EVOLVE

A Trip Through Time and Taxonomy

Jeffrey Bloom

J. Weston Walch, Publisher

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Contents

To the Teacher

The student worksheets that accompany the *Evolve* software are designed to help students construct a more elaborate knowledge of some of the more important concepts of evolution. Developing an understanding of these concepts will allow students to interact with the *Evolve* program meaningfully. Since no real understanding of evolution is necessary to work through the software, it is important that students become more familiar with the process of evolution in another way. With such an understanding, students will be able to apply the concepts of evolution to illuminate the events contained in *Evolve*.

In the following pages, a brief description of suggested guidelines for using the worksheets will be presented, followed by specific suggestions for each of the four activity sets. In general, you should feel free to make adjustments as you see fit.

General Guidelines

Recent developments in science research indicate that learning is a constructive process. Students interpret new information and associate it with information and ideas that they already have in memory. Such a process is an attempt to make learning meaningful. If students simply memorize new information, then little or no meaning is attached to it. It is harder to remember and use for problem-solving. Below is a list of the major implications of the research for teaching.

1. When new knowledge is associated or linked to prior knowledge that is incomplete or not scientifically accurate, the result is that the new knowledge is adapted to fit the misconceptions.
2. Students need to make their own decisions about the validity of their ideas as well as those presented by the teacher.
3. A more elaborate and deeper understanding of a conceptual area is necessary for effective problem solving.
4. Students need to be given the opportunity to use information about a concept in a variety of ways: elaborating, associating, interpreting, inferring, evaluating, and so forth.

The worksheets are meant to be used along with the computer program to clarify and expand on several important concepts, including these:

1. The *Evolve* software alone may unintentionally reinforce students' tendency to anthropomorphize. It is important for you to emphasize that all present-day plants and animals are at the same point in evolution. Man has evolved differently, but has not evolved "more."
2. Darwin's theory of evolution has many unexplained and unaccounted-for gaps. Just how certain species and higher taxa arose or disappeared has not been substantiated (e.g., fish to amphibians; dinosaurs; birds and mammals from reptiles).

4. Have students construct a taxonomy of organisms contained in *Evolve*. The students should then describe and defend the relationships between their groups.

Activity Set II: Interactions in the Ecosystem

Objectives

During the following activities you will be able to:

1. describe how various environmental conditions can act as limiting factors to the growth and survival of species.
2. describe potential limiting factors of organisms by analyzing specific characteristics and their functions.
3. describe the interactions among various organisms in terms of how they compete with one another.

Activities 1 and 2

1. Explore changes in the environment over evolutionary time. How may limiting factors have contributed to the survival and extinction of species?
2. Explore and investigation the limiting factors of other types of organisms (local flora and fauna).
3. Describe the limiting factors of humans and how this species deals with such factors.
4. Discuss limiting factors that may have contributed to the success or extinction of the animals found in *Evolve* (e.g., blue-green algae, trilobytes, cockroaches, brontosaurus, etc.).

Activities 3 and 4

1. Investigate the competition between other species (local flora and fauna).
2. How does competition manifest for *Homo sapiens*? Within the species? Between *H. sapiens* and other taxa?
3. What effect has *H. sapiens* had on other flora and fauna? Look at local examples.
4. Examine the changes in the ranges of animals over the past 50 years.

Activity Set III: Natural Selection

Objectives

During this activity set you will be able to:

1. analyze one way in which new species can arise.
2. describe how isolating mechanisms can prevent new species from arising from the interbreeding of two separate species.

Follow-up Activities

1. Discuss how the following conditions may affect evolutionary trends. Be sure to consider limiting factors and isolating mechanisms. You may want to focus on locally meaningful issues.

   a. Acid rain.

   b. Destruction of the ozone layer.

   c. Thermal pollution (from nuclear reactor effluents).

   d. Nuclear radiation.

   e. Destruction of forests.

   f. Destruction of marshland (by the building of housing developments).

   g. Chemical pollution of air, soil, and water.

   h. The construction of dams and other alterations to rivers, streams, and lakes.

   i. Use of pesticides and herbicides.

   j. Transportation and introduction of species from one ecosystem to another (e.g., kudzu, Japanese beetle, walking catfish, "killer" bees).

   k. Excessive harvesting of whales, seals, and other animal species.

2. Explore a local habitat.

   a. Delineate habitat and environment factors.

   b. Identify and list organisms in the habitat.

   c. Describe ecological relationships (food web, competition, niches, etc.).

   d. Describe evidence of adaptation, limiting factors, competition, and isolating mechanisms.

   e. What man-made or natural changes could affect the habitat? How would these changes affect the ecological relationships? What evolutionary changes could result?

