Photography for the Preservice Biology Teacher

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ONE OF THE OPTIONS in the preservice biology methods course at the University of Washington (see "Project-Oriented Work for Preservice Biology Teachers," in this issue) is a project in biological photography. This projects differs, in design and purpose, from work both in the conventional biology and photography courses. Briefly stated, the objectives are threefold: (i) to develop the student's existing photographic experience or latent interest in photography; (ii) to sharpen visual perception and to stress concepts of visual literacy; and (iii) to provide stimuli for engaging further in a versatile, creative activity with nearly limitless applications in professional years to come.

Like most other human activities, the biological photography project has evolved with the passage of time. It has now attained a stable—although not inflexible—format, since the components needed for effectiveness are clearly defined. They include guidance from an experienced biologist-photographer; a core of quality equipment and necessary supplies; instructional material, both published and specially formulated, together with copies of instructions for all instruments and an extensive, often revised, list of literature; and a collection of illustrative examples—photographs, books, and reports of students who carried out photography projects in previous years.

As noted above, this project is not a photography course with a systematic examination of cameras, optics, negative material, printing papers, and so on. Rather, it is designed to bring the students over the first hurdles, giving them sufficient self-confidence so that they feel they can proceed on their own. More specifically, the objective is to facilitate the students' progress to a level at which they can utilize the photographic techniques (exposure, film developing, enlarging, and mounting the prints) to formulate and present biological concepts, processes, and observations in individualized ways for the use of their own students.

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Introducing the Project

Work in this project proceeds through four phases. First, there is a lecture-demonstration by the instructor, in a two-hour session with the whole class. Concepts of visual aids in teaching are discussed, with special emphasis on the ways in which individual teachers can utilize their photographic skills (for example, in slides, exhibitions of photographs, flipbooks, and flashcards).

Some of the reasons for using photography instead of dead or dying specimens are mentioned briefly. These include nature preservation and independence of critical timing, whether of the seasons or the biological rhythms of the organisms.

Everybody uses slides, but pitifully many errors are made repeatedly. A part of the lecture-demonstration is devoted to discussion of the DOs and DON'Ts in slide presentations. The treatment of this subject varies. Sometimes a brief but horror-filled slideshow is given, showing some of the worst possible cases of slideshow pathology. (There are seven ways of misplacing a slide—and only one correct way; slides can be out of focus, over- or underexposed, or ruined by a camera shake; too small objects may be photographed too far away; and so on.)

In contrast, the real effectiveness of slides is illustrated through presentation of selected topics of interest to the biology educator (ranging from the environment and the weather through animal and plant photographs, and including macrophotographs as well as photomicrographs). A demonstration of equipment available is made as well, together with a brief rundown of the facilities in the laboratory. The session ends with an invitation to students who are contemplating undertaking a photographic project to meet

A saprophytic orchid, Spotted coral root (*Corallorhiza maculata*) is shown as one example of the use of photography as a creative instructional asset. Teachers can accumulate a rich variety of original illustrative materials, drawing on them to enrich their students' learning experiences. The life story of this native orchid was captured without even touching the plants until harvest of the seeds. This example shows several photographic approaches, and can lead into discussion of many biological questions.

Fig. 1. Spotted coral root in its natural setting, the dark woods. The photograph introduces the often unfamiliar concept of higher plants as consumers. Handheld camera with Tri-X film; because of the low light intensity, the exposure was made at low f/stop, which is evidenced by the low depth of field. Only one plant is in sharp focus; the character of the background environment is maintained, but if it had been in sharp focus the wealth of details might have been confusing.

Fig. 2. The beginning of the flowering stage. Such detailed macrophotographs can reveal flower parts without the need for collection. The photographs were made with the camera on bellows with a 105-mm short mount lens, placed on a pistolgrip, and handheld. A small electronic flash was used. Film, Panatomic-X. *Left:* note that the first flower buds are just opening and that the flower stem (pedicle) stretches and changes position, from erect to reflexed. This allows better space development of the individual flowers. *Right, top:* lateral view of a single flower. *Right, bottom:* dorsal view of a single flower.

