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Humaneness Supersedes Curiosity

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Abstract

Ethical considerations need to be addressed with respect to educational use of animals. Society extends greater latitude in what is permissible to do to an animal in the name of science to a professional research worker than to a high school student. A balance needs to be made of the significance of the expected experimental results, on the one hand, with the ethical costs, (in terms of pain or death to the animal), on the other. A reasonable boundary can be drawn, based on ethical as well as on practical considerations, to exclude invasive procedures on vertebrate animals in high school student work. The view is presented that such procedures should only be conducted in research institutions and should not be conducted in students' homes or in elementary or secondary schools. The rational basis for this stance is discussed.

Enhancement of secondary school biology education with classroom maintenance and study of a wide range of species of plants, invertebrate and vertebrate animals is needed. However, progress in this direction is dependent upon establishing sound policies on the educational use of animals based on considerations of social accountability. Current lax standards in science fairs have resulted in animal abuse and this has hampered progress in this direction. Encouragement to teachers and students to study living things must go hand in hand with proper observance of humane considerations.

Introduction

Are there limits to what should be done to animals in the name of biology education? Is *any* treatment to animals all right so long as the student is learning something? If not, then what *are* reasonable boundaries and what is the rational basis for them? Are current practices regarding the use of animals in science fair projects acceptable? What new directions are needed to maintain high standards? These are the questions that will be addressed in this presentation.

There is, I believe, a general consensus that there are very definite limits to what should be done to animals in the name of science. Henry Beecher, a renowned physician at Harvard University has spoken most aptly by stating that in scientific investigations "humane considerations supersede curiosity" (Beecher, 1968).

It is not a desirable objective, as an end in itself, to inflict pain on animals. It seems reasonable to me that, wherever possible, it should be avoided. Dr. W. Lane-Petter of the Huntingdon Research Centre advises research scientists to be "reluctant" in animal experimentation, reluctant to experiment on any animals in the first place, and reluctant to inflict pain. As a practicing physiologist accustomed to using animals

in experimentation, I believe that only as a last resort, when all other means toward the same goal have been investigated and found wanting, should animal experimentation involving animal pain be undertaken.

Limits to what should be done to animals are observed by professional scientists. Voluntary codes of practice and laws set limits to ensure public accountability. Acceptable boundaries entail the replacement of animals with other less sentient forms of life wherever feasible; the avoidance of any pain infliction wherever possible; reduction in the amount of pain wherever possible; and refinement of techniques to utilize the least possible number of animals.

Ethical Costs

On occasion, scientific experimentation includes a certain amount of ethical costs. Some examples of ethical costs are inflicting pain on animals, killing animals, placing human beings at risk, and use of lying and deception. These practices are basically undesirable, but they may be permissible in scientific experimentation in certain circumstances. However, they require scrupulous justification.

A balance is weighed between the ethical costs on one hand and the significance of the expected scientific results on the other. Where there is great significance in expected results, then relatively higher ethical costs may be justifiable. Where the results are of lesser consequence or trivial in nature, then there is less, or no justification for ethical costs.

Where there is potentially great significance to mankind involving new contributions to scientific knowledge, then, I believe, it is justifiable to permit infliction of pain on animals.

At the other end of the scale from a professional scientist, is a beginning biology student. Obviously, the significance of a high school student's experimental results is highly circumscribed. Thus, ethical costs should be kept low. Applying the principle of reluctance to inflict pain on animals, are there alternative ways, other than by inflicting pain on animals, for young students to learn basic biological principles? I strongly believe that there are. This leads then to the conclusion that high school projects should not involve harming vertebrate animals or interfering with an animal's health in any way.

Animals in Education and Research

There are many important differences between high school student biology projects and professional scientific research. These are summarized in Table 1. Unfortunately these differences are not always clearly defined and kept in mind. In the first place, the objectives of the work are completely different in the two situations. The professional scientist is attempting to make new, original contributions to scientific knowledge, whereas the high school student is attempting to learn an established fact. Mankind may benefit from the results of professional scientific research where, for instance, a new therapy for treating heart disease may be established; such profound benefits do not accrue from high school student projects. With professional scientific research, the significance of the results can be so great that a very large population can be affected by the results. For instance, the results could benefit many patients in a hospital, or a whole community or nation. With high school student work, potential benefits accrue to only a narrow few, perhaps to the student alone.