Set I
Activity 1: Classifying

NAME: _____ 1

DATE : _____

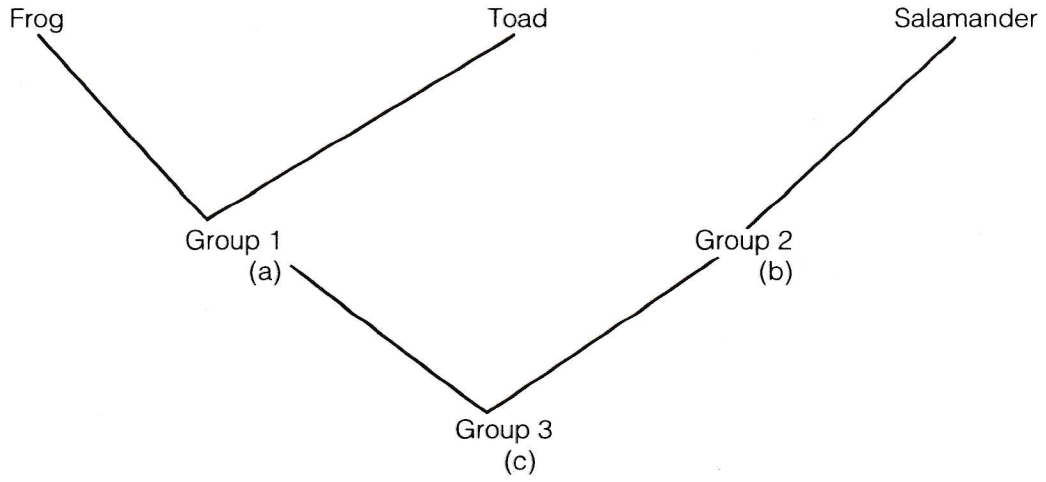
Instructions

The point of this activity is to think through the process of classifying natural objects and to think about the relationships between each object and each group.

This activity can be done individually or in small groups. With a group, one person should be responsible for leading the discussion and taking thorough notes.

1. Cut out the 15 drawings from the Insects worksheets and place them in one horizontal row on a large sheet of paper. Arrange them so that similar objects are next to one another.
2. Below the insects draw lines to connect similar objects into groups, similar groups into more inclusive groups, and so on. The result should look something like a tree. In the tree below, three common amphibians have been divided into groups according to a certain set of characters (characters would be listed at the lettered locations.) Fill in the characteristics. List only enough necessary characteristics to definitively separate each group.
3. Label the branches of the tree in Chart 1A (connecting lines) with the characteristics (characters) of the objects that were used to indicate similarity for belonging to the group.

Example:

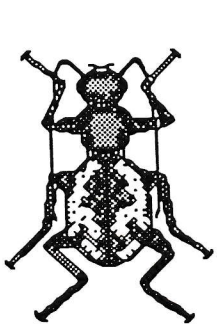


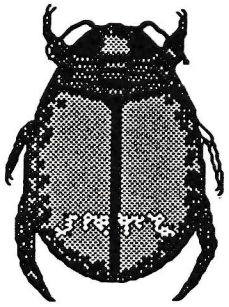
Set I
Activity 1

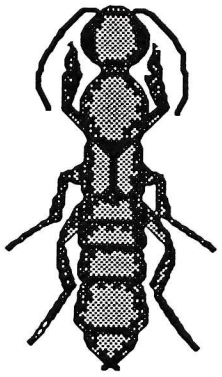
NAME: _____ 2

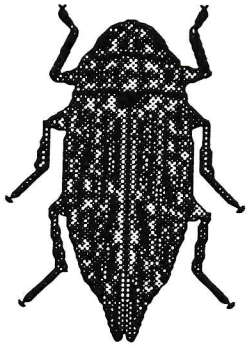
DATE : _____

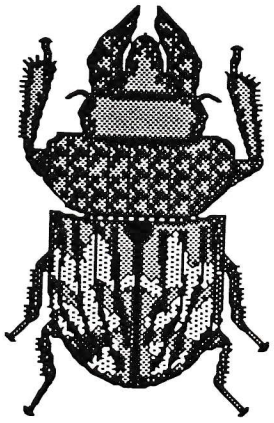
Chart 1A — Insects

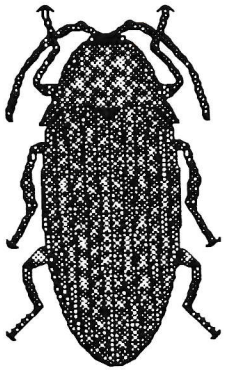


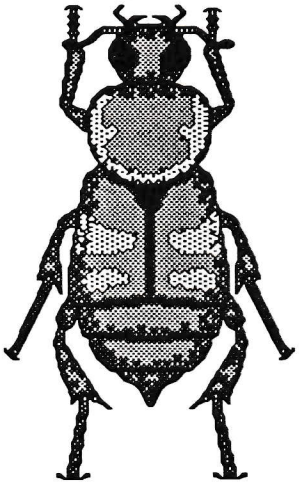


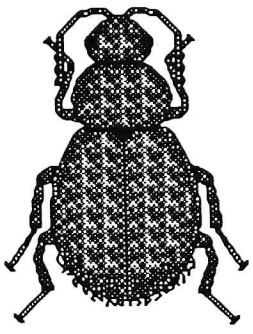






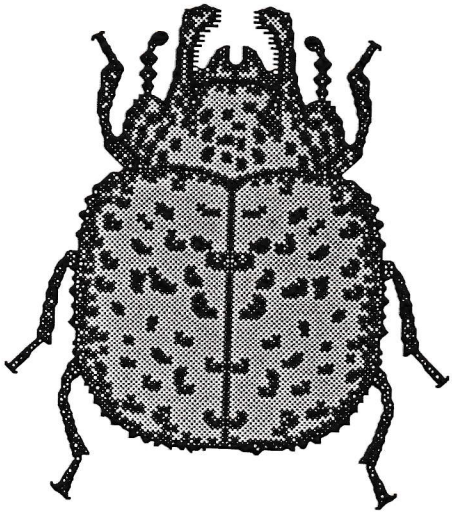


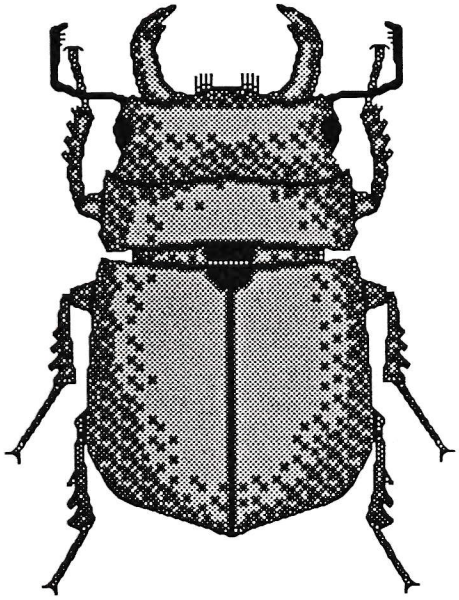


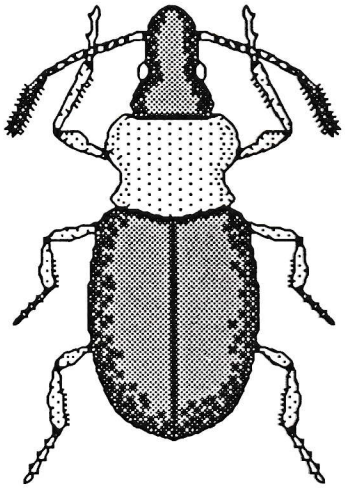


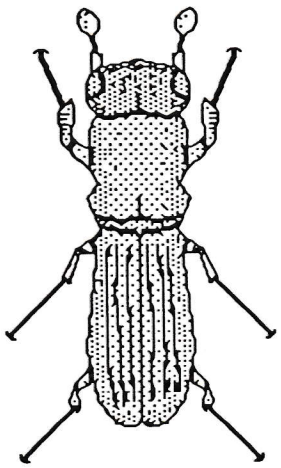
Set I
Activity 1

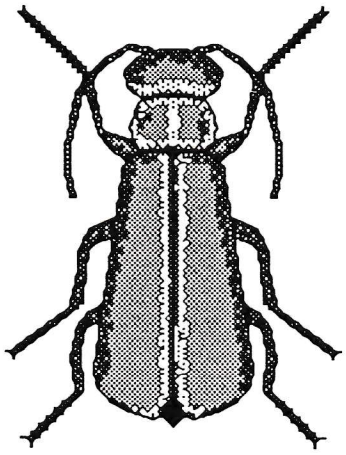
Chart 1A — Insects

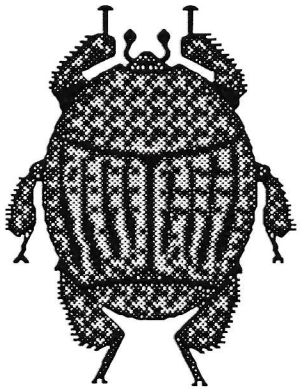


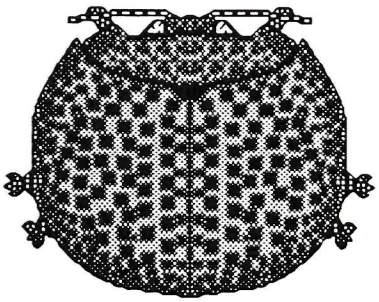












Set I
Activity 2: Adaptation

NAME: _____ 4

DATE : _____

Instructions

1. Make up a name for each organism and each group in Chart 1A. Construct a name that describes some overall quality of the organism or group of organisms.

2. In Table 1A, list the characteristics you used to define each organism and group.
   a. Write the name of the organism or group in the first column.
   b. In the second column, write the characters associated with the particular organism or group.
   c. In the third column, describe how the character(s) allows the organism to be adapted for survival. The way in which the characteristic provides for the organism's adaptation for survival may relate to some of the possibilities listed below:

nutrient acquisition
nutrient use and excretion
air acquisition
gaseous exchange
reproductive behavior
reproductive processes
trophic level (carnivore, herbivore, etc.)
niches (specific function in an ecosystem or habitat)
water acquisition
water regulation
locomotion
protective behavior
homeostasis
habitat

Table 1

NAME OF GROUP OR ORGANISM	CHARACTER	ADAPTATION
Example: Salamander	Long, flexible tail	Mobility in the water (can escape from predators)

Set I
Activity 3: Adaptation

NAME: _____ 5

DATE : _____

Instructions

Answer the following question using the chart below:

Do some of the organisms or groups have characteristics that are similarly adapted for survival? If so, how are the specific adaptations different? (For example, frogs and salamanders are adapted for mobility in the water. Most frogs have webbed feet; salamanders have long, flexible tails.)

ORGANISMS WITH SIMILARLY ADAPTED FEATURES	SIMILAR FUNCTIONS	DIFFERENCES IN ADAPTATION

Set II
Activity 1: Limiting Factors

NAME: _____ 6

DATE : _____

Instructions

Every organism (species) is adapted for surviving and reproducing in a particular habitat or habitats. Many adaptations are characterized by having certain limitations. For example, a frog has moist, permeable skin. Because of the characteristics of this morphological (anatomical) structure, frogs are limited to living in areas near water and with relatively high humidity. If you put a frog in the middle of the desert, it would not survive for very long. If you were to provide the desert-bound frog with a pool of water, the species certainly would not survive in this habitat since no other frogs would be present for reproduction.

Of course, other factors would come into play in terms of species survival. For example, the coloration of the frog acts as camouflage in its natural habitat (green vegetation). This same coloration would make a frog in the desert an obvious target for predators.

