Construction and Use of Equipment To Study a Lake Ecosystem

SISTER KATHRYN PALAS, S.C.

ARE YOUR STUDENTS interested in water ecology? Have you ruled out the possibility of aquatic investigations simply because your budget has been cut, and equipment is too expensive? Don't let finances quell the enthusiasm. Within your laboratory, kitchen, and workshop you have the materials needed to construct equipment to dredge, to sample, and to examine the factors relating to the dynamics of water ecology. Ecology and pollution are words that have become synonymous in some students' vocabularies because of the increased awareness of pollution in so many of our ecosystems. Examination of the structure and dynamics of a lake ecosystem will develop insights into the beauty and the functional aspects of an ecosystem.

Make Your Own

Of the equipment needed to study a lake ecosystem, nine important instruments can be constructed from a minimum of materials:

1. *Apparatus to determine velocity of flow.* With a small piece of rubber tubing, attach a half-meter length of glass tubing, that has been bent to a 45 degree angle about 0.1 meter from the end, to a 7.5-cm funnel. Attach this piece of apparatus to a meterstick with rubber bands (fig. 1).

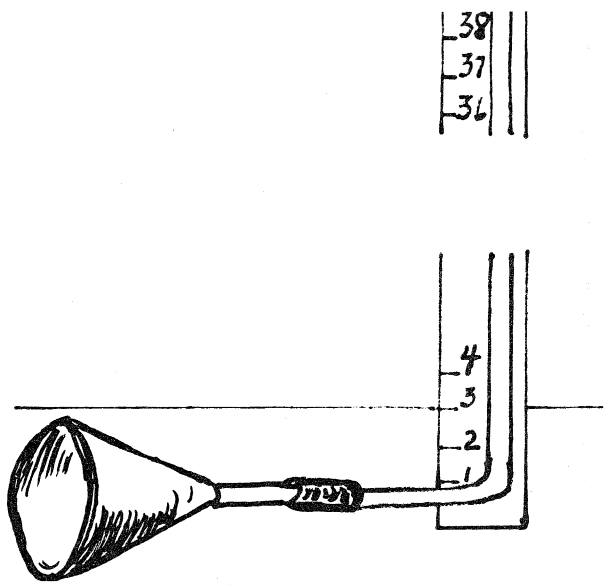

Fig. 1. Instrument to determine velocity of flow. The line indicates water level.

The open end of the funnel should be pointed upstream so that water can enter, and readings will be taken from the meterstick scale. Velocity is determined by using the formula $v = 2gh$, where v is the velocity in meters per second, h is the height in meters to which the water rises in the tube above the normal water level, and g is the acceleration due to gravity (9.8 meters per the number of seconds squared) (Andrews 1972).

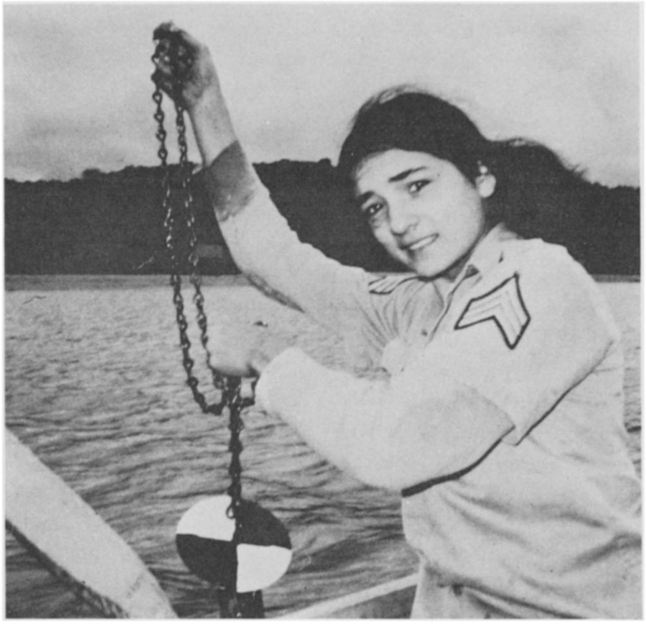

Fig. 2. Secchi disk.

2. *Secchi disk.* Cut the bottom out of a three-pound coffee can, and paint alternate black and white quar-

---

The author teaches at Elizabeth Seton High School, Pittsburg, Pa. 15226. In addition to general biology, she teaches advanced minicourses in ecology, microbiology, physiology-anatomy, and genetics. A 1969 graduate in biology of Seton Hill College, Palas received an M.S. from Purdue in 1973. She is a member of the Pittsburgh Diocesan Curriculum Committee for biological sciences and has an active interest in legislation concerning social justice issues. She enjoys photography, "especially taking colored slides to compile slide shows that illustrate the beauty in science and the ecological aspects of nature."

ters on the bottom. Attach a hook to the center of the bottom side, and on it hang a 1-kg weight. Attach a chain at least 3 meters long, measured and marked with colored wire at half-meter intervals, to the top side of the circle, opposite the weight (fig. 2).

