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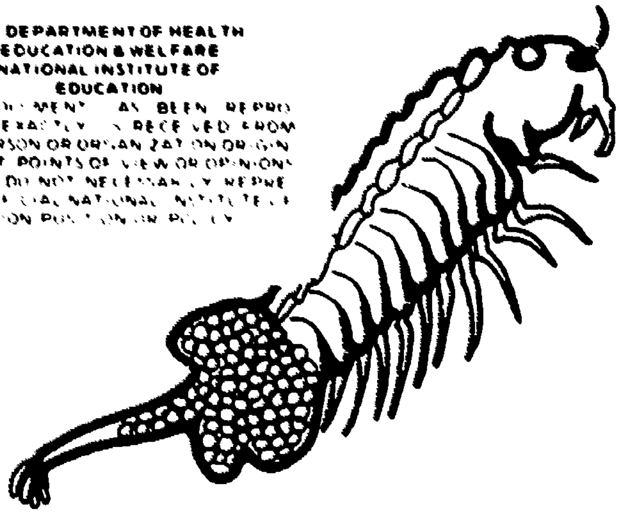
ABSTRACT

This environmental unit is one of a series designed for integration within the existing curriculum. The unit is self-contained and students are encouraged to work at their own speed. The philosophy of the unit is based on an experience-oriented process that encourages independent student work. This unit explores the life cycle of brine shrimp and the effects of the environment on that cycle. The unit contains a series of related activities that illustrate basic ecological principles of interrelationships. Teacher information such as materials needed, background information, and additional topics is given. The unit is designed for students, grades 1-5. More sophisticated investigations are given at the end of the unit. A bibliography is included. (MA)



A Teacher's Preparation for

Brine Shrimp and Their Habitat

An Environmental Investigation into An Aquatic Life Cycle

THE ENVIRONMENTAL UNITS

This is one of a group of Environmental Units written by the Environmental Science Center and published by the National Wildlife Federation.

In both theory and practice education is the essential base for long-range local, regional and national programs to improve and maintain the quality of environment necessary for man's welfare and survival. Citizens must be aware of ecological relationships in order to recognize, appreciate and fulfill constructive roles in society. This awareness should be launched through the existing educational process—in classroom and related school activities. No special courses on ecology can replace the need to integrate ecological learning throughout the existing curricula of our school systems. Furthermore, the life-styles and value-systems necessary for rational environmental decisions can best be acquired through repeated exposure to ecological learning which pervades the total educational experience.

It was with these thoughts that we developed these curriculum materials. They were designed for the classroom teacher to use with a minimal amount of preparation. They are meant to be part of the existing curriculum—to complement and enhance what students are already experiencing. Each unit is complete in itself, containing easy-to-follow descriptions of objectives and methods, as well as lists of simple materials.

The underlying philosophy throughout these units is that learning about the environment is not a memorization process, but rather an experience-oriented, experiment-observation-conclusion sort of learning. We are confident that students at all levels will arrive at intelligent ecological conclusions if given the proper opportunities to do so, and if not forced into "right" answers and precisely "accurate" names for their observations. If followed in principle by the teacher, these units will result in meaningful environmental education.

In the process of development, these units have been used and tested by classroom teachers, after which they have undergone evaluations, revisions and adaptations. Further constructive comments from classroom teachers are encouraged in the hope that we may make even more improvements.

A list of units in this group appears on the inside back cover.

About the National Wildlife Federation—1412 Sixteenth Street, N.W., Washington, D.C. 20036

Founded in 1936, the National Wildlife Federation has the largest membership of any conservation organization in the world and has affiliated groups in each of the 50 states, Guam, and the Virgin Islands. It is a non-profit, non-governmental organization devoted to the improvement of the environment and proper use of all natural resources. NWF distributes almost one million copies of free and inexpensive educational materials each year to youngsters, educators and concerned citizens. Educational activities are financed through contributions for Wildlife Conservation Stamps.

About the Environmental Science Center—5400 Glenwood Avenue, Minneapolis, Minnesota 55422

The Environmental Science Center, established in 1967 under Title III of the Elementary and Secondary Education Act is now the environmental education unit of the Minnesota Environmental Sciences Foundation, Inc. The Center works toward the establishment of environmental equilibrium through education—education in a fashion that will develop a conscience which guides man in making rational judgments regarding the environmental consequences of his actions. To this end the Environmental Science Center is continuing to develop and test a wide variety of instructional materials and programs for adults who work with youngsters.

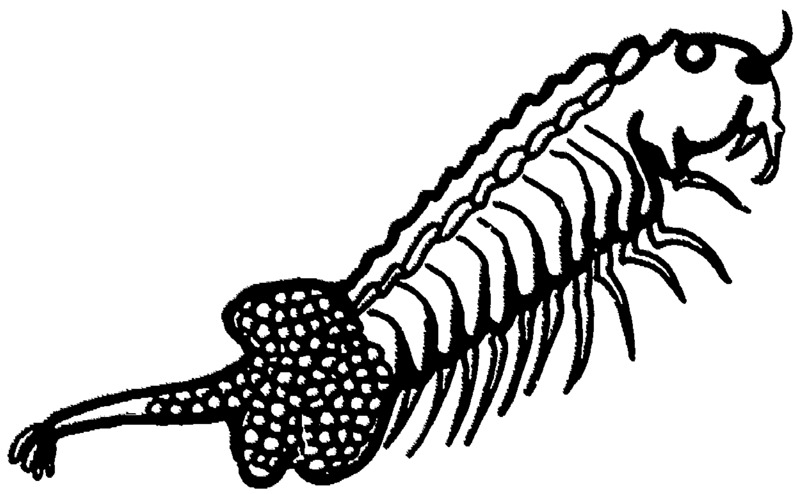
Brine Shrimp and Their Habitat

An Environmental Investigation

BY

NATIONAL WILDLIFE FEDERATION

MINNESOTA ENVIRONMENTAL SCIENCES FOUNDATION, INC.



Design and Illustrations by
JAN BLYLER

Eggs, environment, regeneration—a cycle. The citizen-ecologist must be *concerned* with how things relate, how they develop, and how they will continue to do so. A good way for these concerns to sustain power and effectiveness is for them to be grasped early and become part of a person's way of life. We need to help children become more aware of the environment and their relationship to it if we want them to take care of it.

Brine Shrimp and Their Habitat attempts to get children interested in the life cycle of brine shrimp and how environment affects this cycle. The children will observe the eggs of brine shrimp and then the shrimp themselves. We hope these activities will convey some basic ecological principles and initiate some better understandings about environmental inter-relationships. We also hope the activities will be fun for your students.

We leave it to you to use this unit as a jumping off point for further discovery about the environment.

Table of Contents

INTRODUCTION

Brine Shrimp and Their Habitat contains a series of environmentally related activities. Hopefully, most of the experiences your students will gain from these activities will spring from their own interests and motivations rather than from specific directions set forth in the body of this unit. One activity will merge into another and several will be concurrent. Throughout it all, each child should be allowed to proceed at his own pace.

The unit is introduced by confronting the children with rather mysterious brown objects—the brine shrimp eggs. The children's own observations will probably help to generate questions. These questions, in turn, will lead to closer observation and manipulation of the eggs. The eggs will be hatched and the shrimp raised to adulthood, at which time more eggs may be produced. Once the cycle is complete, the children will have other questions to investigate. Let them experiment as much as your schedule allows and as long as the activities hold their interest. The content of the unit will accumulate as the children discover the answers to their own questions. (We have provided some background information for *you* in the back of the book.)

The second half of the unit contains activities for older children (grades 3-5). The children will investigate some of the variables of environment which affect egg viability, population growth, and organism size. As in the beginning sections for younger children, the emphasis in this second part is on student-generated activities. As the students' investigations become more sophisticated, you will need to provide extra guidance.