The various characteristics of organisms are adapted to specific habitats. In other words, an organism's survival is limited to a certain range of conditions. Tolerance of ranges of conditions is referred to as "limiting factors." For example, many fishes are limited to specific ranges in salinity, temperature, water current speeds (especially in breeding grounds), dissolved oxygen levels, amount of vegetation, and so forth. Species of fish with narrow ranges of tolerance are less likely to survive changes in habitat than are fishes with wider ranges of tolerance (such factors would be less limiting).

On page 7 is a picture of the spring peeper (tree frog), *Hyla crucifer*, and a short description of some of the characteristics of this organism.

1. In Table 2A, column 1, you are to fill in a selected set of characters that may act as limiting factors.
2. In column 2, describe how each characteristic may function to contribute to the peepers' survival.
3. In column 3, describe how these characteristics may function as limiting factors.
4. After you have filled in the chart, go to Activity 2 and answer each of the questions as completely as possible.

Set II
Activity 1

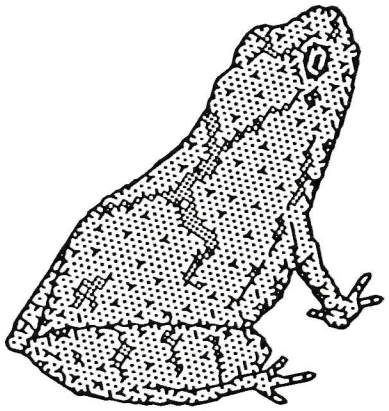
NAME: _____ 7

DATE : _____

Table 2A

Instructions

Consider the following factors when filling out the grid:
habitat, time of activity, nutrients, salinity, temperature, water regulation and acquisition, humidity, conditions for reproduction.



Spring Peeper

CHARACTER	FUNCTION	LIMITING FACTOR
EXAMPLE: moist, permeable skin	absorption of oxygen when under water	humidity when on land, proximity to water

Set II
Activity 2

NAME: _____ 8

DATE : _____

Instructions

For the following questions, be sure to consider the physical characters of the peeper, as well as physiological properties and processes and behavioral characteristics.

1. Describe the peepers' habitat.

2. Describe the climate peepers can tolerate.

3. What do peepers eat? How do they obtain food?

4. How are peepers protected from predators?

5. How do peepers mate and reproduce? What conditions do they need for successful reproduction?

6. What other organisms compete with the peeper? What do they compete for?

Set II
Activity 3: Competition

NAME: _____ 9

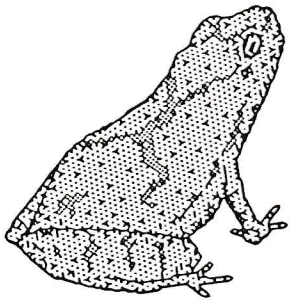
DATE : _____

Instructions

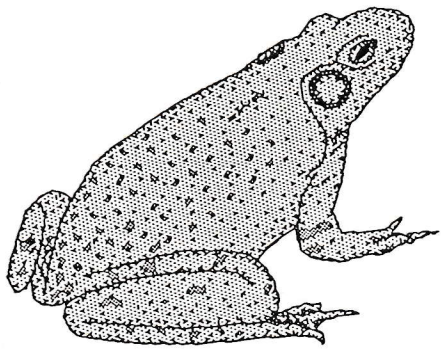
This task is designed to work with the concept of competition. We will look at whether two species of frog, the spring peeper (*Hyla crucifer*) and the bullfrog (*Rana catesbeiana*), compete with each other.

In Table 2B, the first part of the grid supplies certain characters of each species. The second part will ask you to think about how these two frogs may compete with each other.

1. In the first row of Section 2 (labeled "territory"), provide answers for the following questions.
   a. Do the individuals of these two species compete for territory?
   b. If so, describe this competition. Which one has the advantage? If not, describe why they do not compete.
   c. If you decide that these two species occupy the same pond, do they compete for an area to occupy for their normal activitities?
2. In the second row (labeled "food"), answer the following question.
   a. Do the two species compete for the same source of food?
   b. If so, explain which one is likely to have the competitive advantage.
   c. If not, explain why you think they do not compete for the same food.
3. In the third row (labeled "reproduction"), provide answers for the following questions.
   a. Do the two species compete in finding mates? Consider their mating rituals (vocalizations and other possible behaviors).
   b. Do they compete for egg-laying locations?
   c. Do they compete in terms of fertilization of eggs (do they run the risk of fertilizing the wrong eggs)?
   d. Explain why or why not the two species compete reproductively.



Spring peeper



Bull frog

Table 2C

	BULLFROG	SPRING PEEPER
SECTION 1: Characteristics		
coloration	plain green above with gray or brown markings and whitish below	brown, gray, or olive
vocalization	very low pitched series of notes; "jug o' rum"	short, high pitched whistling notes; "peep"; individuals sing in duets or trios
breeding season	in the south: February to October in the north: May to July	in the south: November to March in the north: March to June
range	Nova Scotia to central Florida; west to Wisconsin and Nebraska and south through the Great Plains	Maritime Provinces to northern Florida; west to eastern Manitoba and western Texas
size	3 1/2" to 6" maximum: 8"	3/4" to 1 1/4" maximum: 1 3/8"
feet	nearly fully webbed	about half webbed; legs and toes are long; toes end with adhesive disks
eggs	laid in several large clumps	laid singly on stems and leaves of aquatic plants
SECTION 2: Competition		
territory		
food		
reproduction		

Set II
Activity 4

NAME: _____ 11

DATE : _____

Instructions

1. In Table 2D, the first column, "Organisms," an example pair of organisms that demonstrate competition is provided. Provide your own examples to complete the rest of column 1.
2. With each pair of organisms, describe what they are competing for (could be more than one thing).
3. In column 3, describe the dynamics of the competition and which organism is likely to succeed.