TABLE 1: Differences in Use of Animals

Differences	In Education	In Research
Objectives	Learn established facts	Acquire new knowledge
Significance of results	Limited	Up to profound
Benefits accrue to:	An individual	A wide universe
Technical ability	Early stage	Skilled
Location	Home or classroom	Research laboratory
Equipment and facilities	Frequently minimal	Up to optimal

Practical Considerations

In addition to ethical factors, practical factors also need to be weighed in assessing the justification for infliction of pain on animals. Limitations in technical skill alone can render some procedures (such as animal surgery) an improper activity for the unsupervised amateur. A comprehension and manual dexterity in the skills required for the procedure are all necessary prerequisites for undertaking invasive, potentially painful techniques. These skills are not instantly acquired, but are painstakingly achieved after many years of long training.

The quality of animal care and the humaneness of certain procedures is also dependent, in a certain measure, on the quality and type of facilities and equipment available. Thus, the location of where the work is conducted is important in determining what type of procedures should be undertaken. Equipment and facility limitations alone can render some procedures, especially those involving invasive animal techniques, either impractical or inhumane or both. High school classrooms are not usually suitably equipped for conducting invasive vertebrate animal procedures. How much less so is a student's home which is the location where very many science fair projects are undertaken?

Thus, there are clear distinctions between animals used in education and those used in research. These distinctions are all factors that need to be weighed in justifying whether or not vertebrate animals' pain should be sanctioned in high school student projects. The conclusion, I believe, is clear and can be summarized as follows:

Animals Used in **Education**	Animals Used in **Research**
• Pain to vertebrates NOT permitted	• Pain to vertebrates permitted under certain circumstances

This so-called "painless rule" for student animal investigations states that in elementary and secondary school biology education, the study of plants, protozoa, invertebrate animals and other living organisms including human and other mammalian studies shall be fostered and that vertebrate animal studies shall not include invasive procedures. In practice, this means that, as a general rule, small mammalian studies shall include only those procedures that could be done without pain or hazard to human beings and that the student would undertake on her or himself.

A Wealth of Projects

There are some unimaginative people who think that if you eliminate pain-inflicting projects, there aren't any others left to do! Obviously, this is false. There are multitudes of sound educational projects involving the use of living organisms that can be undertaken within the previews of the "painless rule".

In the first place, there are many plant studies that make excellent student projects. Such studies can cover genetics, germination, effect of hormones, light, heat and other environmental factors on growth and maturation, the ability of vines to grow toward a nearby object, studies of crown gall and other plant diseases, observations of the food chain, the use of leaves and other plant parts as insect homes, and investigations of the interdependence of plants with other living organisms, and other topics. An example of a good plant study is seen in Figure 1.