Some of the activities in this unit can be coordinated with other areas of the curriculum. Brine shrimp drawings, for example, could be made during an art class. Reports of the students' results could be incorporated into language arts. You may find that the children want you to read them stories about the shrimp or other marine animals. Or they may want to tell you stories of what they have observed. In short, as the children engage in the activities of **Brine Shrimp and Their Habitat,** take every opportunity to practice any related skills that might ordinarily be developed in other areas of your curriculum.

MATERIALS

brine shrimp eggs (available from a biological supply house or pet store)
medicine droppers or soda straws
non-iodized salt or crushed rock salt
iodized salt
babyfood jars with caps
larger jars or gallon jugs
1 cup measures
teaspoons and tablespoons
hand lens (preferably with a low and high manification lens)
stereo-binocular microscopes
well slides (depression slides)
light sources (microscope lamps, flashlights, or pen lights)
overhead projector
petri dishes or other low, flat, transparent containers
grid paper
construction paper
brewer's yeast
microscopes
test tubes, corks
microprojector
crayons
paper

Brine Shrimp and Their Habitat

Brine Shrimp Eggs

This section introduces the students to the material they will be using for the next several weeks. First, they will observe the brine shrimp eggs, and many will try to guess what these might be. This guessing and observing could continue over a period of several days. As the children become acquainted with the material, they will begin to identify some problems they would like to investigate. You will probably want to make note of their plans.

Encourage the children to begin making **record books.** Pictures, drawings, and short, written observations can be entered into these booklets. When the booklets are completed, the children will be able to take them home

Your objective in this first section will be to provide the type of classroom atmosphere conducive to question-asking.

MATERIALS

brine shrimp eggs—one 1 oz. vial
hand lens—½ dozen or more (preferably with a low and high magnification lens)
slides
crayons—1 set for each child
stereo-binocular microscopes (100X Bausch and Lomb)—several, if possible
paper

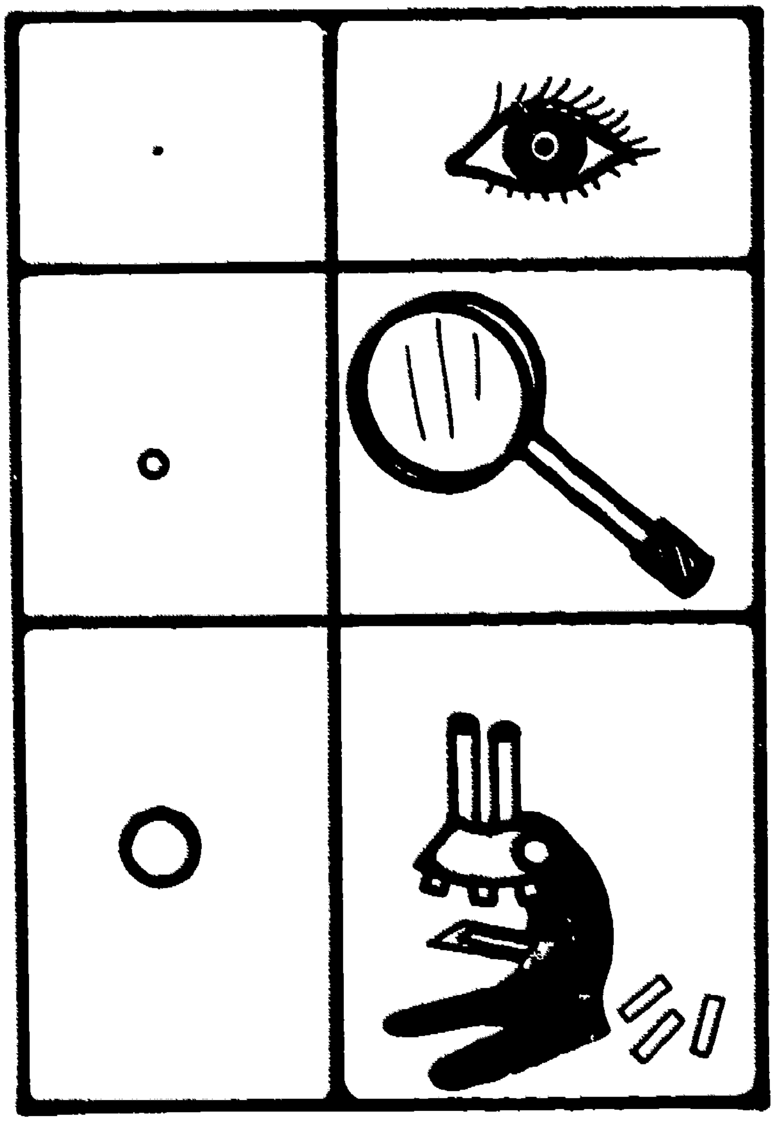
Before you start, set up one or more binocular microscopes somewhere in the room. Also, prepare a well-slide of eggs for each microscope, using just the dry eggs without water.

Begin the activity by sprinkling some of the eggs onto pieces of paper placed on each child's desk. Do this without comment. The eggs are easily blown away, so you might caution the children not to breathe heavily on them. The class will probably begin questioning you immediately.

After the children have had a few minutes to examine the eggs, discuss any guesses made about what these "things" might be. There may be one or two children who have fish tanks at home where the eggs are used as food for tropical fish. But there probably won't be *many* children who have seen them before.

Take note of your students' guesses, and then suggest they look more closely at the objects in the well-slides with the hand lenses. How do any new comments compare with their first guesses? Have them describe what they see. You might want them to suggest some physical characteristics of the eggs such as color, size, form, etc. Record these comments and then introduce the binocular microscopes to the children. Make sure each child gets to see the eggs through a binocular.

During the next several days, encourage more observation and record-taking. The children might begin their record books or notebooks with a set of three drawings—one representing what they see with their eyes alone, one of what they see through the hand lens, and finally, their view through the binocular. If a quick sketch of each "optical system" (eye, lens, binocular) appears next to the drawing for each system, there will be little confusion about what each picture represents.



The children might want to try testing some of their guesses about the objects' identity. If one or several children suggested that the eggs were seeds, for example, have them plant the "seeds" and observe the results.

At some point, someone may suggest that these "things" are eggs. Since you cannot expect most of the students to know they are brine shrimp eggs, you might now disclose this, but try to avoid describing the eggs' appearance.

Hatching Brine Shrimp

A bit of mystery surrounding the identity of the round, brownish eggs may now have disappeared. But enthusiasm can be regenerated by the prospect of hatching the eggs. (Before the class gets involved, you will want to become familiar with the hatching procedures yourself by actually hatching some of the brine shrimp eggs. See the back of the book, page 14, for detailed instructions.)

Encourage close observation on the part of the children. This will be best accomplished if each child has his own eggs for hatching. A personal supply is also helpful in case the children want to *compare* their cultures.

Permit the children the freedom of making some mistakes. Possible sources of error can be discussed when they are making comparisons between their results. The children will have a base for these comparisons if they keep careful records or drawings of their procedures.

MATERIALS

- ***brine shrimp eggs***
- ***small babyfood jars with lids (1 jar per child)***
- ***non-iodized salt or crushed rock salt (6 cups)***
- ***teaspoon and tablespoon measures—half dozen each***
- ***medicine droppers (1 per child) or soda straws***
- ***paper***
- ***kettle of aged or pre-boiled water***
- ***crayons and grease pencil***
- ***microprojector—1 or more***
- ***well slides—half dozen***
- ***hand lens—half dozen***
- ***stereo-binocular—1 or more***
- ***1-cup measure—(4)***

When the time seems appropriate to begin hatching eggs, assemble the materials and display them before the class. As the materials are viewed and as questions about them arise, you may wish to discuss the use for each item. Inform the children that each student will be responsible for hatching his own eggs and tell them how *you* have done it. Demonstrate the procedure for them. You may have to repeat the directions several times.