Table 2D

ORGANISMS	COMPETE FOR	DESCRIPTION
lichen moss	substrate (space to grow)	Lichen attached to rock helps accumulate soil; as soil builds up, moss begins to grow and slowly outcompetes lichen for substrate to attach to; more extensive roots of moss physically "drive out" the lichen.
oak trees pine trees		

Set III
Activity 1: Isolating Mechanisms

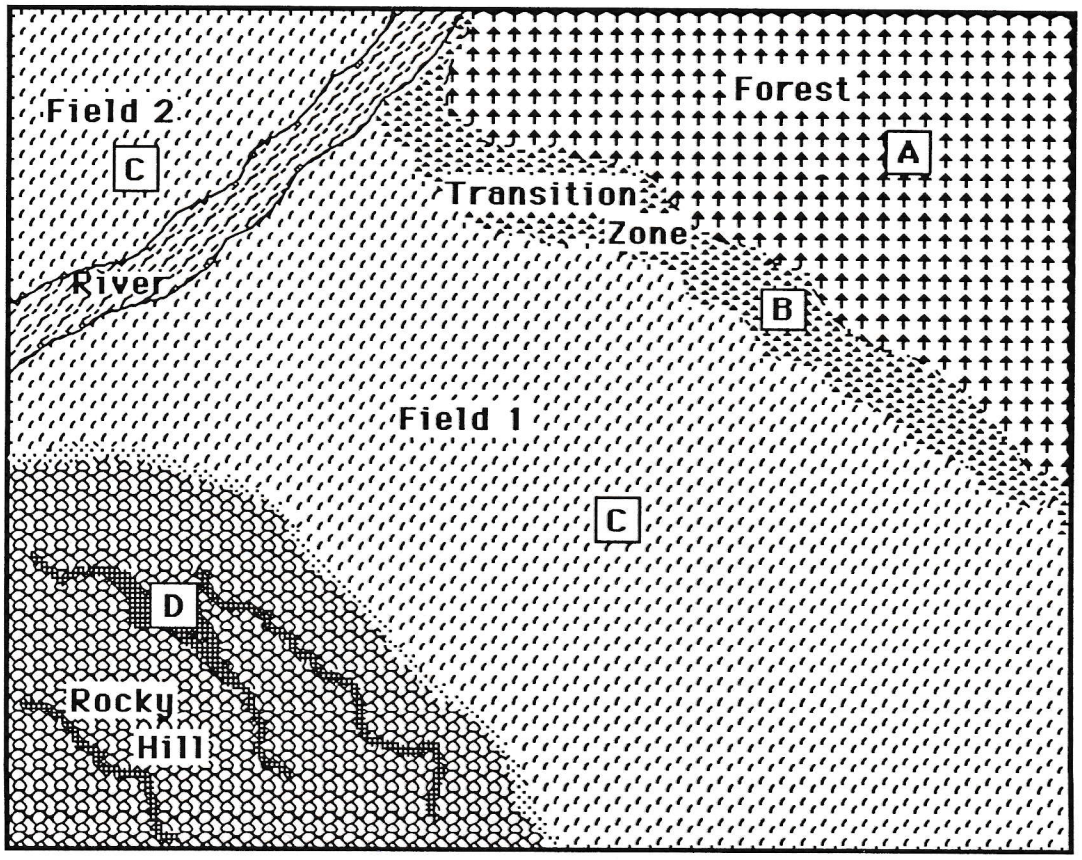
NAME: _____ 12

DATE : _____

Instructions

1. On the map (Chart 3A), four different ecosystems are shown: (1) hardwood forest, (2) open field, (3) transition zone between field and forest, and (4) rocky hill.
2. Although many species of animals live in each ecosystem, you are to consider four species of mice (labeled with letters A through D on the map). A different species is most commonly found in each ecosystem. Individuals of each species may wander into an adjacent area, but not frequently.
3. Most species of living organisms cannot interbreed and produce fertile offspring. However, we will assume that such interbreeding may be possible among these four species.
4. In Table 3A, fill in the second column with "yes" or "no" in response to the question, "Is interbreeding possible?"
5. In the third column, labeled "Why or why not?", discuss your reasons for why interbreeding is possible or not. Also, include a description of how likely it is that interbreeding will occur. (How frequently could the two species be found in the same location at the same time?)

Chart 3A



Set III
Activity 1

NAME: _____ 13

DATE : _____

Table 3A

PAIRS OF SPECIES	INTERBREEDING POSSIBLE?	WHY OR WHY NOT?
A - B	yes	Species A and B live in two areas that are not only adjacent but also somewhat similar. More movement between areas is possible, therefore providing more opportunity for interbreeding.
A - C		
A - D		
B - C		
B - D		
C - D		

Set III
Activity 2: Isolating Mechanisms

NAME: _____ 14

DATE : _____

Instructions

1. You will need to refer to the map (Chart 3A on page 12) for the following activity.
2. Consider the four species (A–D) and their possible interbreeding mixes.
3. Notice on the map that species C is found in fields on both sides of the river. On the map, label the species in the field between the forest and the rocky hill as C1. Label the species on the other side of the river as C2.
4. In Table 3B, enter the letters of species that result from breeding. Include both breeding within a species and between species.