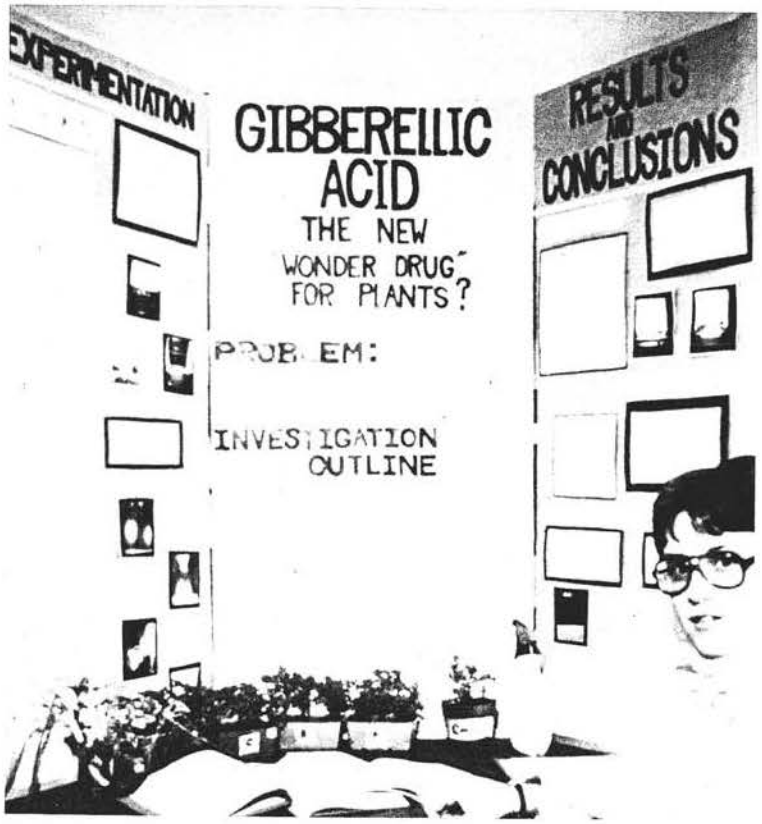

FIGURE 1—This biological investigation is of the effects of a hormone called gibberellic acid on plant growth. This is one of many interesting plant studies that can be pursued by high school students.

A similar long list of suggested projects could be made involving the use of fungi, nonharmful bacteria, protozoa and invertebrate animals. Such studies could include, but are not limited to investigations of effect of temperature on growth, sensory perception, activity cycles, water balance, ability to regenerate, behavior, nutritional requirements, environmental preferences, genetics, pheromones, growth, reproduction, learning, locomotion, field studies and control of insect pests. An example is seen in Figure 2.

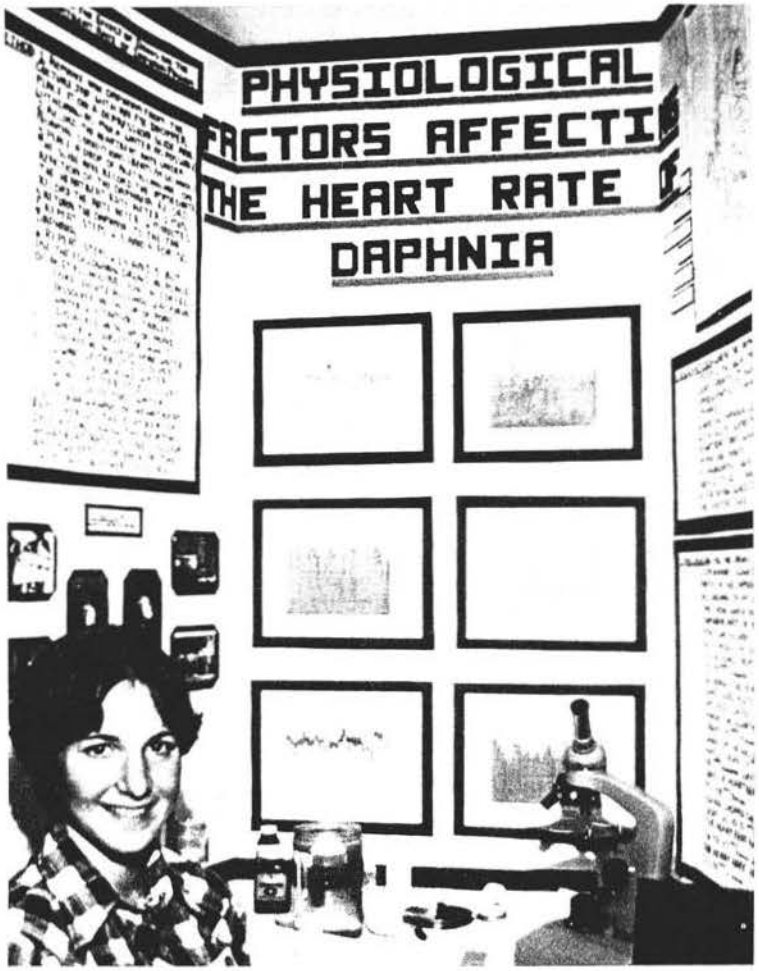

FIGURE 2—The physiological factors affecting the heart rate of small aquatic organisms called daphnia were investigated in this good project from a Canadian science fair.