Supervise the procedure but try to limit do's and don't's to a minimum. For hatching the eggs, each child may obtain his own babyfood jar from the materials on the table and his own supply of water.

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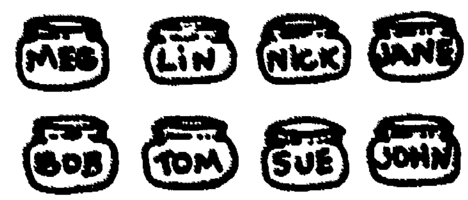
Have each child add the necessary amount of salt, put the cap on the jar, and shake it. Ask what happened to the salt. Next, each child should place a "pinch" of eggs into his brine mixture. Finally, the children can put their names on their jars, using a grease pencil.

STEP 1
Make Brine Mixture

STEP 2
Add Eggs To Brine Mixture

STEP 3
Put Names On Jars



At this point you might ask the students when they think something will happen. You might want to have each child estimate at what time he thinks changes will take place in his jar. List the various estimates on the board with the corresponding name.

Make up several of your own cultures to insure a continuing supply. Encourage the children to draw pictures of the procedures as they make their own cultures.

When they are finished, have them discuss what they think is going to happen. Have them imagine what the eggs will develop into and then have them draw pictures of their imagined ideas, to compare and discuss. Perhaps each child could also tell a story about why he thinks the hatched eggs will look like his drawing.

Observations of the eggs can be made at intervals during the next two days. Some of the children may wish to view several eggs with the binocular microprojector, the binocular microscope, or the hand lens. To use this equipment the children will have to remove some of the eggs from the babyfood jars and place them on well slides. Have them u̇se either a medicine dropper or soda straw to place about one drop of water containing eggs into the depression on the slides. They should then place these slides on the equipment. Demonstrate how to use the soda straw as a pipette by placing it in the water to the desired depth (about 1/4 inch), placing a finger across the upper opening, and then lifting the straw. Straws may be cut in halves or quarters to accommodate small fingers.

When the first egg hatches have the class try to determine how long it took in hours. Each child should record this figure for his own set of eggs. (You may need to help.)

As more and more eggs hatch, the children will deluge you with questions. Answers to many of these questions can be found by the children themselves, through observation and investigation. Ask the children if the appearance (the look) of the shrimp surprises them. Do any of their drawings resemble the shrimp?

After Hatching

When all the children have successfully hatched some shrimp, you will have to handle their questions, guide their investigations, and promote further observation. You can expect a wide variety of questions ranging from "Are they alive?" to "What do we feed them?" Within reason, permit the children to explore all the possible answers to their questions. Try to avoid imposing too much structure on their investigations. Some possible categories of observations and investigations follow. The discussions that accompany the observations and investigations, together with the background information on brine shrimp (see the back of the book, page 14), should provide you with the data needed to guide the children through their activities.

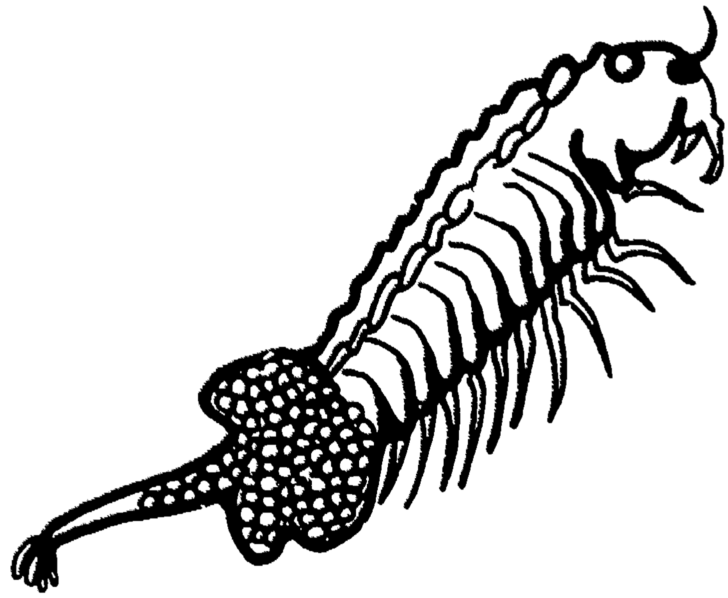
MATERIALS

brine shrimp, individual cultures	*light source—optional (flashlight works well)*
hand lens—½ dozen or more	*brewer's yeast—one package to be used as food for shrimp*
stereo-binocular microscopes	
microprojector	
medicine dropper	

I. Observations and Investigations

A. Physical Characteristics

These are easily observed through the hand lens or binocular microscope. The shrimp have two eyes, various numbers of jointed appendages (depending on their age), and a jointed tail section.



B. Maintenance

The back of the book, page 14, tells how to properly feed and care for the shrimp. If the children wish to try food other than the yeast, permit them to do so, but recommend tiny portions.

C. Behavior and response to the environment

Shrimp behavior, like that of all organisms, depends upon both internal and external environmental conditions. Positive and negative reactions to light can be observed using the light source. The light could be shown for a few minutes on one side of a jar containing brine shrimp and then the light could be removed. Note any reactions of the shrimp. Perhaps the children can also determine if the shrimp react to varying salt concentrations, to each other, to temperature changes, etc. (See page 8.) One aspect of behavior easily observed is the means of locomotion. The shrimp swim on their backs using their appendages as we would use oars.

D. Reproduction

Try to maintain a culture long enough for the shrimp to reproduce. A female's first set of offspring will be born as tiny shrimp. Her next set will be born as eggs. (See page 14.)

E. Life requirements

Some children may want to know if the eggs will **hatch** in non-salt water or another liquid. Allow them to experiment. They might also ask whether or not the shrimp will **live** in non-salt water. (See page 12.) Transfer some live shrimp to tap water and have the children observe the results. If someone asks, "Do they breathe?" transfer one shrimp to a small container and have the child observe one closely to see if he can detect anything he thinks is evidence of breathing. Try to get the child to observe a single shrimp eating. How does he know it is eating?

F. Population factors

Some cultures will contain more shrimp than others. One reason could be the initial number of eggs placed in the water. There are always live baby shrimp being produced, but there will be an increasing reserve of eggs which must be dried in order to hatch. Other reasons for differences in population density might be the salinity of the water, overcrowding, etc. See if a child can count his own shrimp. If so, he may wish to transfer a known number of them to water containing different amounts of salt to see if salinity has any effect on the populations. (See page 9.)

During the course of the activities encourage drawings, stories, and as much discussion of observations as possible. When it seems appropriate, you might ask the children if they have reported what they have seen to their parents or to brothers or sisters. This might be one indication of interest level.

II. Additional Topics

These topics for discussion and investigation represent several levels of difficulty. Select only those which could be discussed and investigated by most of the students in your class.