Table 3B

SPECIES	A	B	C1	C2	D
A	A				
B	AB				
C1					
C2					
D					

Set III
Activity 3

NAME: _____ 15

DATE : _____

Instructions

1. From Table 3B, enter the letters of species that do NOT interbreed in column 1 of Table 3C.
2. In column 2, enter a description of the isolating mechanism that prevents the interbreeding.

Table 3C

SPECIES THAT DO NOT INTERBREED	DESCRIPTION OF ISOLATING MECHANISMS

Set III
Activity 4

NAME: _____ 16

DATE : _____

Instructions

1. Refer to the map (Chart 3A) and Tables 3B and 3C as you work through Table 3D.
2. Consider the following ecological change to the area shown in the map (Chart 3A). Over approximately 100 years, the field between the forest and the rocky hill is overgrown by the forest. The result is that only the rocky hill, a transition zone, and the forest remain on that side of the river. The open field on the other side of the river is still intact.
3. In Table 3D, enter the letters of the species that can conceivably breed (in the same way as in Table 3B).
4. If a species can no longer survive (since its habitat has disappeared) put an "X" in the appropriate square.
5. Extra columns and rows have been supplied in Table 3D. Be sure to enter the new species that resulted from interbreeding, as you indicated in Table 3B.

Table 3D

SPECIES	A	B	C1	C2	D				
A	A								
B	AB								
C1									
C2									
D									

Set III
Activity 5

NAME: _____ 17

DATE : _____

Instructions

Consider all of the material so far in this Activity Set to answer each of the following questions.

1. What species were not able to survive the change in habitat? Describe the factors that prevented their survival.

2. What one species remained the same and had little or no probability of interbreeding? What isolating mechanism(s) was (were) responsible for maintaining this species' characteristics? Explain.

3. What different kind of change in habitat could isolate one of the new species so that this species would remain unchanged over a long period of time?

NAME: _____ 18

DATE : _____

Instructions

1. Although interbreeding, in reality, rarely occurs, what other isolating mechanisms could have prevented new species from arising?
2. Isolating mechanisms have been divided into two categories: (1) pre-mating and (2) post-mating. Consider each of the following isolating mechanisms:

Pre-mating	**Post-mating**
Seasonal	Gamete mortality
Habitat	Zygote mortality
Behavioral	Hybrid inviability
Mechanical	Hybrid sterility

3. Describe how three of the new species you came up with would not have arisen. Use as many of the isolating mechanisms listed above as you can. Provide specific examples of how these mechanisms work.