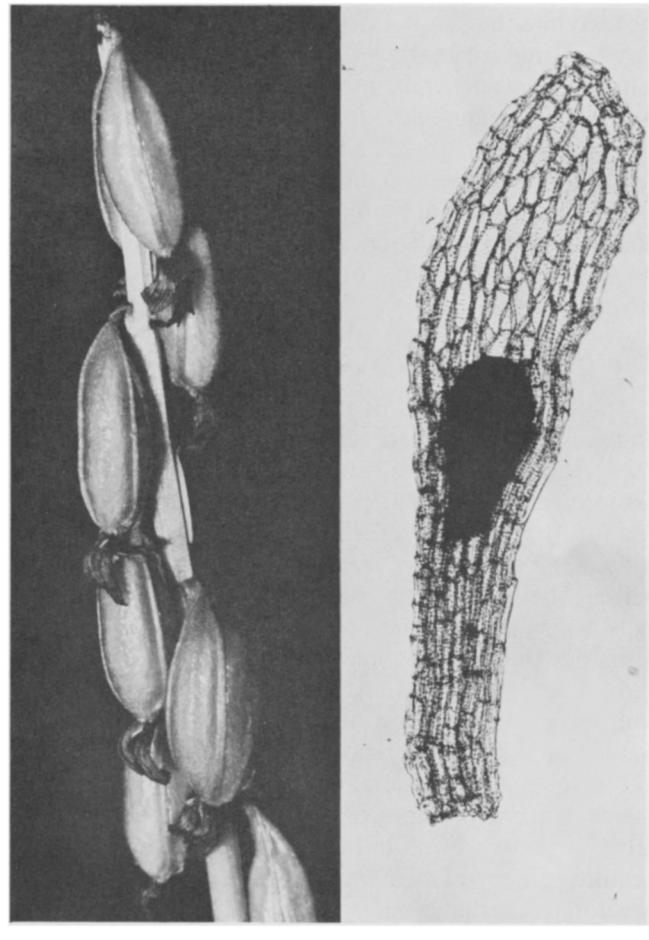

Fig. 3. Seeds. *Left:* nearly ripe seed capsules, containing great numbers of very small seeds. Note the further movement of the pedicle. Same photographic technique as used for fig. 2. *Right:* note the small embryo inside the seed coat. Photographed with a Nikon S-Ke microscope; film Plus-X; magnification 96X.

with the lecturer for a more detailed examination of the prospects.

Preliminary Planning

For the next session, often far more students show up than the facilities can handle, but nobody is turned away directly. The students themselves make the decision as to what project to participate in, but the ensuing discussion often makes it clear to some that other kinds of projects will better suit their desires and skills.

A number of points are stressed; first, that the project is not a photography course and that the students must be prepared to spend some time to acquire basic skills if they have no previous experience. Further, they must be prepared to work on their own, individually or—preferably—in groups. The students understand that all necessary facilities are on hand, but they are given the instructor's telephone number and encouraged to use it if they encounter insoluble problems.

An important aspect of this discussion is analysis of the direction of individual interest. Often the students have definite ideas, but some need more time to contemplate the possibilities.

After the general discussion, the equipment is demonstrated in detail, including, if necessary, actual use of the camera—how to put a film in, how to push the buttons, how to reload, how to place film in the developing tank, and so on. Only one camera is available to the group, but many students have their own or can borrow a camera. They are encouraged to cooperate and share, both in working out their ideas and in the use of facilities.

The Project Report

The final two stages of the project involve preparing and presenting a project report. In the weeks following the preliminary stages, students get started on their projects, expose their first rolls of film (often, literally for the first time in their lives), and get a feeling for what they themselves can accomplish. During this period, the instructor sometimes gets frantic telephone calls when catastrophes befall, but in most cases it turns out that a telephone conversation can solve even "insoluble" problems. At the end of the period the students print their best negatives and prepare a brief written and illustrated report.

The long-range value of the report to the students is the evidence it provides of something concrete accomplished on their own, and the assurance that they have acquired the rudiments of a skill which they can develop further later on.

The presentation for the whole class, with a discussion of the goals of the project, its relevance to their teaching, and experiences (sometimes even frustations) with the tools and techniques, clearly reveals the student's enthusiasm.

Some students have had the opportunity to test their new skills in a classroom situation in the field, prior to their peer presentations. The discussion with their classmates which follows demonstrates the value of this communication. The students are asked to make at least one copy of their reports for filing in the teaching laboratory, but material is also provided so that they can make an additional copy for themselves. Naturally, most people choose to do this.

Selecting Equipment

The equipment provided for this project was selected on the basis of a strong feeling of need for the students to have access to quality tools—without unnecessary gadgetry.