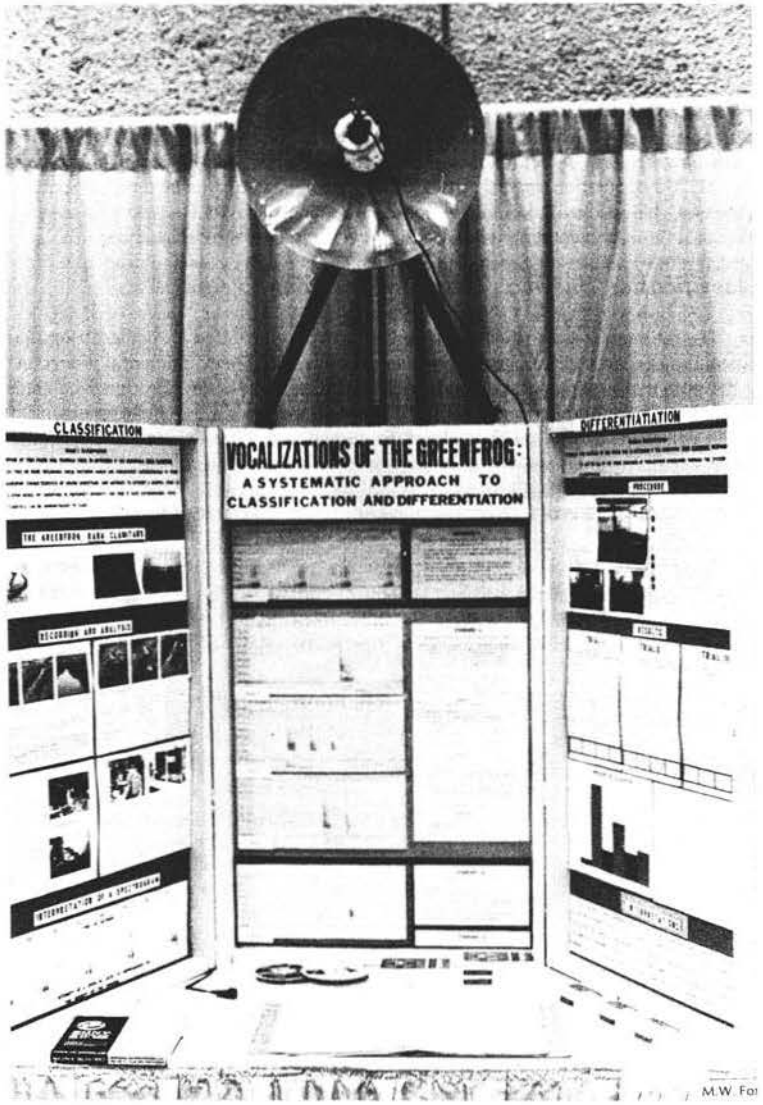

FIGURE 3—This project, which is an example of a nonpainful vertebrate animal study, dealt with vocalizations of the greenfrog. The inventive student recorded frog sounds in the wild and then analized the sounds by means of a spectrogram. This gives a visual picture of the patterns of sounds according to the frequency of the soundwaves. Some of the student's spectrogram tracings can be seen in the center and lower left of this science fair display.

Ideas for nonpainful projects on vertebrate animals are also many and varied and cover all the basic biological principles of living matter. Vertebrate animals include fish, amphibia, reptiles, turtles, lizards, small mammals and human beings. Nonpainful, nonhazardous, educational projects on one or the other of these vertebrate animals can include investigations of schooling behavior of fish, group behavior, social structures, genetics, learning, field studies, excretory systems, respiration, growth and development, alarm reaction, locomotion, activity cycles, properties of skin and hair, sex ratio in a population, special senses (touch, hearing, taste, smell and proprioceptive responses), blood circulation, pheromones, grooming behavior, reaction to novelty, nervous reflexes and conditioned responses. An example is seen in Figure 3.

Classification Based on Degree of Invasion to Animal

The rational basis for the "painless rule" can be elucidated by categorizing biological projects according to the degree of invasiveness of the experimental procedure to the potential experimental animal. Table 2 depicts such a classification. The categories range from number one in which the studies involve no use of living organism and in which the ethical costs are least, to number nine in which severe trauma to highly sentient animals is involved and ethical costs are high. Looking at things from

TABLE 2: Classification of Biological Studies According to Degree of Invasion to Animal†

1) No living organism involved (e.g., biochemical studies).

