Live Organisms in High School Biology

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High school biology instruction has, fortunately, begun to emphasize the study of live rather than preserved specimens. Learning biology can hardly be pursued satisfactorily without the use of live organisms. It is surprising, therefore, that so little attention has been paid to finding out just what kinds of plants and animals are most used in high school biology classrooms and what help is needed to overcome reluctance to study live organisms.

Accordingly, I undertook two studies. One obtained information from high school teachers who keep animals in the classroom; the other, from students using live organisms for biology projects.

Kinds of Animals Kept

In the first study, secondary-school teachers visiting the Animal Welfare Institute booth at the National Science Teachers Association convention in Cincinnati, in March 1970, were asked which animals they kept in their classrooms. (This sample probably was not representative of the total teaching population; more likely, it represented the best teachers in the country.) The results (fig. 1) showed that most of the 53 respondents kept several kinds of animals: 42 kept mammals, 24 kept fish, and 18 kept amphibians. Only eight kept protozoan cultures and only three kept insects, though these creatures have considerable advantages over small rodents: protozoa and other invertebrates offer wide variety, are available in far greater numbers, are inexpensive to rear, require minimal attention for maintenance, and offer no problems of weekend care. The numbers of teachers who reported keeping particular kinds of mammals were as follows: mice, 23; gerbils, 14; guinea pigs, 14; hamsters, 11; rats, 10; rabbits, 4; chipmunks, 2; ground squirrel, 1; and—Mary notwithstanding—one kept a lamb at school.

The survey showed that the enormous group of invertebrate animals was sparsely represented in the classroom. On the other hand, cold-blooded vertebrates (fish, frogs, snakes, and turtles) were far more widely kept. This is surprising because, judged as experimental animals, many of the cold-blooded vertebrates are not particularly useful and certainly not so versatile as many of the invertebrate animals. One can only assume that snakes, turtles, and salamanders were maintained mainly for observation as representatives of their taxa.

An important criterion of a "useful" classroom species is the multiplicity of its educational uses. But although paramecia, planarians, earthworms, fruit flies, and brine shrimp each have numerous uses in demonstrating many basic principles of life, they were rarely kept by teachers.

Animals Seen at Science Fairs

Another way to assess current practices—the second of the two studies—was to determine the live organisms used by high school students at science fairs. Three fairs were investigated: one local, one regional, and one state fair, which were held in the vicinity of Washington, D.C., and of Boston. Of 109 biology projects using live organisms, 76% used animals and 24% used plants or bacteria (fig. 2). Comparatively few (28%) used invertebrate animals. Despite the science-fair rule that "Protista and other invertebrates are preferable for experiments involving animals" (National Society for Medical Research, 1969), twice as many projects made use of vertebrates as made use of invertebrates. (In my experience, science-fair organizers usually make no attempt to enforce that good rule.) Small rodents were by far the most commonly used animals at these science fairs (fig. 3). The relative popularity of insects at the fairs was welcome, in view of their neglect by teachers.

Although the functioning of the normal human body should be of central interest in high school biology, few students chose to study themselves. Even fewer studied animals and plants living normally in their natural habitats. Indeed, the normal physiology or behavior even of caged animals was rarely studied.

Of 28 students using small rodents, such as ham-

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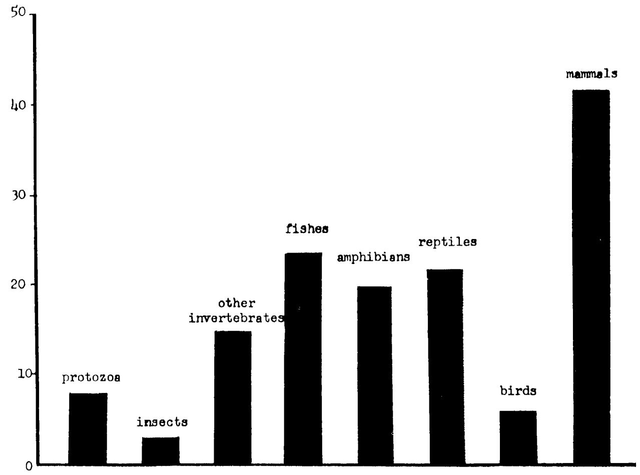

Fig. 1. Kinds of animals kept in high school classrooms. Scale (left) is the number of teachers (actually 53) who, in response to a questionnaire, reported keeping those particular animals. The geographic distribution of respondents was Ohio, 18; Michigan, 6; Indiana, 3; 2 each from California, District of Columbia, Illinois, Kansas, Massachusetts, New Jersey, New York, and Ontario; and 1 each from Connecticut, Kentucky, Minnesota, Missouri, Texas, Virginia, and Wyoming. 3 gave no location.

sters and guinea pigs, 17 chose to inflict pain, disease, or protracted death on them (excluding painless death to examine tissues). The sole project on a cat involved inflicting pain. In another project a monkey was given a poison that produced an irreversible diseased state and probably caused an exceedingly painful reaction, as it is known to do in humans. Many projects were very badly done and many mammals suffered painful, lingering deaths. In all, one out of every five biology entrants elected to hurt or painfully kill vertebrate animals.