A. Salt Lakes

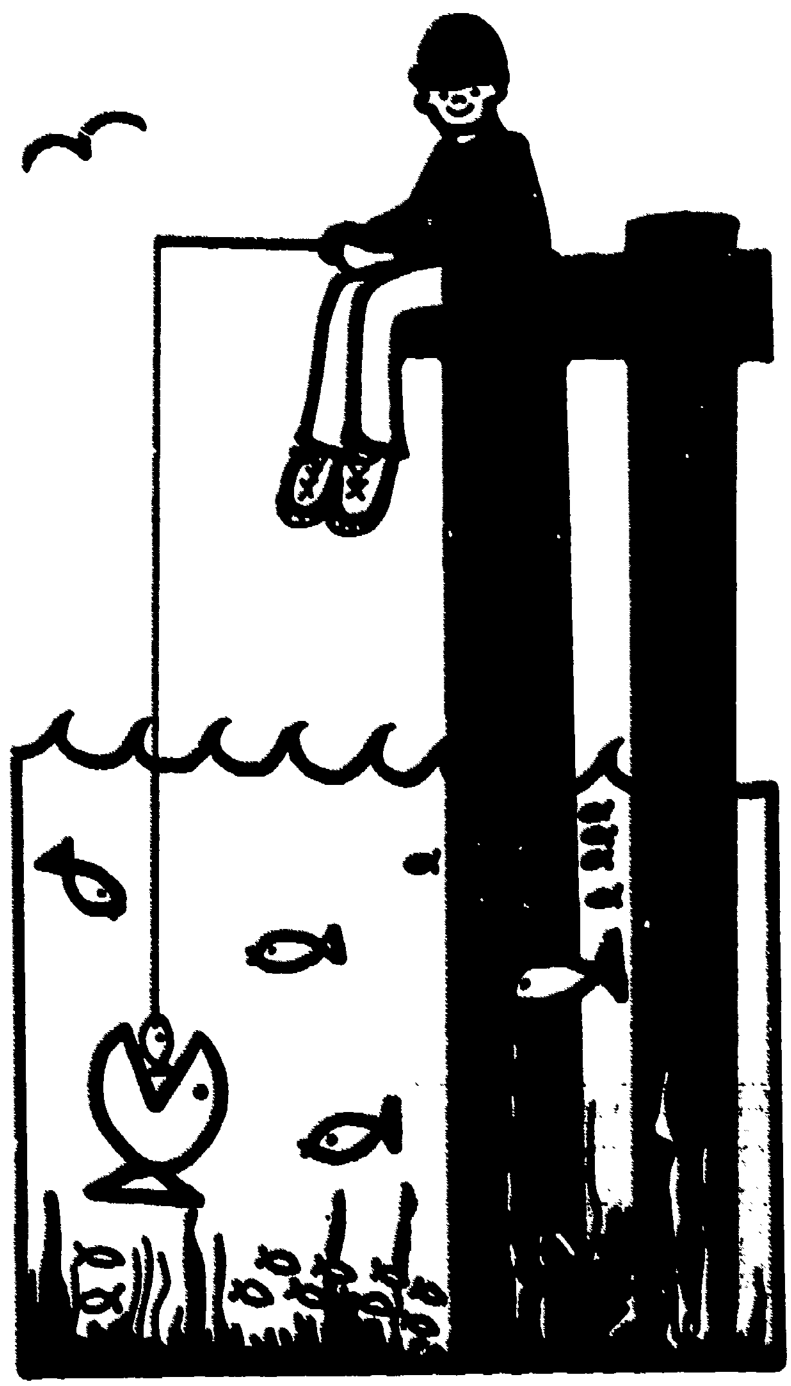
Many of the children will wish to know where the shrimp live. They are collected from salt lakes, mostly in Utah and Southern California, and you might want to indicate these locations on a map. Here is an opportunity to involve the class in some geography. Try to get them to see that salt lakes exist only in certain parts of the country and that there are relatively few of them. The children might want to discuss possible reasons for why the salt lakes are found where they are.

B. Other Shrimp

Bring to class some unshelled edible shrimp. Discuss similarities and differences between these and the brine shrimp. There is also a tiny fresh water shrimp called a fairy shrimp. Though rarely found around metropolitan areas, you may be lucky enough to collect some from ponds in the spring and compare them with the brine shrimp.

C. Food Chains

If you have an aquarium with tropical fish, you might demonstrate something about food chains by feeding the shrimp to the tropicals. First, wash the shrimp under tap water by placing them in a very fine mesh net (nylon hose will work well). Remind the children that the shrimp eat tiny plants found in water. Finally, have them suggest possible predators of the small tropical fish. The children might want to draw pictures of this food chain and enter them in their record books.



D. Color, Temperature, and Light

Maintain several brine shrimp cultures over the year. A number of interesting experiments can be tried. For example, the class might try hatching and raising several generations of shrimp in complete darkness or continuous light. Keep some shrimp in the refrigerator to note the effects of cooling. Also, students might place non-toxic food coloring in the water to discover some of the internal structure of the shrimp. This can be done by placing the shrimp in colorless water after they have absorbed the food coloring from the first container.

Effects of Environmental Variables

In the preceding activities, the children have hatched brine shrimp eggs and have made some initial observations. In this next section, the children will carry out some investigations relating to the shrimp's response to its environment. You will probably want to select several of the activities included in this section for the entire class to do, or, have different groups select for themselves the activities that especially interest them. In addition, you will want to have the students devise some of their own experiments to add to those from the unit.

Should two or more groups do the same experiment, have them compare their results and discuss their findings with one another. If they do not get the same results, encourage them to seek reasons for the differences. Stress the record-keeping aspect of these activities so that accurate comparisons can be made.

When the class has completed its investigations, the students might wish to compile a class notebook containing descriptions of their experiments, results, and conclusions. The notebook would provide a valuable reference for the children, especially if they return to their textbooks for background reading. By relating their experiences with brine shrimp to text material, they will broaden their exposure to life cycles and environments.

I. Hatching in Various Liquids

MATERIALS

babyfood jars, 1 per student or team, all the same size
non-iodized salt
iodized salt
preboiled water, 4 quarts
tap water
quart jars (4)
vinegar, 1 cup
alcohol, 8 ounces
salad oil, 1 cup
other liquids

Have students assemble or prepare about one cup of each of the following liquids and solutions:

1. Unsalted tap water
2. Unsalted pre-boiled water
3. Tap water, properly salted with iodized salt, ½ teaspoon of salt per every ounce (2 tablespoons) of water. (See the back of the book, page 14.)
4. Preboiled water, properly salted with iodized salt
5. Tap water, properly salted with non-iodized salt
6. Preboiled water, properly salted with non-iodized salt
7. Tap water that has as much iodized salt in it as it will dissolve (**saturated** with the salt. A saturated solution is one in which the salt no longer dissolves but precipitates out of the solution).
8. Preboiled water, saturated with iodized salt
9. Tap water, saturated with non-iodized salt
10. Preboiled water, saturated with non-iodized salt
11. Vinegar
12. Alcohol
13. Salad oil
14. Other combinations of liquids and solutions

Assign each student or team of students a solution in which to try to hatch the eggs. Have the students place approximately the same amount of eggs in each solution. A level eighth of a teaspoon might be a convenient amount. The students might want to make their own measuring device. Whatever they decide upon, all students should use the same amount of eggs per jar.

Place the containers in approximately the same location to keep external conditions as nearly the same as possible. Have the students make guesses as to which liquids will best hatch the eggs. Stimulate guesses by asking questions like, "Do you think the eggs will hatch in all the containers?" Have students record their guesses. This is a good place to discuss the value of hypothesizing—making intelligent guesses—in science.

Label each container and check every few hours for live brine shrimp. Have the students keep accurate records. After two days, compare the number of hatched brine shrimp in each container. Discuss ways of counting the hatched shrimp so that accurate comparisons can be made between jars.

It would be good if the students themselves could devise a method of counting or estimating the number of hatched brine shrimp in a jar. Again, whatever procedure is decided upon, each student or group should use that same method. In this way, comparisons between jars will be more meaningful.