2) Studies involving plants, fungi, bacteria or protozoa.

3) Studies involving invertebrate animals (e.g., hydra, flatworms, roundworms, snails, crustacea, and insects).

VERTEBRATE ANIMALS (Categories 4 to 9)

4) Observation of normal living patterns of a pet, an agricultural animal, zoo animal or wild animal.

5) Painless vertebrate experiments.

6) Painless killing of a minimal number of animals to provide fresh tissues for study.

7) Invasive procedures conducted under anesthesia with no post-operative recovery and no return to consciousness.

8) Pain-inflicting experiments (e.g., surgery with post-operative recovery, administration of toxic substances, induction of pathological conditions, stress studies, etc.).

9) Severe and/or protracted pain (e.g., severe deprivation, burn trauma, etc.).

†This classification is adapted from one given in Professor D.H. Smyth's *Alternatives to Animal Experiments*, 1978, Scolar Press, London, U.K.

the point of view of a potential laboratory animal or other sentient being, the procedures most preferred are obviously those in the lowest numbered category! From an ethical viewpoint, all other things being equal, the lowest possible category should be selected that is commensurate with the objective and significance of the exercise. Sometimes the ethical costs can be reduced by careful planning of an experiment or by actual redesign of an experiment. However, in order to achieve balance in educational projects, it is highly desirable that studies falling within each of the categories 1-6 be pursued.

Projects that are suitable for high school student investigations are those which fall in categories 1 through 6. Work within these categories is, of course, frequently performed by professional scientists. The cut-off point for students is indicated in the figure with a dotted line.

For the reasons given earlier, those projects which fall below the dotted line, categories 7 through 9, should only be conducted in established research institutions. All categories 1 through 9 are appropriate and I believe should be available to professional research workers to select from according to the nature of the investigation.

Some comment is perhaps appropriate regarding category 7 in which invasive procedures are conducted under anesthesia. The experiment may proceed for up to a number of hours, but then the animal is painlessly killed without being permitted to recover consciousness. Such procedures, if correctly performed, involve no pain other than the slight discomfort of induction of anesthesia. Unskilled, novice surgery would not cause the animal any suffering. However, in order to be painless, such studies require a sound knowledge of anesthesiology on the part of the operator in order to maintain the appropriate deep level of unconsciousness for prolonged periods of time. Because of the complexities involved and the need to use controlled drug substances, such studies are appropriate only if conducted in research institutions and in the presence of a supervising scientist knowledgeable in the technique. Such studies are appropriate for some undergraduate and graduate student exercises.

In their 1959 book, *The Principles of Humane Experimental Technique*, Russell and Burch elucidated their famous 3R dictums calling for "Reduction", "Refinement" and "Replacement." That is, that in animal experimentation, efforts should be made to reduce the number of animals used, to refine the techniques to minimize pain, and to replace animal experiments where possible with nonanimal experiments. Nowadays, there is much discussion about alternatives for animal experimentation. However, this centers almost exclusively on the "Replacement" theme. I believe much of the current emphasis is too narrow and constricting. Perhaps the idea of alternatives can be expanded to include a broader perspective. The classification offered in Table 2 based on ethical costs could be viewed in the light of all three concepts of reduction, refinement and replacement.

Classification Based on Degree of Sentience

Superimposed on this classification based on the degree of invasiveness to the animal, is another classification based on the degree of sentience of the organism (Table 3). The degree of complexity of the nervous system is a key factor in determining the ability of an organism to perceive pain. Thus, as we move up the phylogenetic scale, increasing ethical costs are incurred. As before, preference should be given where possible to using the lowest numbered category that is commensurate with the objectives of the investigation, thus incurring the least ethical costs.

TABLE 3: Classification of Biological Studies According to Degree of Sentience

1) Plants
2) Protozoa
3) Invertebrate animals
4) Cold-blooded vertebrates (fish, amphibians, reptiles)
5) Warm-blooded vertebrates (birds, mammals)
6) Primates and marine mammals

Are Current Practices Acceptable?