Table 3E

NEW SPECIES	ISOLATING MECHANISM(S)	DESCRIPTION AND EXAMPLES

Set IV
Activity 1

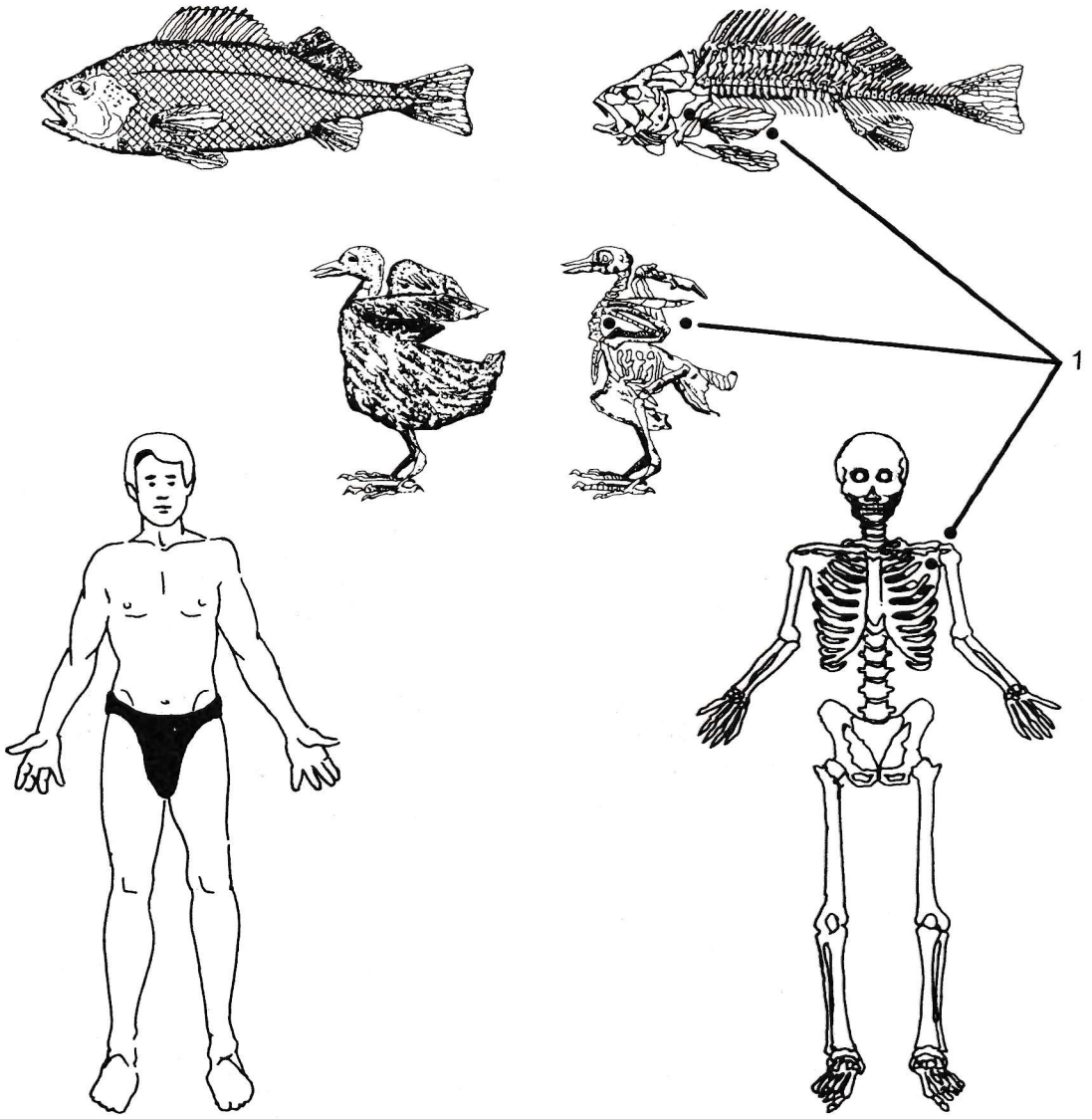
NAME: _____ 19

DATE : _____

Instructions

1. Look at the drawings of the animals and their skeletons below. Try to find six similar features in each of the animals.
2. Draw a line from each drawing in Chart 4A and label similar features with the same number (as shown in the example).
3. In Table 4A, enter the label number of the feature and a name or description of the feature.
4. In the next column of the Table 4A, describe how the function(s) of the features is (are) similar among the three animals.
5. In the last column of Table 4A, describe how the function(s) of the features is (are) different among the three animals.

Chart 4A



Set IV
Activity 1

NAME: _____ 20

DATE : _____

Table 4A

Label number	Name or description of feature	Description of similar function(s)	Description of differing functions
1	pectoral girdle	balance, movement (locomotion)	fish – swimming bird – flying man – object manipulation

Set IV
Activity 2

NAME: _____ 21

DATE : _____

Instructions

1. In the first column of Table 4B, copy the name of each of the features listed in Table 4A.
2. In the first row of each feature (STR), provide a detailed description of the structure of each feature.
3. In the second row (FNC), describe how the function of each structure is specifically adapted for the animal's survival.

Table 4B

FEATURE		FISH	BIRD	MAN
pectoral girdle	STR	small, chunky scapula	long, slender scapula	wide, flat scapula
	FNC	limited forward & backward movement	up/down, to/from body movement	free swinging rotational movement
	STR			
	FNC			
	STR			
	FNC			
	STR			
	FNC			
	STR			
	FNC			
	STR			
	FNC			

Set IV
Activity 3

NAME: _____ 22

DATE : _____

Instructions

1. Enter the features from the previous tables in the first row of Table 4C.
2. Which of the organisms listed in Table 4C have features with similar structures (analogous structures)? Place a plus sign (+) followed by a number (indicating each group of similar structures) in the appropriate box.
3. Which of the organisms listed in Table 4C have features that are not structurally similar, but have similar functions (homologous structures)? Place a circle (o) followed by a number (indicating each group of similar homologous structures) in the appropriate box.

Table 4C

	1	2	3	4	5	6
FEATURES	pectoral girdle					
fish	+1					
bird	+1					
man	+1					
frog						
lizard						
octopus						
crab						
earthworm						
cockroach						
oak tree						

Answer each of the following questions.