One way to estimate live shrimp population in a jar would be to take a measured sample of the liquid, count the number of shrimp in the sample and multiply that number times the number of liquid measures in the entire jar. For example, you might find that the jars your class is using each hold twenty-five thimblefuls of liquid. If you take a thimbleful of the solution, count the number of live shrimp in that thimble sample and then multiply by twenty-five, you will get an estimated shrimp population for the whole jar. Whichever method the children decide to use, they should mix their solutions gently before sampling (possibly by capping and shaking slightly), so that the shrimp will be evenly distributed throughout the solution.

ASK THE STUDENTS:

Were there solutions or liquids in which no eggs hatched?

Were there some containers in which more eggs hatched than in others?

Was there much difference in number of eggs hatched between the tap water solutions and the preboiled water solutions?

Did the amount of salt seem to make a difference?

Did the iodized salt keep eggs from hatching?

Can you make any general statements about the solutions in which brine shrimp eggs will hatch?

Do not allow students to make statements that are not supported by the evidence. Repeat portions of the experiment that your students feel were not conclusive. Now would be a good time to discuss the value of experimentation where results are not definite and general statements cannot be made.

Have students compare the results of the experiment with the guesses or hypotheses they made earlier. Discuss how scientists must sometimes give up "pet" ideas when the results of their experiments do not support these.

Have the class continue to observe for two weeks. Ask: Are there any live shrimp in solutions where there were none before? If so, what does this indicate about the time it takes brine shrimp eggs to hatch? Did any statements have to be revised?

II. Hatching in Various Salt Concentrations

MATERIALS

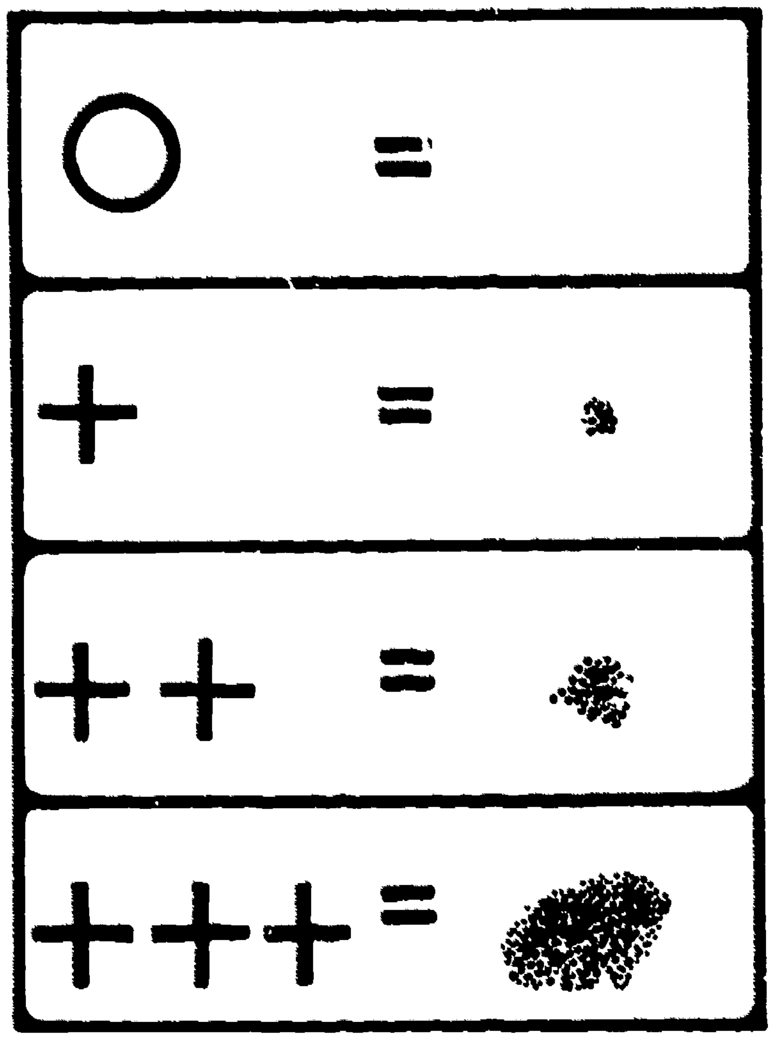
babyfood jar
preboiled water
non-iodized salt
measured amounts of brine shrimp eggs
salt measure

In this section, the students will experiment with hatching the brine shrimp eggs in solutions with different salt concentrations. Divide the class into teams of two students each, and provide each team with a container (for example, a babyfood jar.). Make sure that there is an equal amount of pre-boiled water in each of these containers.

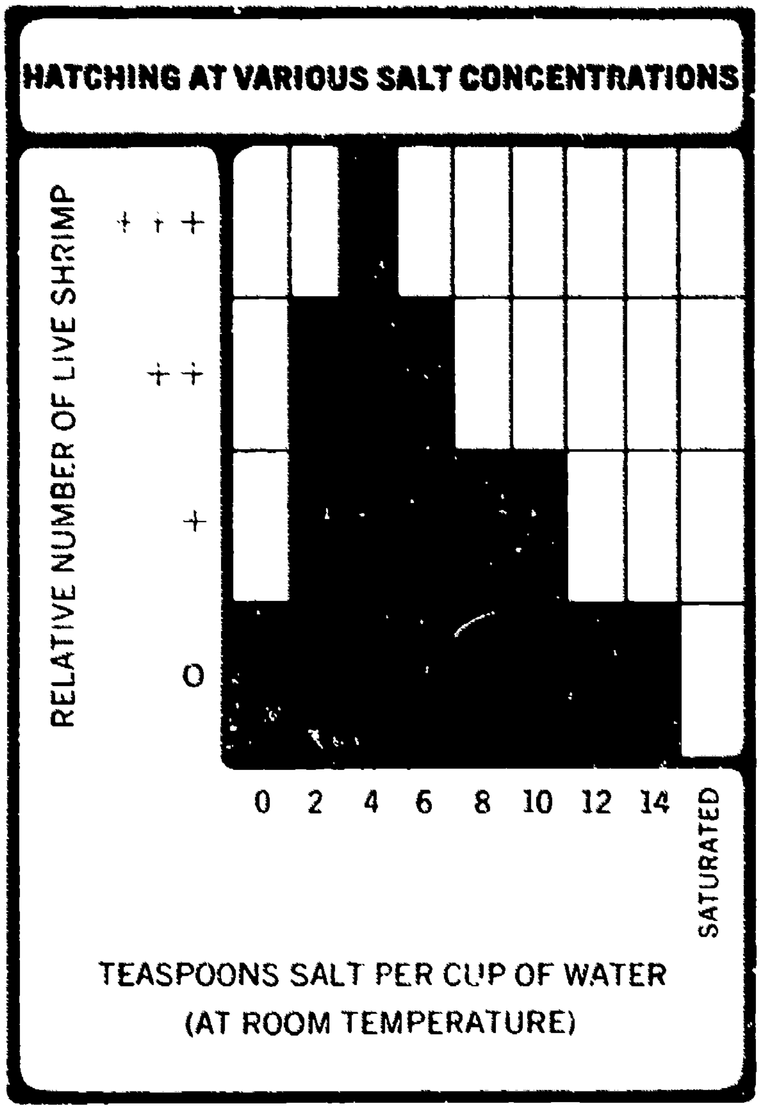
Now have each team dissolve a different amount of salt into the water of its container. The range of salinity in the classroom should be from unsalted to saturated. The students should decide what quantity of salt they wish to test, as well as a standard means of measuring the quantity so that they may compare their results.

When this has been accomplished, an equal amount of brine shrimp eggs should be placed in each container. Have the students store the containers in similar locations (regarding temperature and light) and make sure that the teams keep records of their observations.