There appears to be a general consensus among the participants at this symposium that animal abuse is rarely encountered in the classroom but is encountered in extracurricular projects such as science fairs. I share this view.

Current standards in most science fairs are unacceptable. There are some noteworthy and refreshing exceptions, but by and large, the standards for science fairs have followed the permissive, unsatisfactory practices of the International Science and Engineering Fair (ISEF). Every year, many improper animal projects are officially sanctioned and even rewarded by ISEF. For example, a prize-winning project in the 1977 ISEF involved a student amputating the tails and feet of lizards to show the already well-documented fact that tails regenerate and feet do not.

Two other improper projects are shown in Figures 4 and 5. These projects are in full compliance with ISEF rules. These three examples all fall within class 7 of the Table 2 classification based on degree of invasiveness to the animal. Thus, they are near to the top in terms of ethical costs and yet are being conducted by unskilled youngsters. Sometimes projects within class 8 (with highest ethical costs) are encountered in science fairs.

Obstacles

There are two major obstacles preventing establishment of satisfactory standards in science fairs. First, there is a problem of human behavior and misconceptions. All too many youngsters seem to think that it is highly desirable to undertake a project involving harming a small mammal; the second obstacle is the inadequate ISEF rules which tend to perpetuate unacceptable standards.

On the first point involving human behavior, it is a fact that a great number of students of their own volition choose to work on vertebrate animals in perference to invertebrates, protozoa or plants, and furthermore, they choose to inflict harm on these vertebrate animals. These facts have been repeatedly documented by independent observers. There is a misconception, promoted I believe by some science fair officials, that projects involving animal harm are more "sophisticated," more glamorous, more akin to "real" science, and therefore more meritorious than nonharmful animal projects or those involving invertebrates or plants.

Despite the good science fair rule that "protista and other invertebrates are preferable for experiments involving animals," this is not enforced.

A study of three science fairs showed that of a total of 109 biology projects in which some kind of living organism was used, half (53) involved the use of vertebrate

M.W. Fox

FIGURE 4—A young student tried to induce hearing loss in her pet kitten for this prize-winning science fair project exhibited at the 1976 International Science and Engineering Fair.

HEALTH

Rats receiving the largest dose of caffeine (160 mg/kg) had poor health. Observable symptoms were: infected eyes, occasional diarrhea, restless sleep, staggered gait, little weight gain, pallor, and breathing difficulties. They generally seemed to be in a state of depression.

Rat which received large dose.

FIGURE 5—The deleterious effects of caffeine poisoning are clearly evident in this picture of a sick rat, which along with the catalogue of toxic symptoms listed above, were part of an exhibit at the 1976 International Science and Engineering Fair. Such needlessly repetitious projects demonstrating that well-known poisons do indeed produce toxic effects are a regular feature in many science fairs.

animals; a quarter (27) involved the use of invertebrate animals and the other quarter (31) involved the use of plants and bacteria (Orlans, 1972c).

In another study of eight science fairs, it was shown that of those projects in which only warm-blooded animals were used (89), two thirds (58) involved infliction of pain or lingering death and only a third (30) were noninjurious (Orlans, 1972a).

Science fair judge, Dr. James R. Nazzaro (1972), reporting on the 1972 ISEF, encountered a similar overemphasis on pain-inflicting projects. He states,

> *Fully one half of the students with entries in the behavioral science category worked with vertebrates in their projects, and* **all** *of these used aversive stimuli, environmental stress, or brain electrode implantation, with eventual animal sacrifice. The majority of entries under medicine also involved vertebrates and over half of these employed aversive stimuli.*

Data from a study presented by Dr. Dorothy Tennov earlier in this symposium demonstrated that a majority of undergraduate psychology students elected to undertake projects involving harming small mammals.

Young students are constantly being rewarded for conducting pain-inflicting vertebrate animal projects. A survey showed that a high school student's chance of winning a prize in a science fair for conducting a project in which mammals are harmed or painfully killed is one in three. Thus, of 58 pain-inflicting projects, 21 received prizes (Orlans, 1972b). This very high frequency of reward, unfortunately, leads people to believe that such projects are not only acceptable but somehow particularly meritorious.

Another major problem is the rules governing animal use in many science fairs.