The secchi disk is lowered into the water in order to measure the amount of suspended matter in the water, or its transparency. The depth at which the painted quarters of the disk are no longer visible is noted. A low reading (around 2 meters) indicates that the water contains a great deal of suspended matter. A reading of approximately 5 meters is obtained from water that is clear and relatively free of suspended matter.

3. *Bottom sampler (dredge).* Remove the top of a three-pound coffee can, and punch several holes in the bottom of the can. Attach a 2-kg weight to the bottom of the can and a 5-meter chain (measured and marked with colored wire at half-meter intervals) to the top of the can on the edge opposite that to which the weight is attached at the bottom (fig. 3).

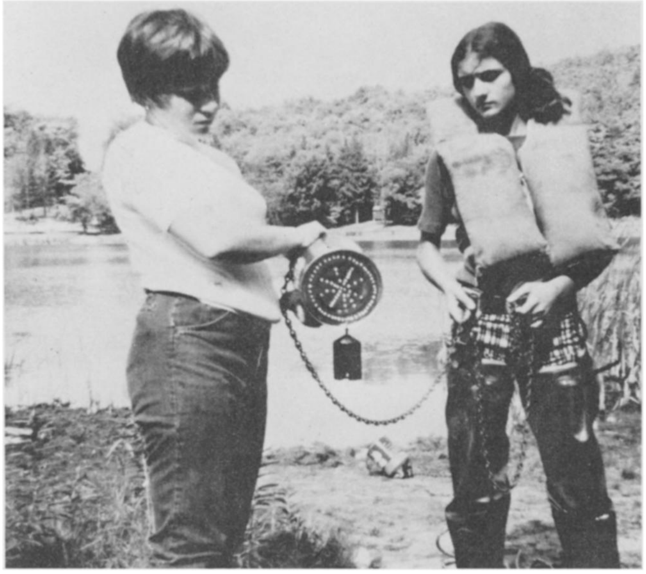

Fig. 3. In the foreground, students examine a bottom sampler (dredge). On the ground near the water note the plankton net.

The dredge is attached to a boat or dragged by hand along the bottom of the water bed to collect soil, mud, and stones containing organisms. Mineral content can later be determined, and organisms are separated out and identified.

4. *Plankton net.* Cut out the top and bottom of a three-pound coffee can, and with rubber bands attach 25 cm of nylon stocking over one end. Tie the loose end of the stocking to a small collecting bottle. On the other end of the can, attach a 1-meter chain and opposite (on the same end of the can) a small sinker (fig. 3, on the ground).

This apparatus can be used to collect free-swimming organisms. To remove plankton from the net, pour the water from the collecting bottle into another container and run the stocking through it. More water may be needed to wash all the organisms free, but use only a small amount of water to give a more concentrated sample.

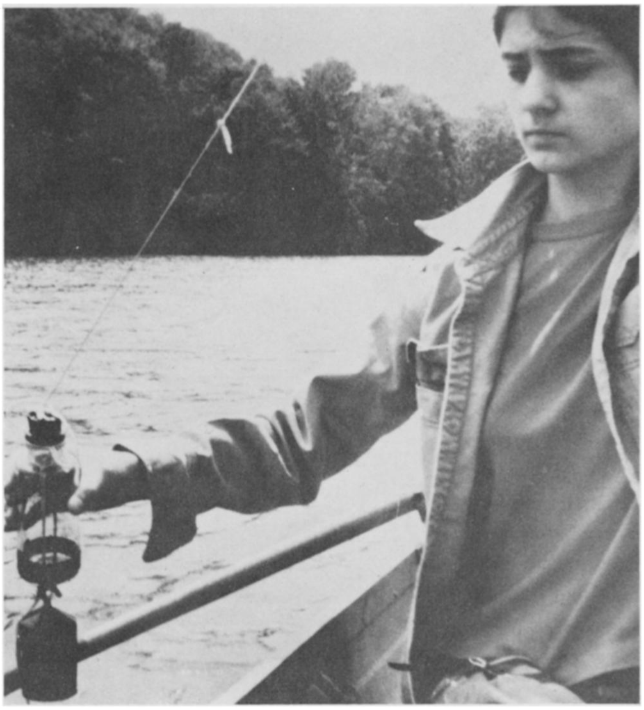

Fig. 4. Water sampling bottle.

5. *Water sampling bottle.* Tie heavy waterproof cord around the neck of a gas bottle, and attach it to a 5-meter cord (measured and marked at half-meter intervals) which has been run through a rubber stopper. Attach a 2-kg weight to the bottom of the bottle.