Why do so many youngsters choose to inflict abnormal, pathologic states on sensitive animals? Is it in any degree a reflection of our violent age or of the insensitiveness of scientists and science teachers? Surely, scientists and teachers must bear some responsibility for the social and ethical consequences of permitting, and even encouraging, children to inflict suffering on higher animals.

There appeared to have been no change in the pattern of animal experimentation at science fairs since 1968 (Orlans, 1968). Evidently the 1968 and 1969 revisions of the National Science Fair rules on the use of animals, which attempted to respond to criticisms of standards, have failed to reduce pain-inflicting experiments. The persistent laxity of standards gives a bad name to high school science competitions and brings professional animal research into disrepute. Organizers of these competitions should take affirmative and strong action to change the current situation.

Acceptable Experiments

In view of the popularity of keeping small rodents in the classroom and of using them as subjects for science-fair projects, it would be wise if biology teachers became more familiar with small-mammal projects suitable for young students. Such studies could include experiments on activity cycles; metabolic rate; normal growth; relationship between volitional activity and age; dentition; different kinds of body covering; growth response to enriched living conditions, including extra handling and stroking; perception of color and smell; the estrus cycle; and normal sexual behavior. Experimental details of imaginative, challenging, and humane experiments with mammals are given in books by Benton and Werner (1965), Davies (1969), Hainsworth (1967), McBlair (1965), Minahan (1971), Pringle (1970), Simon (1968), and Stokes (1968). Other non-painful mammalian experiments include those in which tissues are investigated after the animal has been painlessly killed. These experiments require that the teacher be trained in the techniques of euthanasia; but, unfortunately, few teachers have had this training.

Ways of Keeping Live Organisms

Teachers who do not keep live organisms for use in their classrooms argue that they do not know how to keep them; that caring for them is too much trouble; that plants and animals take up too much space; that physical conditions in the classroom are not suitable; and that the school cannot afford them. Some of these objections are not warranted, and others can be overcome. Thus, live protozoa, insects, or worms need little space and are far less expensive than preserved specimens. All too often, teachers receive no instruction or information on selecting,

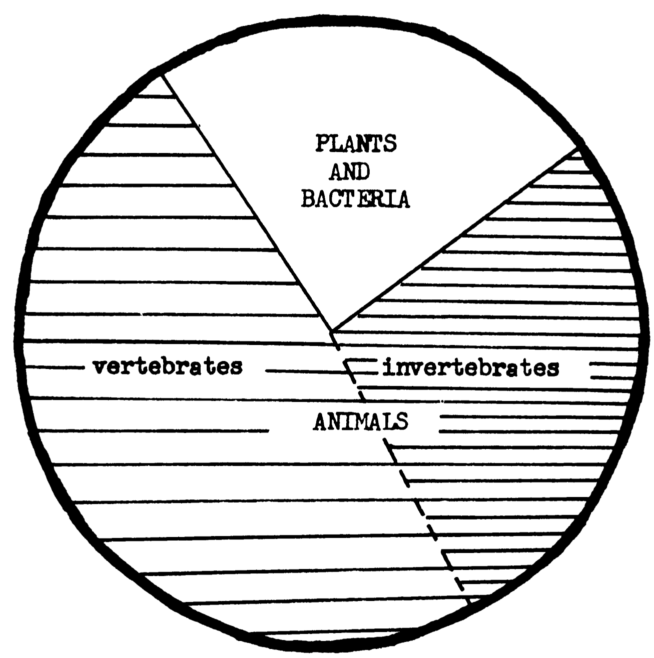

Fig. 2. Kinds of live organisms used in science fair projects. Of a total of 109 projects in which some kind of living organism was used, 27 were on plants and bacteria, 31 on invertebrate animals, and 53 on vertebrate animals. (Two projects used two kinds of live organisms and therefore are counted twice.)