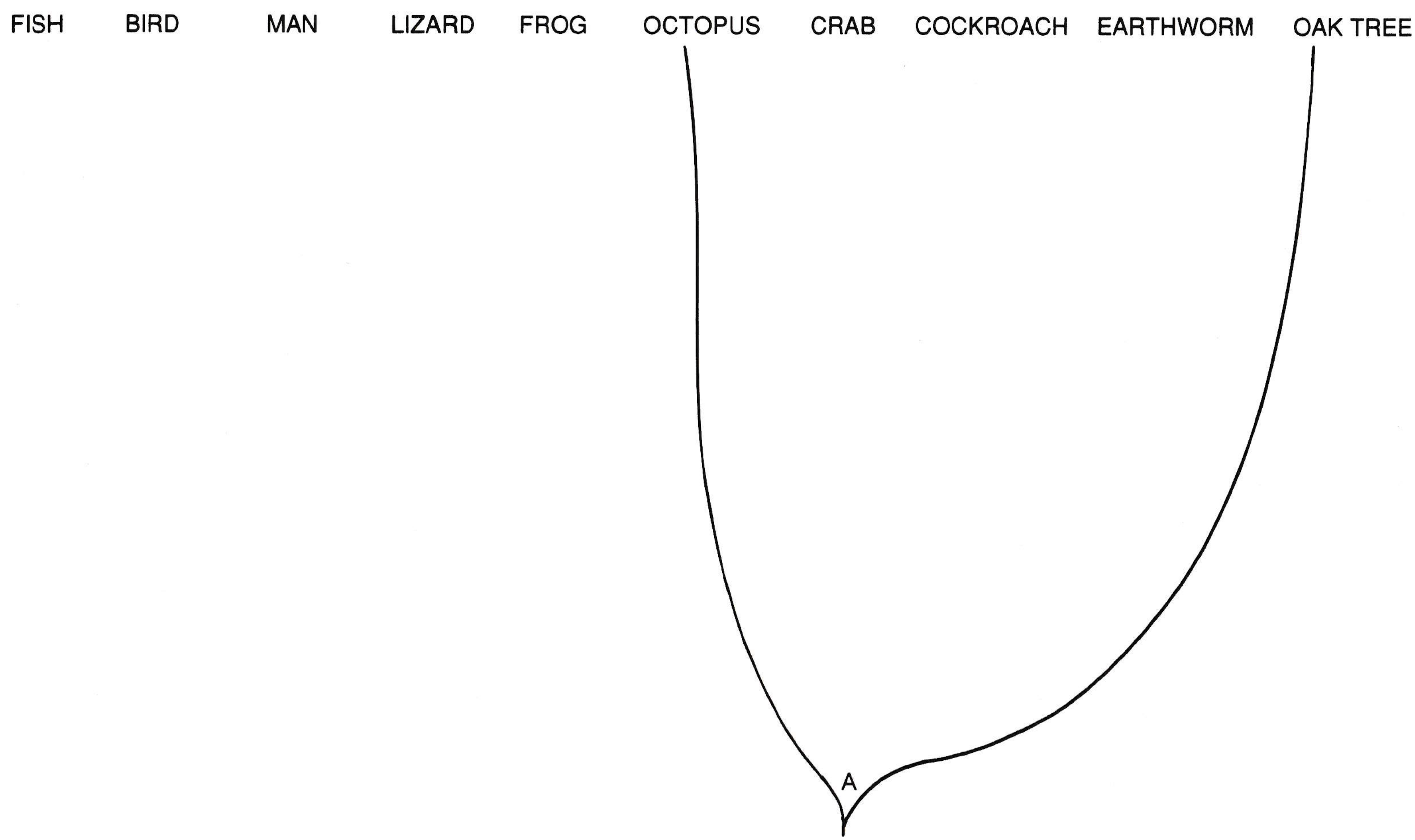
What reasons can you think of for the existence of similar analogous structures among such different organisms?

What reasons can you think of for the existence of similar homologous structures among such different organisms?

Instructions

1. Consider the information in Tables 4A–4C.
2. According to the number and nature of the similarities of features, construct a "tree" that shows how each of the organisms could be grouped (Chart 4B).
3. The point at which a branch occurs should indicate when in evolutionary time the divergence of the animal group occurred.
4. Label each divergence with letter (B–I).

Chart 4B



Set IV
Activity 4

NAME: _____ 24

DATE : _____

Table 4D

Instructions

Provide an explanation of your reasons for each divergent branch from Activity 4 in the space provided.

DIVERGENCE	EXPLANATION OF REASON
A	Animals diverged from plants very early in evolutionary time.
B	
C	
D	
E	
F	
G	
H	
I	

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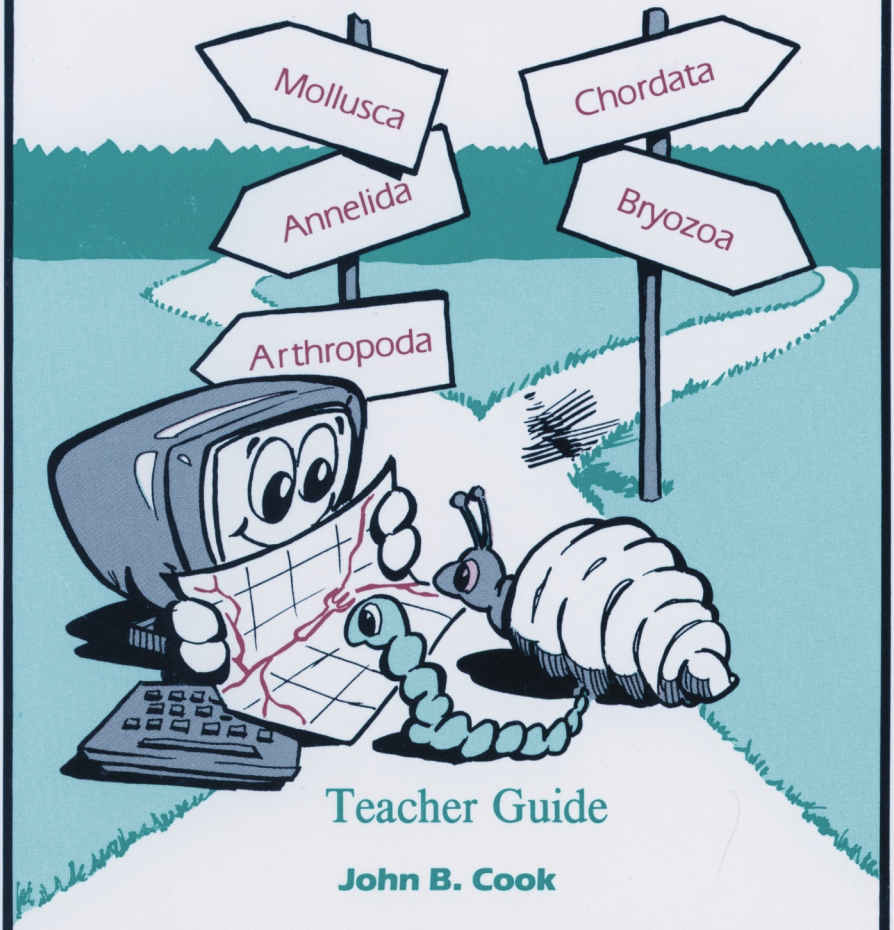

Teacher Guide

John B. Cook

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