The bottle is lowered to the required depth, with the rubber stopper in position. A quick jerk removes the stopper, allowing water to enter the bottle (Andrews 1972) (fig. 4). The collected water can be analyzed for temperature, dissolved oxygen content, and pH at varying levels.

6. *Dark and light bottle apparatus.* Two 250-ml bottles are used. Cover one completely with aluminum foil, and leave the other one clear. With heavy cord, attach the bottles to opposites ends of a half-meter wooden plank. To the center of the plank attach a 1-kg weight and a long string. The string will be used to anchor the apparatus at a specific level in the water (fig. 5).

This instrument can be used to determine primary productivity, an index of the rate at which the energy from the environment forms organic compounds through photosynthesis. (See "Procedures" below.)

7. *Hand screen.* To a piece of screen at least 30 cm by 60 cm in size staple two pieces of wood to serve as handles (fig. 6). This screen can be used in shallow waters to collect small organisms.

8. *Insect net.* Cut two triangles of netting 45 cm at the base and 60 cm on each side. Sew the 60-cm sides

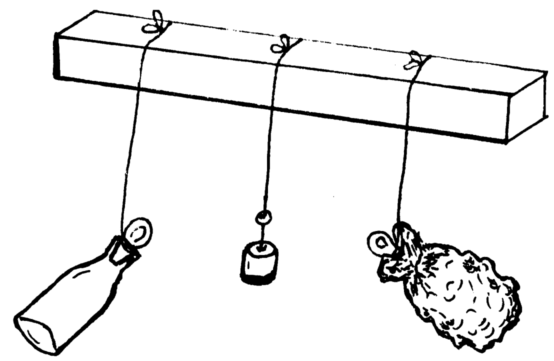

Fig. 5. Dark and light bottle apparatus.

together, and attach the netting to a circle of wire 30 cm in diameter. After this apparatus has been attached to a broom handle, (fig. 7), it can be used to collect insects skimming over the water surface or flying through vegetation along the water's edge.

9. *Killing jar.* Place about a half-cm of potassium cyanide in the bottom of a jar and cover it with an equal amount of sawdust. Place three pieces of blotting paper, cut to the same diameter as the jar, on the sawdust and press down firmly. Next, place a drop of water on the blotting paper with a pipette. The water starts the reaction of the potassium cyanide, thus producing fumes to kill insects.

These fumes are deadly poisonous, and should be labeled such. Insects that cannot be readily identified in the field can be killed in this bottle and returned to the laboratory for identification.

Procedures

In addition to the equipment described above, we used the following in our study of a lake ecosystem:

- tool kit
- first aid kit
- life preservers
- hip boots
- rope
- gallon jars for collecting
- alcohol—70%
- buckets
- identification keys
- three-layered sieve
- LaMotte dissolved oxygen kit
- soil detection kit
- LaMotte free carbon dixoide kit
- Fisher alkacid test tapes
- sling psychometer
- thermometers (laboratory immersion, Celsius)
- sorting trays
- stop watch
- styrofoam balls
- meterstick
- large fish net

Before venturing into the field with the class, I found it very beneficial to train four of my most interested students as laboratory assistants. We worked at the lake for two weekends, following the procedure step-by-step and learning to use all the equipment. After we had explained our project to the state patrol officer, he gladly agreed to lend us a rowboat to sample the deep waters.

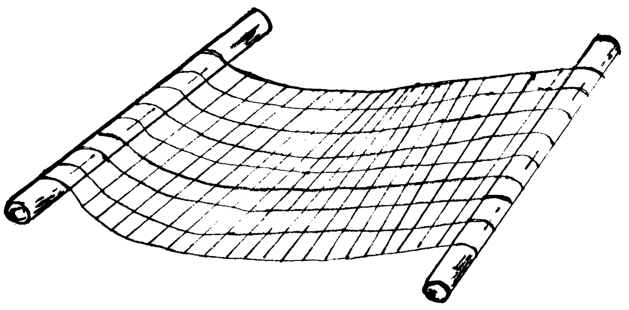

Fig. 6. Hand screen.

While the assistants worked at perfecting each technique, I took colored pictures and compiled a slide show. I used this presentation to introduce the class to water ecology and to explain all the procedures to be followed at the lake and in the laboratory.

During the class's time at the lake, each laboratory assistant guided a group of five other students in obtaining an overall picture of the structure and dynamics of the ecosystem through the collection of data on the physical, chemical, and biotic conditions of the lake.

Fig. 7. Insect net.

The procedure was as follows:

1. First the students drew a rough sketch of the lake area. They noted the flora around the lake and collected samples that could not be identified in the field so that they could be keyed out later. They listed all the fauna observed along the lake's edge and collected unidentifiable samples of small organisms, fish, and insects to take back to the laboratory for identification.