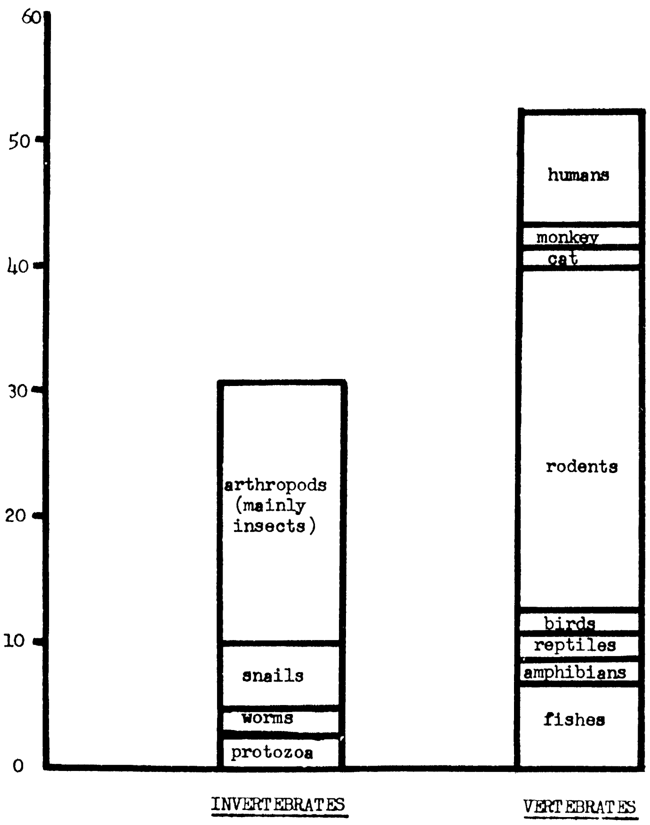

Fig. 3. Comparative use of kinds of live animals in science fair projects. Scale (left) is the number of projects. The total number was 82.

caring for, and using particular species. There is also a need for instruction as to suitable experiments and the limits on the use of animals by juveniles and novices. Teachers who responded to the questionnaire affirmed that they needed more information in order to diversify the species they kept and to improve their standards of animal care and use. Teachers' colleges and summer institutes could do much to meet these needs.

Useful information is emerging from Educational Use of Living Organisms (EULO), a project of the Centre for Science Education, in England. It estimates that 94% of the primary and secondary schools in England maintain some living organisms (Kelly and Wray, 1971). Small mammals represent 40% of the organisms maintained but were responsible for the vast majority of the problems encountered. Kelly and Wray state that "It is likely that [algae, mosses, liverworts, earthworms, woodlice, mealworm beetles, freshwater mollusks, goldfish, and guppies] could be used for a wider range of purposes than they are and as substitutes for organisms more difficult to maintain." They recommend the setting up of small habitats on school grounds and more simulated natural habitats in the classroom for collections of organisms living in mutual harmony or competition. These "minihabitats" could be used for the study of certain topics in ecology, including the influence of environmental factors, the flow of energy in the food chain, and population numbers and control. They express concern about the current heavy reliance of schools on the use of native frogs and recommend use of more *Xenopus* frogs (South African clawed frogs, which can be bred in captivity). The depletion of wild frog populations through overharvesting in both England and the United States is worrying conservationists.

A crucial future need is for better organizational arrangements to help introduce suitable live plants and animals into the biology classroom and to ensure their good care. One promising development in the United States is the centrally organized animal "library," which serves several schools and to which animals are returned for weekend and vacation care. Pioneer programs have shown that under such a system more species of animals can be maintained in classrooms, with better care and at lower cost. The Newton, Mass., elementary schools have such an animal center; it is run by a person competent in animal husbandry, who takes responsibility for advising teachers on how to care for the animals during the week. For various reasons the program has not been successful in the secondary schools there; nevertheless, this is a good idea.

Information Required Nationally

Much remains unknown and much remains to be done, in the promotion of useful study of live organisms in high school biology courses. I hope this paper will induce others to study these problems further. Particularly valuable would be a national assessment of the current use of, and the projected need for, live organisms in secondary schools, together with a survey of the problems encountered in their maintenance and how they can be overcome. Although the numbers of small mammals kept as classroom animals should not be reduced, the present results indicate that more emphasis should be placed on keeping protozoa, insects, worms, and plants; that teachers need more instruction in animal care; and that wider circulation of ideas for nonpainful, nonhazardous physiologic studies of mammals would be helpful.

REFERENCES (Annotated)

BENTON, A. H., and W. E. WERNER, JR. 1965. *Manual of field biology and ecology*. Burgess Publishing Co., Minneapolis. Describes field techniques and population and animal-behavior studies.

DAVIES, H. 1969. *Projects in biology*. Science Publications, Normal, Ill. Describes experiments on metabolism, genetics, longevity, and visual perception.

HAINSWORTH, M. D. 1967. *Experiments in animal behavior*. Houghton Mifflin Co. Boston. Describes many behavior experiments on rodents and invertebrate animals.

KELLY, P. J., and J. D. WRAY. 1971. The educational uses of living organisms. *Journal of Biological Education* 5: 213-218.

MCBLAIR, W. 1965. *Experiments in physiology*. National Press, Palo Alto, Calif. Describes human experiments in taste perception, visual acuity, respiration, effects of exercise, and many others.