After two days, compare the number of live shrimp in each container. This time arrange the containers in order of salinity. You may simplify the record-keeping by establishing a scale and symbols for estimating the number of live shrimp. A zero (0) might stand for no live shrimp; one plus sign (+) might represent very few shrimp (1-10); two plus signs (+ +), many shrimp; and three plus signs (+ + +), very many shrimp. Constructing a histogram with this scale to record the results at the end of two days might help the students zero in on the important concepts without getting bogged down in statistical data.



The following sample shows one method the students could use for plotting their information on a histogram. The information used is intended as a sample and does not necessarily reflect the data the students would find. The horizontal axis represents the relative degrees of salinity, ranging from no salt to a saturated solution. The actual amounts of salt that each relative number represents will depend on the amounts the students have chosen for their different solutions. The vertical axis indicates relative numbers of live shrimp, ranging from none to very many. Information plotted for the various solutions will provide the histogram.



Discuss the results with the students. Can they make any general statements as to how salinity affects the hatching of brine shrimp eggs? Have them continue to observe and record for two weeks. They can make histograms showing the results after one week and again after two weeks.

ASK THE STUDENTS:

Were there containers in which no eggs hatched?
Were there containers in which few eggs hatched?
How did the salinity affect the *time* it took the eggs to hatch?
Might a longer period of observation produce new data?

III. Hatching Eggs Under Various Conditions

MATERIALS

- *babyfood jars with same size caps (8)*
- *hatching solution—preboiled water and salt (see the back of the book, page 14).*
- *jars for storing salt water solution*
- *brine shrimp eggs*
- *measuring device*
- *medicine dropper*
- *black construction paper*

Do brine shrimp eggs need air, light, or warmth in order to hatch? For this activity, the hatching solution should have been stored in full, sealed containers, prior to use, so that almost no air will reenter the solution after the air has been removed by boiling.

Have the students place the same amount of hatching solution in each of eight containers, so that each is filled *nearly* to the brim. Next, have the students place a small, equal amount of eggs in each container and then add enough more hatching solution so that each jar is **brimful.**

Then have the students place one of the eight containers **uncovered** in a warm, light location. A second container should be placed next to it, but the air must be excluded by putting a cap on the jar. (In order to exclude as much air as possible, you may want to cut out a cardboard spacer disk to fit inside the cap and to take up any extra air space). Have the students place two more containers—one with and one without a cap—in the same location as the first two, but exclude light from the second two by covering them with boxes of black construction paper. Have the students also place two more of the containers, (one capped and one not) in a refrigerator and the last two (one capped and one not) in a cold place where they will receive light. You will probably be able to have these last two conditions only during the cooler months of the year when you can place the containers in the sun outside a window. Label each container appropriately as follows:

CONDITION CHART	
Condition 1:	Warm, Light, Air
Condition 2:	Warm, Light, No Air
Condition 3:	Warm, Dark, Air
Condition 4:	Warm, Dark, No Air
Condition 5:	Cold, Dark, Air
Condition 6:	Cold, Dark, No Air
Condition 7:	Cold, Light, Air
Condition 8:	Cold, Light, No Air

At regular intervals (perhaps once a day) for two weeks, have the class observe the eggs under the preceding conditions.

ASK THE STUDENTS:

In which container did the eggs hatch first?

Were there containers in which no eggs hatched?

Compare the containers that were warm with those that were cold. Does temperature affect the hatching of eggs?

Compare the containers that were in the light with those that were in darkness. Is light necessary for the hatching of eggs?

Compare those containers which were exposed to air with those from which the air was excluded. Do the eggs need air to hatch?

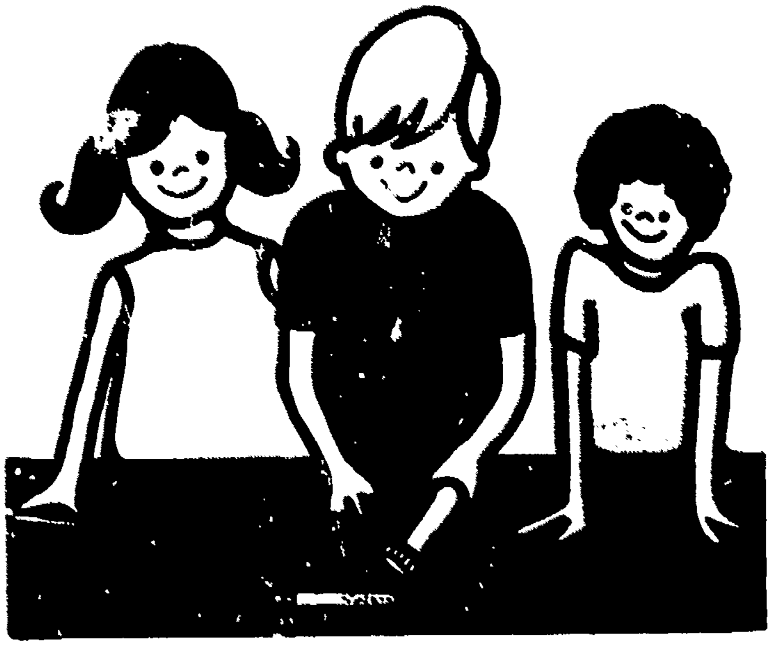
In the last comparison, be sure to make a distinction between **hatching** and **continuing to live.** Eggs may hatch without air, but live shrimp soon die.

IV. The Effect of Light on Live Brine Shrimp

MATERIALS

test tubes with corks (any small, long, narrow, transparent container will do)
black construction paper
live brine shrimp
flashlights

Divide the class into teams and provide each team with a flashlight and a test tube. Have each team fill its test tube within one-half inch of the top with solution containing live brine shrimp. Have each team cork its tube tightly and place it on its side, supporting it so it will not roll. Then each team should shine a flashlight on the tube at right angles so that the beam illuminates only one end of the tube. The light should be left shining on one end for several minutes while the behavior of the shrimp is being noted. Now the flashlight should be moved so that it illuminates the other end of the tube. Ask the students what they observe. Does the light appear to have any effect on the live shrimp?



Have the students make a black construction paper sleeve and cover one end of the test tube with it. Make sure they leave the other half of the tube in daylight. Have the students lay the test tube on its side, supported so it will not roll. They should carefully remove the sleeve after one-half hour and compare the number of shrimp in each half of the tube. Discuss the results.

V. Conditions Needed for Brine Shrimp to Grow

MATERIALS

For the class:
8 babyfood jars and 4 caps
black construction paper
hatching solution that has been kept in full sealed jars

For each team of two pupils:
2 babyfood jars with caps
live brine shrimp
a medicine dropper or one-half of a drinking straw

On the day you wish to begin this next section, have the students, as a group, set up one class set (eight jars) of the same eight conditions as those described in Part III, "Hatching Eggs Under Various Conditions." (See page 10.) But this time, place an equal number of **live** shrimp in each jar using shrimp hatched according to the instructions in the back of the book. These eight jars are **control groups.** In the activities which follow, they will be used by the students as standards for making comparisons. At this point, you will probably want to explain what a control group is and why it is needed in a scientific experiment.

Now, have each team of two students make up one jar using whichever one of the eight environmental conditions they wish. They will need to follow directions given in Part III with regard to temperature, light, air tightness, and so forth. Also, each team must put the same number of live shrimp into its jar as is contained in each control group jar.

One team may decide to have a **Warm, Light, No Air** condition for its jar, another a **Cold, Dark, Air** condition, etc. In this way, the members of each team will be able to compare the conditions in their own jar with conditions in three of the other control jars. For example, a team with a **Warm, Light, No Air** condition should compare the life in its jar with the **Warm, Light, *Air*** control jar, or with the **Warm, *Dark*, No Air** control jar, or ***Cold*, Light, No Air** control jar. Each comparison would involve a **single variable.** Hopefully by making such comparisons, the students will be able to arrive at some preliminary generalizations and conclusions, based on their own observations.

