tals of botany and zoology a body of knowledge directly applicable to the welfare of the human race could be presented, that the laws of evolution and heredity and reproduction could be made a part of the courses in biology without in any way offending the students, and that the attempt to attract students to biology by giving such courses as agricultural botany, zoology, and bacterioloy, or household biology, or any other designated course was futile. They also believed that the tendency to highly departmentalize work for the student who was going to teach biology was a mistake, that those highly specialized in botany, zoology, physiology, or bacteriology, in the nature of things, could not be the best teacher of the fundamentals of all the biological sciences. They also realized that if the high school biology teacher was to present the biological knowledge most intimately related to man's well-being, he must fill his courses with the essentials of the developing sciences of bacteriology, endocrinology, genetics, entomology, and plant pathology.

Today it is encouraging to this group of men that The Union of Biological Societies of the American Association for the Advancement of Science has turned its attention to promoting a wider and better biology teaching in our elementary and high schools. It is also of interest that at the graduate level several universities are offering graduate work with a major in biology as preparation for secondary biology teaching. Probably the most significant move looking to better and more universal teaching of biology is the organization of the National Association of Biology Teachers. It should enlist the support of all secondary, college, and university teachers of any biological subject who are interested in having the knowledge in their fields find wider application in the lives of men and women.

Opaque Projection in Biology

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Opaque projection is ordinarily still projection, and still projection remains one of our most effective means of instruction. Moreover, as will be noted later, a considerable amount of motion can be shown with an opaque projection instrument. Such a machine directs the attention of all observers to the same thing at the same time and for as long an interval as is necessary for careful study and discussion. Material can be repeated as needed. The whole process is very flexible. In the paragraphs which follow the writer hopes to point out some of the wide variety of uses to which this instrument can be put.

Opaque Objects

The amount of opaque material which can be projected advantageously in the biology classroom is almost unlimited, and the cost is negligible. Illustrations from books, magazines, and catalogues are easily screened. Charts, hand-drawn sketches, and maps can often be used effectively. Typewritten or handwritten assignments and announcements can be made by the use of this machine. Postcards and photographs—photographs

taken by the instructor or students on a summer's trip, for example—can be shared by all at the same time. Excellent permanent collections of opaque illustrative materials can be made by cutting up old textbooks and catalogues and mounting the cuttings on cardboard backs of a uniform size which will handle easily in the projector. Riker specimen mounts slipped into the machine will show insects, life cycles, leaves, etc. Newspaper reports can be used while information is opportune. The story and pictures of an ascent into the stratosphere, another of Beebe's ocean descents, forest and wildlife destruction by a tornado, news of an epidemic or any other pertinent scientific news can be flashed upon the classroom screen on the very day the report appears in print. This function alone would make the opaque projector a very valuable piece of equipment.

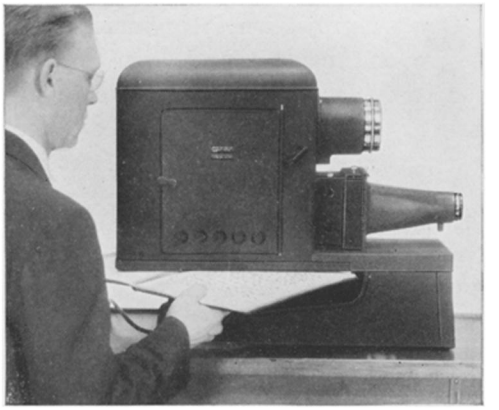
For the best results the room should be as dark as possible for opaque projection—considerably darker, for instance, than for satisfactory lantern slide work. The reason for this is the fact that the screen receives only that light which is reflected from the opaque object being projected. As a result, the image is not as bright as in the case of the transparent glass slide where the light is transmitted.

"Daylight" Projection

However, "daylight" projection is satisfactory in rooms which admit a considerable amount of light. In this case a short focus projector is used in connection with a translucent screen which is placed between the machine and the observers. The size of the picture is considerably smaller than that attainable with lantern slides in a dark room, but in small class groups this use is quite adequate for ordinary needs. Here in the Canal Zone, where tropical temperatures and high humidity make a tightly closed, dark room highly undesirable, "daylight" projection is used most of the time.

Chart Making

Good charts are indispensable in successful biology work, but at prices ranging from two to ten or more dollars each the cost for an adequate collection of this graphic material becomes prohibitive for the average school. Charts can be drawn by hand on large sheets of cardboard or chart cloth. However, this is generally a tedious process, and unless the individual has some talents along these lines the results may not be entirely satisfactory. We have found the combination opaque and glass slide projector to be of great value in making classroom charts. Lantern slides or pictures, diagrams, tables, and similar opaque materials from various sources are projected against large pieces of good grade cardboard or chart cloth. The desired size of the chart is obtained by regulating the distance between the projector and the image. Next the image is outlined lightly in hard pencil. Later these lines are inked with a broad-point pen and



Courtesy Spencer Lens Co.