(Concluded on p. 352)

ABT'S APRIL COVER RE-COVERED

Readers may have been puzzled by our April cover, about organs of communication. We regret that three sets of superimposed circles—essential to the meaning—were omitted. The accompanying picture, from BSCS pamphlet 20, *Animal Language*, shows how the cover should have looked.

CORRECTION

Bernard I. Sohn has called to our attention an error in his article "Algae as Pollution Indicators: Analysis Using the Membrane Filter" (*ABT* 34 [1]: 19–22). On p. 21 equation (i) should read:

$$\frac{1{,}380\ (\text{mm}^2)}{\text{area of field (mm}^2) \times \text{number of fields counted}} = \text{factor}$$

This alters some of the values in the example given at the bottom of col. 1 and the top of col. 2, so that it should read: "His calculations would be (i) (1,380/ 5 ×10) = 27.6; (ii) 55 × 27.6 = 1,518 algae in the original, 50-ml sample; and (iii) 1,518/50 = approximately 30 algae per milliliter."

Live Organisms . . .

from p. 345

MINAHAN, N. M. 1971. *Experiments on a shoestring: a handbook of experiments and demonstrations for general psychology.* Available from Frank Coston, Psychology Dept., University of Illinois, Urbana. Describes practical experiments, using human subjects, on reaction time, cutaneous sensation, hearing, vision, and motivation and learning.

NATIONAL SOCIETY FOR MEDICAL RESEARCH. 1969. *Guiding principles in the use of animals by secondary school students and science club members.*

ORLANS, F. B. 1968. The frequency of inhumane work in high schools. *Information Report* 17 (2): 1–4. Animal Welfare Institute, New York.

PRINGLE, L., ed. 1970. *Discovering nature indoors: a nature and science guide to investigations with small animals.* Doubleday & Co., New York. Describes simple experiments on various invertebrate and vertebrate animals.

SIMON, S. 1968. *Animals in field and laboratory: science projects in animal behavior.* McGraw-Hill Book Co., New York. Describes easy-to-do experiments with many animals.

STOKES, A. W., ed. 1968. *Animal behavior in laboratory and field.* W. H. Freeman & Co., San Francisco. Describes experiments, useful for advanced students, on a wide variety of invertebrate and vertebrate animals. Useful ones on rodent behavior, available separately from the publisher, are no. 796, "The analysis of behavior"; no. 804, "Wall-seeking behavior in mice"; no. 805, "Negative geotaxis among inbred strains of mice"; and no. 810, "Food hoarding in rats."

SUGGESTIONS FOR CONTRIBUTORS

STYLE. *American Biology Teacher* would rather receive an ill-written article containing worthwhile ideas than a stylistic masterpiece that says little: our editors can mend bad writing in a good cause. However, we do hope for clear terse prose, free of jargon. Sensible·advice for writers will be found in the *CBE Style Manual* (3rd ed.) of the Council of Biology Editors and in *How to Write Scientific and Technical Papers,* by Sam F. Trelease.

In matters of punctuation, abbreviation, and the like we follow generally the CBE manual and the University of Chicago *Manual of Style.* Our spellings are usually those preferred in *Webster's Third New International Dictionary* and its abridgment, *Webster's Seventh New Collegiate Dictionary.*

Technical measurements are in metric, not English, units.

Avoid footnotes of any kind. References to the literature are made on-line (not by means of superscripts) within the text. If only one, two, or three works are cited, each is given in full, in the form "A. B. Smith, 1969: *Elements of Biology,* 4th ed., Jones Publishing Co., New York" for a book and "W. X. White and Y. Z. Green, 1965: 'The Inquiry Process,' *Journal of Pedagogy* 7 (2): 53-56" for an article. If four or more works are cited, they are presented at the end of the article as a bibliography arranged alphabetically by authors' last names, in the following forms for books and journals:

SMITH, A. B. 1969. *Elements of biology,* 4th ed. Jones Publishing Co., New York.

WHITE, W. X., and Y. Z. GREEN. 1965. The inquiry process. *Journal of Pedagogy* 7 (2): 53-56.

(Note punctuation and spacing; the lowercase style for titles, and no quotation marks; and the full names of periodicals and publishers.) Reference to the bibliography from the text takes the parenthetic form "(Smith, 1969)"; if the same title is cited a second time this short form is repeated or, better, the reference is recast as, for example, "Smith also says . . . ." The aim is to disburden the text of apparatus–*ibid.* and its relatives. Within text or bibliography a reference may be made precise by adding, for example, "p. 123-145" or "ch. 8." Responsibility for exact quotation lies with the writer, not the editor.

MANUSCRIPT. Double-space on one side only of standard (8½-by-11-inch) erasure-resistant bond paper, allowing 1½-inch margins all around. Avoid line-end division of words.

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