The program is built around a Nikon FTN-camera with three lenses (55-mm f/3.5 Micro-Nikkor-P Auto; 135-mm f/3.5 Nikkor-Q; and 200-mm f/4 Nikkor-Q Auto) and a tripod. For macrophotography, a Nikon bellows PB-4 is available; a slide copier PS-4 is used in connection with the bellows for copying of transparencies and for photographing microscope slides. The darkroom contains a Durst enlarger, together with a timer and necessary utensils. The washing of prints and films is performed outside the darkroom; the dried prints are mounted with the help of a small mounting press. Photomicrography holds great interest for many students, and the laboratory has a Polaroid ED-10 microscope camera as well as a Nikon S-Ke microscope with a Microflex semi-automatic photographic attachment.

Film material is provided; in most cases this is Panatomic-X and Tri-X. Occasionally the reversal process for Panatomic-X has been used for black-and-white transparencies as well as Kodak's High Contrast Copy film. The paper is Polycontrast F, which is chosen for its economy and for the instructional value of the variable gradation. Color material is not supplied, but if the students want to present a project in the form of a slide show, they are encouraged to do so—but at their own expense.

A New Tool for Communication

In the preliminary discussion of the possible subjects for the project, it is stressed that the most important objective is to get started and to become familiar with techniques. The widest latitude is allowed for student choice of actual topics.

The students have come up with a broad range of ideas. As one could expect, in our Pacific Northwest location the outdoors plays a major role. Many ecologically oriented projects are developed, drawing in particular on city parks, nearby rural areas, and even a forest. Several have investigated aquatic life in bogs or ponds, while others have centered around the marine tidal zones. One student examined animal

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Table 1. Analogous corporate and cellular structures and their function.

Organelle	*Corporate structure*	*Function*
membrane	walls, fences	protection, regulation
endoplasmic reticulum	hallways	transport
nucleus	executive offices	control
nucleolus	foreman	messenger
chromosome	data banks	hereditary information
vacuole	warehouse	storage
ribosome	manufacturing	synthesis
mitochondrion	powerhouse	energy conversion
golgi	packing	modifying materials for export

the cell. The role of chromosomes as hereditary information and the role of RNA in the transfer of that information are important ideas that flow from this analogy.

Students have used this analogy to learn functions of cell organelles. It seems that a clear statement and example of the functions, and a view of the total relationship of these functions to the life of the cell, are important factors in reducing the degree of abstraction and therefore enhancing learning.

A real advantage of this kind of analogy is that after the detailed study of all the parts of the cell has been made, it may be more obvious why all these organelles are required to function to produce that set of conditions we call life. It can be pointed out that a corporation exists by virtue of the fact that it functions in a certain way. Without all of its components it would not function in the prescribed manner. So too, the cell requires certain essential structures in order to sustain life. The cell organelles may now be viewed as departments or components in charge of individual processes, all of which lend to the functioning of the larger process of life.

Further Views of Cells as Corporations

Some might argue that the analogy presented here may give an inaccurate picture of the role of organelles. Although the parts of the corporation are dependent on one another in order for the corporation to remain intact, the parts have a certain degree of independence in that they may have been in existence before the corporation itself existed. Some views of cells and their organelles are close to this idea. Margulis (1971) cites evidence pointing to the possibility that chloroplasts and mitochondria were once independent organisms. She refers to the origin of eukaryotic cells as a possible symbiosis of several cells without nuclei. Thomas (1974) has likened cells to societies and has expressed this same idea that cells may be aggregates of simpler forms which have lent themselves to a cell society.

Building an analogy that can be analyzed to this extent can offer a thread that can be maintained throughout an extended unit in cytology. This, along with a clear view of the functions of organelles and a view of the interrelationship of organelles, has made the development of this and other analytical analogies well worth the time and effort. The key to the success of these analogies is that they withstand (to a high degree) analysis, encourage it, and benefit by it.

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behavior in a pond (the mating behavior of ducks), and another did a study of city life, with emphasis on the more or less feral cats and dogs. In contrast, a couple of students prepared a photographic dissection of the fetal pig.

Botanical subjects have ranged from horse chestnut development to a description of plant tumors. A number of students have chosen to investigate the potentials of various technical aspects, such as copying book illustrations and transparencies, or photographing microscope preparations. One student cultivated the classroom use of mounted photographs and other illustrations. Macrophotography attracted some students, while others centered their work on the use of photomicrography and its use in teaching.

As indicated above, a few hints on operation are given at the beginning of the project to prevent serious mistakes, but no narrow technical criticism is offered of the final report, as would be expected in a conventional photography course; nor, in general, is such criticism sought by the students themselves. It would be aside from the main purpose of the photography project. This purpose can be fulfilled and attested to by the enthusiasm for a new tool for communication expressed by students—who, a few weeks before, did not even know how to put film in a camera, let alone know how to develop films and complete the process of expressing biological ideas in photographic terms.

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