2. The students measured dissolved oxygen content of the water with the LaMotte dissolved oxygen kit. Next, using the light and dark bottle apparatus constructed beforehand, they filled the bottles with water and algae from the lake and then suspended the apparatus into the water at a depth of 2 meters. At the end of the day they removed the bottles from the lake, and their contents were later examined in the laboratory to discover the difference in productivity between the two environments.

3. Relative humidity was measured with the sling psychometer, and the secchi disk was used to determine turbidity. Several readings were taken for each of these

parameters and an average, computed later in the laboratory, was used.

4. The students used the water sampling bottle to obtain water from the surface and from half-meter intervals to the lowest possible depths. They measured the temperature at each depth and recorded it. They used the Fisher Alkacid tapes and recorded the pH according to the color scale, and measured carbon dioxide content with the LaMotte free carbon dioxide kit.

5. The students took two tests of velocity of flow. First, they set a stopwatch, dropped a styrene foam ball on the end of a meter of string into the water, and started the watch the moment the ball hit the water's surface. As soon as the string became taut, they stopped the watch and recorded the time and the length of string. An average of several attempts was computed later in meters per second. Next, they used the apparatus we had constructed ourselves to measure velocity of flow. After taking several readings, they used an average to compute the velocity, using the formula given above (with instructions for constructing the instrument).

6. Before leaving the lake, the students dredged the lake bed for a bottom sample and collected plankton with the plankton sampler. They used the three-layered sieve to collect larger suspended particles.

7. Back at the laboratory, graphs were drawn, tables were constructed, and calculations were carried out. The students keyed out the specimens they had not been able to identify in the field. After all the data had been compiled, we had a scientific basis for extensive analysis and synthesis. Needless to say, lengthy discusions ensued.

"First Hand" Success

No teacher today needs to be convinced of the importance of the study of ecology. However, a few may not realize the advantage of working in the field and how inexpensively equipment can be made to accomplish the study of an ecosystem. Constructing my own equipment, training students as laboratory assistants, and, finally, working with the class convinced me of the success of this project.

Although the instruments are rather crude, they proved to be accurate enough to obtain an overall picture of the structure and dynamics of a lake ecosystem. The laboratory assistants were all good teachers, and they enjoyed the preliminary experience. They knew the procedures and had perfected many laboratory techniques.

Now I understand and appreciate the value of the time and attention focused on "first hand" examination of an ecosystem. Mainly, it helped me overcome many fears—the fear that students would not learn enough factual material; the fear that preparations and field trips would take too much time; and the fear that I would not guide their learning effectively.

When the data were all collected the following questions were considered: What degree of stratification is present in the lake? Is a definite thermocline present? How are the temperature-density layers related to stratification patterns shown by chemical substances? What pattern of carbon dioxide concentration with depth is suggested by the data on oxygen concentration and pH? At approximately what depth is the light compensation level? What is the significance of stratification to the various plants and animals occurring at different levels in the lake?

In addition to the fun of working in the field, the class did indeed learn the basic ecological principles, and the teacher's fears were allayed.

Acknowledgment.—My thanks to my first laboratory assistants, Regina Liberatore, Sue Golling, and Lisa Louvola, and to Sister Mary Lou Palas for the drawings.

REFERENCES

ANDREWS, W. 1972. *Freshwater ecology*. Prentice Hall, Englewood Cliffs, N.J. P. 3.

CLARKE, G. 1965. *Elements of ecology*. John Wiley & Sons, New York.

COX, G. 1969. *Readings in conservation ecology*. Meredith Corp., New York

SMITH, R. 1966. *Ecology and field biology*. West Virginia University Press, Morgantown. P. 619.

TURTOX. 1944. *How to make an insect collection*. Service Leaflet No. 1. Turtox General Biological Supply House, Chicago.

WHITTAKER, R. 1970. *Communities and ecosystems*. Macmillan Co., London.

Minorities Science Education Survey

The American Association for the Advancement of Science needs your help in locating science education projects for minorities that have been undertaken since 1960. AAAS has received a grant from the National Science Foundation to prepare and publish a comprehensive annotated bibliography of such projects. The bibliography is aimed at identifying and categorizing efforts from *all* educational levels to improve the quality of minority education in the sciences, engineering, agriculture, health sciences, and related areas. This minority science education inventory will include programs to attract, motivate, and train minority students in the sciences as well as in-service training programs for teachers and counselors of minority students.

Any information on such projects and/or the names of the individuals involved in such projects is welcome. Please send this to Dr. Shirley Mahaley Malcom, Research Assistant; Science Education for Minorities: a Bibliography; Office of Opportunities in Science, AAAS; 1776 Massachusetts Ave., N.W.; Washington, D.C. 20036. A copy of the finished bibliography will be furnished to all contributors.