The ISEF rules specifically sanction vertebrate animal surgery and other invasive procedures including administration of toxic substances, nutritional deprivation studies, use of cancer-producing agents, and production of pathological lesions and exposure to stress. The rules state that projects should be supervised. These rules have failed to achieve acceptable standards. There are a number of reasons why this is so.

A. The rules do not set a clear limit on pain infliction. It is difficult, if not impossible to comprehend what boundaries ISEF is trying to establish regarding what can be done to an animal.

B. Supervision does not act as a satisfactory limiting factor in determining what should or should not be done to animals. Many projects are not supervised, and some are only cursorily supervised. Furthermore, even if they are supervised, that still does not guarantee that projects are humane. Sole reliance on supervision has formed the basic concept of ISEF rules for about 15 years. During the time a vast accumulation of evidence has shown that reliance of supervision does not work. A basic change in concept is required.

C. The rules are not addressed to the majority of students but focus on an elitist few. In attempting to attract the "sophisticated" student, they have missed out on providing sound guidance to the vast majority.

D. The rules are complex and difficult to understand. They consist of 9 pages of forms and approximately 7 pages of printed instructions. This complexity reduces their effectiveness.

E. The rules do not make provision for differences in suitability of project according to the location where the work is conducted. In a 1972 survey, it was found that 80 percent of science fair projects were conducted in students' homes, and the rest in schools or research institutions (Orlans, 1972b). Experience shows that it is almost impossible to exert effective control over projects conducted in homes because here, supervision is frequently absent or cursory. It is unrealistic not to address this important factor of location.

F. The rules specifically mention that projects involving animal surgery, use of toxic and cancer-producing substances, exposure to stress and nutritional deprivation are officially sanctioned and do not mention any other suggestions of noninvasive vertebrate projects or invertebrate or plant studies. This tends to draw attention to the invasive studies and may lead students to do them.

In view of the record of the U.S. science fair movement and the deficiencies of some current policies, it appears that radical changes in the International Science and Engineering Fair are needed if they are to achieve public accountability. Many scientists and leading educators who are here today have deplored the absence of living organisms in the classroom study of biology and yet we have an overabundance of invasive vertebrate studies in extracurricular projects. Thus, we have two dual and opposing needs. One is to encourage study of living organisms in the classroom and the other is to curb improper animal practices in science fairs. I believe we need to have separ-

ate approaches to accommodate these two separate needs. For this reason, I endorse the Canadian national policies which provide one set of rules for the classroom (CCAC, 1975), which limit student projects to classifications 1-6 in Table 2, as discussed above, and other rules for science fairs. These "Regulations for Animal Experimentation in Science Fairs" (YSF, 1975), have been described in detail by Dr. Harry Rowsell in another part of this proceedings.

Future Prospects

It will require effort to effect changes in human behavior and attitudes to overcome the obstacles outlined above. However, there are a number of welcome signs that indicate that this will be achieved. Activity among professional organizations voluntarily to adopt student codes of practice based on the "painless rule" is encouraging. Such actions would have a profound effect on uniting opinion and would be highly beneficial in influencing current attitudes and practices. A readily comprehensible, national code of practice would then be in place which focuses on the majority of students. Bright students would continue to be encouraged to work as part of a team with professional scientists in research institutions. Widespread adoption of such a code would, I believe, be a most positive step toward achieving increased study of live organisms in biology education.

Over recent years, there has been a notable increase in awareness among teachers and policy-makers of the need to encourage use of living organisms in the classroom and the need to promote humane standards. Sound information on methods of care of animals and maintenance of invertebrates and plants are becoming available.* The professional societies are beginning to see the need for written materials, workshops and increased teacher-training on the care of living organism and selection of appropriate educational projects.

The dual needs in the biology classroom to study living organisms and to be sensitive to ethical concerns regarding animals can go hand in hand. The current climate is very positive and overwhelmingly in accord with the thesis that "humane considerations supersede curiosity."

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*Bibliographies, one for the elementary level and another for the secondary school level, of texts on care of living organisms and suggested projects in compliance with the "painless rule" are available on request from the Scientists Center for Animal Welfare, P.O. Box 3755, Washington, D.C. 20007.

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