, a pretty little snail which looks rather like a periwinkle. It is an obligatory calcicole and is only found in chalky districts, its distribution being related to the alkalinity of the soil. This can be clearly established by selecting quadrats in various places on the slopes behind Box Hill, counting the number of snails, living and dead, in each square and relating this to the pH of the soil. It will be found that where the quadrat lies on more acid soil—due to local accumulations of fallen leaves and humus for example—the number of snails drops markedly.

The effect of humidity is particularly important to small animals which have a large surface area in relation to their weight. Many terrestrial invertebrates such as insects, spiders, and mites avoid becoming dried up by covering themselves with a thin layer of wax which is relatively impervious to water vapour. Unfortunately, such a layer is also impervious to oxygen and carbon dioxide. A respiratory mechanism has therefore had to be evolved which permits gaseous exchange to take place whilst restricting water-loss to a minimum. The spiracles of insects and the lung-books of arachnids are normally kept closed by special muscles, and only when the carbon dioxide in the body begins to increase are they opened to facilitate respiration. Insects and arachnids have also evolved special excretory products—uric acid and guanine respectively—which are extremely insoluble so that waste matter can be eliminated from the body in a dry state and no water is lost in the process.

A second method of avoiding desiccation on dry land is found in wood-lice, millipedes, centipedes, springtails and many other small animals which remain most, if not all of the time, in a damp or humid environment by means of physiological orienting mechanisms. Observation of such behaviour coupled with precise measurement of micro-climates in the field not only underlines these points, but may even add considerably to our meagre knowledge of the biology of these creatures.

The influence of biotic factors on the numbers and distribution of animals can be illustrated by observing the habitats of phytophagous insects in relation to their food plants. Some species are very catholic, but others are restricted to a particular diet. Thus gorse (*Ulex europaeus*) will be found to harbour the small weevil, *Apion ulicis*, which does not occur elsewhere; *Ulopa reticulata* is characteristic of heather; and the beautiful green tortoise-beetle, *Chrysolina menthastri*, is found only on tansy (*Tanacetum vulgare*) and mint (*Mentha* spp.).

The interaction of predator and prey, parasite and host, which form such an important aspect of the biotic environment are rather more difficult to demonstrate during a short course; but adaptive colouration and behaviour are a fertile source of examples, while the phenomena of mimicry and protective resemblance lose all meaning when the animals are removed from their natural surroundings.

Adaptive colouration provides important evidence for Darwin's theory of natural selection or survival of the fittest. Since this is one of the cornerstones upon which the modern concept of evolution is based, the desirability of presenting students with practical examples whenever possible, is obvious. Again, the descriptive approach developed by Linnaeus and T. H. Huxley still dominates the objective and methods of much present-day instruction. The major difficulty facing both the university and school teacher lies in breaking down the rigid and artificial components into which knowledge is segregated, thus enabling the pupil to see biology as a whole. In addition, the restrictions of a detailed syllabus based on types do not make it easy to capture a student's interest. Both these difficulties can, to a large extent, be resolved by the introduction of field work into biological courses.

Unfortunately the biological sciences and especially zoology are still only in the process of being generally incorporated within the curriculum of the grammar schools, many of which have yet to be provided with adequate laboratory facilities. At the same time there is a great shortage of biology teachers. This may be partly due to the fact that, to many scientists, research is the *raison d'être*, the goal of a university career. If the schools could provide both time and opportunities for research, more graduates would, I think, be attracted to the teaching profession. If a science teacher can find the time and energy to do a certain amount of research, it will be of great value to himself and to his pupils, especially if they can see him at work and understand what he is about.

Lack of suitable laboratory facilities ceases to be a deterrent when it is realized that, beyond the walls and within easy reach of everyone, is the open air (if not the open country)—nature's own laboratory is always ready to yield its secrets to the observant eye. Maybe, as a higher proportion of zoologists decides to specialize in ecology, more of them will be prepared to supply the increasing demand for biology masters and mistresses.

Not every undergraduate who attends a field course expects to specialize in zoology, and there is always a natural tendency for subsidiary subjects to be neglected as uninteresting. For this reason I consider attendance at a Field Centre to be an extremely important part of every zoological syllabus: in my experience there are few students who do not thoroughly enjoy their field work and whose interest is not thereby stimulated.

Field work should form an integral part of every university course in zoology or botany. For not only does it enable the student to observe the living organism in its own realm, but, equally important, it enables him or her to savour in detail an aspect of the beauty of nature without which the study of biology loses much of its charm.