Have the teams keep records of their observations over a two-week period. Discuss the results. Have them graph their findings where possible. You will want to ask such questions as: How long did the shrimp survive without air? Did darkness affect the shrimp in two weeks? How long did the refrigerated shrimp survive? (See the back of the book for ½" and ¾" grids that can be reproduced.)

These investigations should establish some of the conditions necessary for brine shrimp to grow. Now would be a good time to discuss conditions under which various other organisms prosper. Discuss the need of all living things for air and food. Discuss the importance of temperature. (You might want to refer to **Fish and Water Temperature,** another unit in this series.)

Set up a "shrimparium." Any large jar will do. If possible, aerate the solution with an aquarium aerator. Try to raise shrimp until they produce a new batch. It might be interesting for the class to see how large brine shrimp get.

VI. The Effect of Various Liquids on Live Brine Shrimp

MATERIALS

several similar containers of brine shrimp
medicine droppers
alcohol
vinegar
aspirin dissolved in a small amount of water
clorox
carbonated beverage—Seven-up
other clear liquids—salt water, molasses and water, sugar water, colored water

Have the students place one drop of alcohol into a container of shrimp, and have them observe the shrimp for a few minutes. Then have them repeat this with *other liquids* in *other containers*. They should continue to add liquids, one drop at a time. Ask: Which liquids affected the brine shrimp most quickly? Did all liquids finally kill the shrimp?

VII. Examining Dead Brine Shrimp

MATERIALS

microprojector or microscope
microscope well slide
vinegar
live brine shrimp
medicine dropper

Have the students place a drop of water containing dead brine shrimp on a slide. Have them place the slide under magnification and observe the shrimp. Ask: What body parts can you identify? Have them notice the black spot on the head, the orange portion of the body, the antennae, and the two large "legs." Have the students draw pictures of a brine shrimp.

FOR DISCUSSION:

How are the brine shrimp adapted for their environment? Where would you expect to find brine shrimp in nature? What factors affect their life-span?

The Back of the Book

I. Background Information

The brine shrimp (**Artemia salina**) is a member of the phylum Arthropoda and the class Crustacea. Arthropods share the common characteristic of jointed, movable appendages. All crustaceans have a chitinous exoskeleton which is typified by the external coverings of crayfish and lobsters. With the exception of lobsters and the king crab, most crustaceans are small, not exceeding one eighth to one-half inch in length. Fresh water relatives of brine shrimp are the fairy shrimp (a "look-alike" organism found in most ponds), and Daphnia, which is also found in ponds and is used as fish food.

Salt lakes, sinks, and ponds in the western portion of the United States are the primary sources of brine shrimp eggs. They are found less frequently in the ocean. The Great Salt Lake in Utah is an especially rich source of shrimp eggs where, blown by the wind and consequent wave action, they accumulate on the lee side of the lake. There the eggs are gathered and packaged for pet supply stores and biological supply houses.

An adult female will produce young in your cultures when cultivated under optimum conditions. Her first batch will be born as tiny immature forms (baby shrimp); her second will be produced as eggs. Examination of the eggs reveals them to be small, indented, spherical structures which must be dried before they will hatch. **Drying** is a means of survival for these organisms. Their ability to withstand lengthy periods of drought insures the preservation of the species. It has been estimated that some dried eggs may remain viable for periods of approximately ten years.

Upon soaking in a salt solution (brine) the eggs swell, burst, and a tiny pre-adult form of the shrimp called a Nauplius emerges. Increasing the salinity of the water shortly after the shrimp are hatched provides a more favorable environment and contributes to the rapid growth of the organisms. Successive molts produce a mature adult whose form and behavior is somewhat different from the Nauplius. With proper care and feeding, the adult may reach an overall length of one-half inch within six weeks after hatching if the temperature is kept at approximately 28 degrees C. or 82.4 degrees F. (The organisms are killed by heat in excess of this amount.)

If you examine a mature brine shrimp with a stereo-binocular microscope, you will see that it characteristically swims on its back, exposing six to eight pairs of appendages. These structures function both as a means of locomotion and as gills for breathing. The number of appendages increases with the age of the shrimp.

Upon hatching, the young shrimp will gather where the *most* light is available. A shrimp has two compound eyes which are thought to perceive light, shadow and movement, but not images as do vertebrate eyes. The adults, however, respond negatively to light. It is interesting to speculate upon the survival value of various responses to light at different stages in the development of the organisms.

II. Hatching Feeding, and Caring for Brine Shrimp

In order to hatch the shrimp, a general "recipe" to follow would be to use sixteen teaspoons of **non-iodized** salt per one quart of water. (A simplified rule of thumb is to use ½ teaspoon of salt per every ounce, or 2 tablespoons, of water.) It is a good idea to age or pre-boil the water to remove chlorine, and to do the mixing in a large, flat (2" depth) container for **aeration.** Non-iodized salt may be found in most grocers but if it is not available, rock salt used for melting ice in the winter will also work.

After the salt and water are mixed, sprinkle the eggs onto the surface of the water. Depending on the temperature of the room, the eggs will hatch in 24 to 48 hours. The higher the temperature, the more rapid the hatching. Some sources recommend temperature around 80° F. for the most rapid hatching. Stir the eggs from time to time to insure proper aeration.

The eggs will hatch into a Nauplius stage of development—a form many crustaceans take before developing, through successive molts, into an adult form. If you have success in getting the shrimp to reproduce, the first set of new organisms will be born as baby shrimp, the second set (from the original mother) will be produced as eggs. These eggs will need to be **dried** before they can be induced to hatch.

After the shrimp hatch, they will live for some time before they require food, but this does not mean they need not be fed at all. The most easily obtainable food is brewer's yeast. Small pinches of it may be fed once or twice a week. For best results in obtaining large adult shrimp, make certain the cultures are not crowded. Over-population of the culture results in decreased oxygen supply, an accumulation of wastes and undersized shrimp. Small (½ teaspoon) amounts of bicarbonate of soda maintains the alkalinity of the water, counteracting the effects of accumulated carbon dioxide produced by the breathing organisms.