The combination projector is a versatile instrument for developing interest.

permanent black or colored ink and the chart labeled. A whole library of graphic material can be built up in this way, and the cost per chart is only a very few cents for cardboard or chart cloth plus an hour's work. Careful students can learn the technique in a very few minutes and will enjoy doing this kind of work because it will soon come to the attention of the whole group in classroom usage. In many cases we have found it desirable to label the charts with letters or numbers rather than names. Then they may be useful for both teaching and testing purposes.

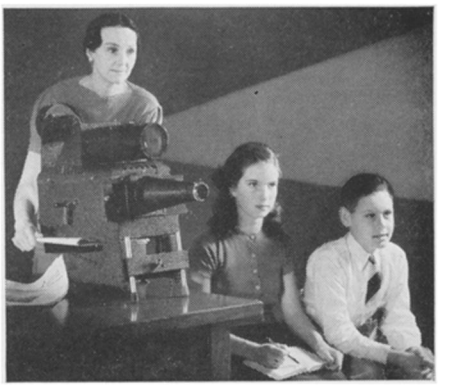
Frog Heart Beat Demonstration

The effect of temperature on the rapidity of heart beat in cold-blooded animals can be demonstrated in a striking manner with the opaque projector. For this purpose an average- to smaller-than-average-sized common leopard frog, *Rana pipiens,* is excellent. First, pith the brain and spinal cord or thoroughly anesthetize the animal. Carefully remove the body wall which covers the body cavity and expose the viscera. Be sure the heart is well exposed and functioning normally. Now place the specimen back down in a white-bottom, shallow pan or pin it out in a wax-bottom dissecting tray through white paper. Finally, surround the heart with snow or finely crushed ice, leaving an opening just large enough to observe the heart action. After the heart has slowed down to its minimal speed, place the whole dissecting tray under the projector and focus. Count the rate of heart beat for half a minute as soon as the focus is sharp. The heat from the projection lamp will melt the snow or ice rather rapidly and warm the resulting water. As the temperature mounts the rate of heart beat increases. After three to five minutes or so the rapidity should be noted again. An increase of fifty, seventy-five, or even one hundred or more beats per minute will ordinarily be noted. This makes an excellent demonstration and one which is relatively easy to execute.

Miscellaneous Uses

Earthworms, lubber grasshoppers, and other small animals can be pinned out and the whole mount projected for the study of gross anatomy. Twigs covered with scale insects, wood destroyed by termites or borers, leaves bearing galls, and similar materials are readily screened. Likewise, fossils can, in many instances, be studied by the whole class at one time through the use of this machine.

Occasionally it is desirable to show some development in a chemical test tube, for example the growth of crystals or Fehling's reaction. With a combination opaque and lantern slide projector this is a relatively easy matter. Simply remove the slide carrier, insert the test tube into the light path, and focus. The entire class will be able to see what is going on at one time.



Courtesy Bausch and Lomb Optical Co.

The amount of opaque material which can be projected advantageously in the biology classroom is almost unlimited, and the cost is negligible.

Combination vs. Separate Opaque Projectors

As long as standard makes of instruments are used there is little or no difference in the quality of projection between separate opaque projectors and combination opaque and lantern slide machines. Both are entirely satisfactory for ordinary purposes. However, the separate projector is good for one use only, namely opaque projection. The combination machine costs more than the separate instrument, but the price is considerably less than the combined prices of the opaque projector and projection lantern purchased separately. In the opinion of the writer the combination machine is well worth the difference in price over the separate instrument. In this combination machine all the classroom equipment necessary for ordinary still projection is combined into a single compact unit. Lantern slides properly screened probably make the nearest approach to perfection in visual aids to instruction. Simple inexpensive attachments convert combination machines into satisfactory film slide projectors or microprojectors, instruments of unquestioned value in biological work. The combination unit for opaque materials and lantern slides, together with its various attachments, has so many advantages that it must be considered as perhaps the most versatile projection instrument available for use in the biology classroom.

Arousing Interest in Senior High School Biology

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The element of interest is most easily obtained in school work when the teacher can bring to the students subject matter that they can successfully master. It should be that type of subject matter which is going to be of immediate or of assured future value to them. That element of interest is most easily obtained when the teacher is willing to sacrifice time and energy to adapt the subject matter to the varying degrees of ability and capacity that make up the personnel of the class. That element of interest is gained when teachers begin to measure achievement not in terms of percentage or grades, but in terms of educational growth.

Interest can be aroused by offering as many allied educational experiences as the field can embrace. In this way each student becomes conscious of some one particular phase of the work, which, due to close correlation, creates interest in other phases and leads the student on to new fields of endeavor. Educational growth consists not merely in the acquisition of factual knowledge, but also in the application of the principles as they are learned. These principles, having once become part of the actual experience of the individual, have a definite place in his educational background and tend to modify his reactions.

In the New Rochelle Senior High