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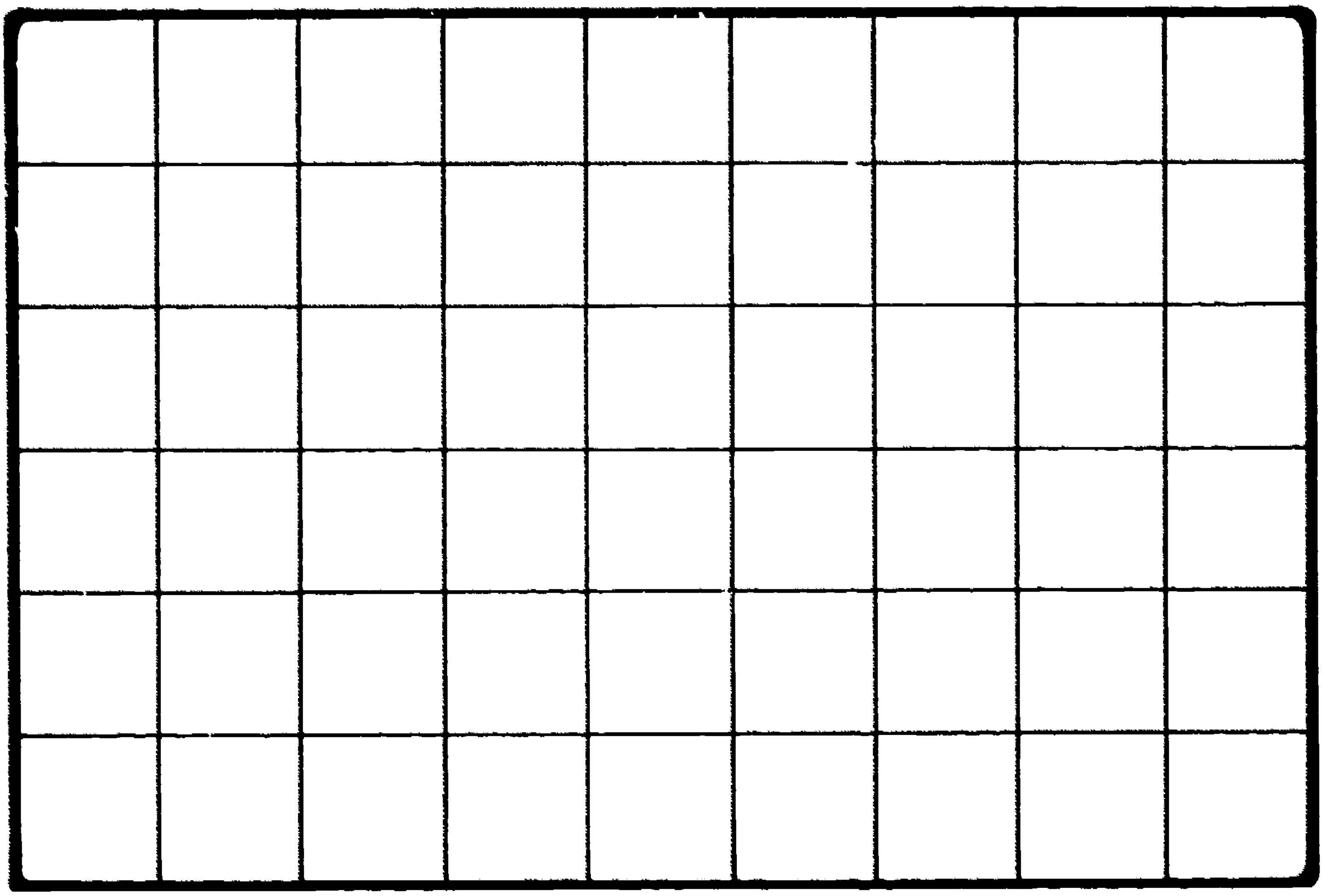

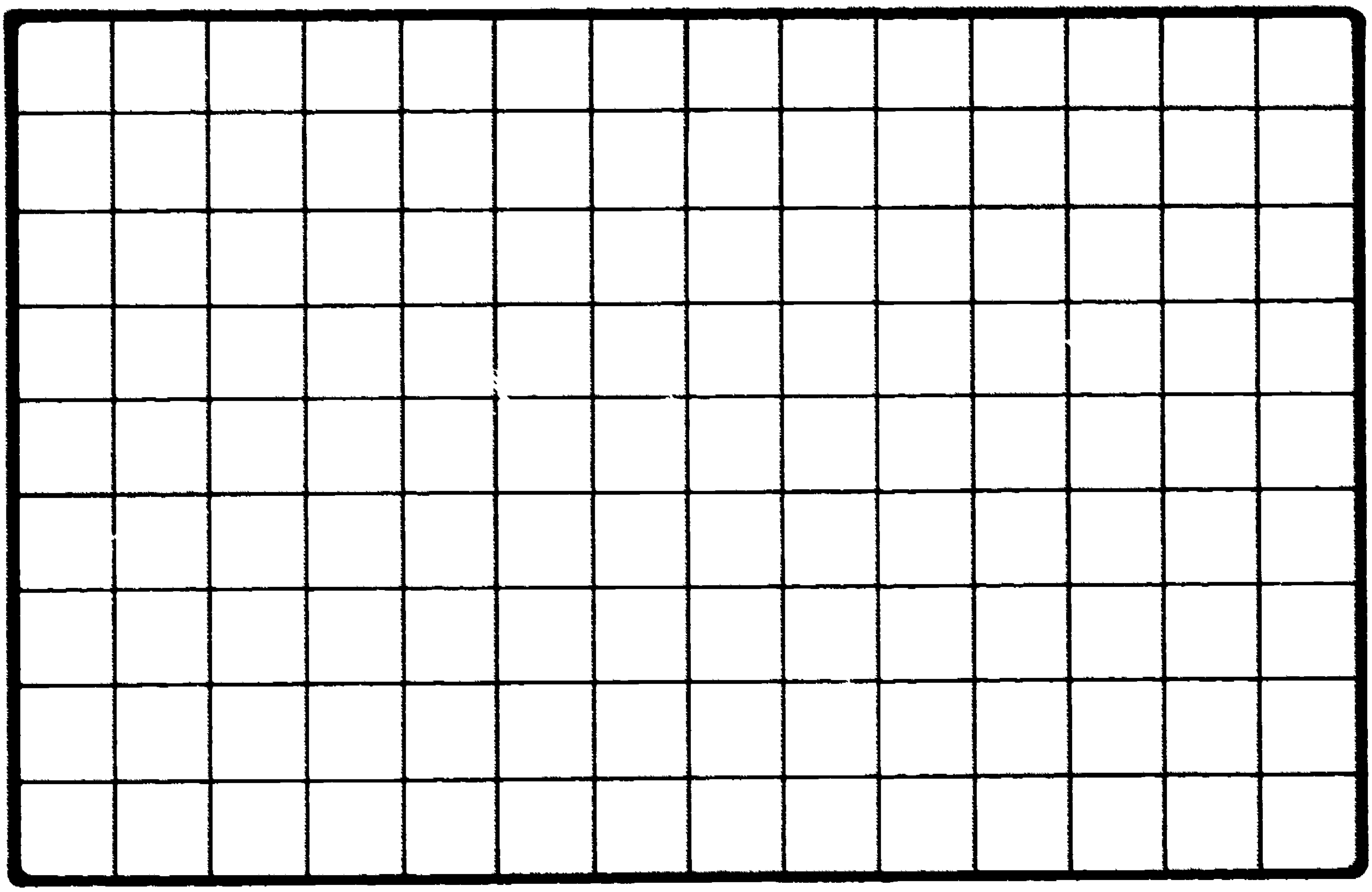

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Kathleen DiBlasio
Wendy Kay
B. J. Mitchell
Phil Nicholson
Tom L. Smith
John Cary Stone

MESF
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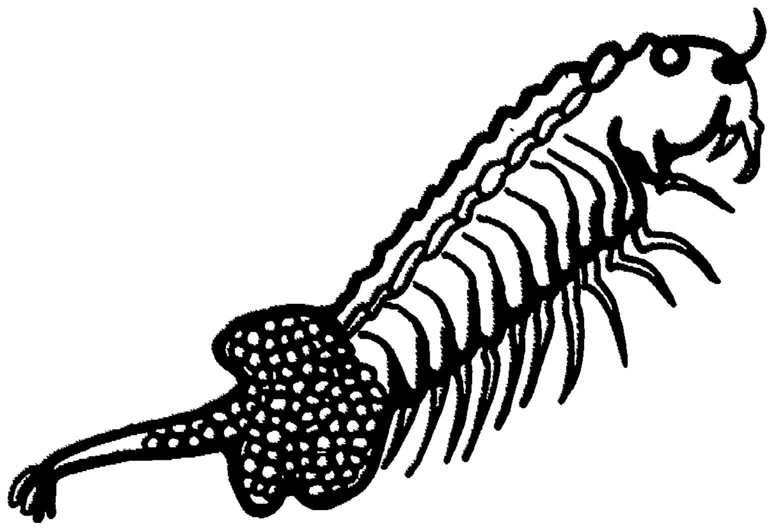

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