CALVIN AND HOBBES

CAN I USE THE GARDEN SHOVEL?

WHAT DO YOU WANT IT FOR?

HOBBES AND I ARE GOING ON AN ARCHAEOLOGICAL EXPEDITION.

IF YOU'RE LOOKING FOR FOSSILIZED REMAINS, YOU SHOULD DIG THROUGH YOUR ROOM.

HA HA. SOMEDAY I'LL NAME AN AUSTRALOPITHECUS WOMAN AFTER YOU.

I'VE BEEN READING UP ON PALEONTOLOGY. IT'S AMAZING STUFF.

SCIENTISTS CAN TELL HOW OLD SOMETHING IS JUST BY ANALYZING THE LAYERS OF DIRT IT'S IN.

HEY!

WHY, YOU MUST BE SIX YEARS OLD.

OH, YOU'RE A SCREAM.

ARCHAEOLOGISTS DIG SLOWLY AND CAREFULLY, USING SMALL, DELICATE TOOLS.

EACH ROCK HAS TO BE PAINSTAKINGLY BRUSHED AND SCRAPE SO NOTHING IS BROKEN OR MISSED.

DIG DIG SCRAPE BRUSH

ARCHAEOLOGISTS HAVE THE MOST MIND-NUMBING JOB ON THE PLANET.

I DON'T THINK YOUR DAD WILL WANT TO SUE ME WITH THIS TOMORROW.
Hey, look! I hit something! Don't break it! Dig carefully!

Gosh, what do you suppose it is?

Dust it off so we can see.

It's some bizarre skull! Look at its mouth. Maybe it's a prehistoric anteater.

Wow! I can't believe we found a dinosaur skull on our very first archaeological dig!

It's completely intact, too! What a discovery!

Maybe the rest of the skeleton is nearby!

Yeah! If we can find the whole thing, we'll be world famous!

With the grant money we'll get, we can buy a Porsche!

How will this look on the cover of National Geographic?

I found another bone! I found another bone!

Boy, this is a weird one. What is it?

It could be a forearm and fingers.

I can't wait to see what the complete Calvinosaur looks like.

I didn't know bones came in decorative colors, did you?
Gosh, look at all the dinosaur bones we discovered.

Let's glue them together so we can see how they fit. Then you can draw a reconstruction of the actual dinosaur.

After that, we'll write up our findings, and get them published in a scientific journal.

Then we'll win the Nobel Prize, get rich, and go on talk shows.

What about Babes? When do we get those?

Well, here's the complete skeleton as near as I can figure out.

Try to draw the dinosaur as it really looked with muscles and skin.

Right.

What's it doing? Whistling? You tell me. Maybe it's puckering up.

See the dinosaur skeleton we discovered and assembled?

I'm going to call the Natural History Museum and tell them they can have it for ten billion dollars.

Those are...um...peculiar bones.

Do you think I should ask for more money?

That's not quite what I meant.

Mom says she doesn't think we've found a skeleton at all.

She says we just dug up some trash somebody littered.

Our dinosaur is a fraud.

I guess it wouldn't be right to sell it to a museum then.

Not at full price, anyway.
PROCESSES OF SCIENCE INQUIRY

Observing
see & hear & taste & smell & touch

Communicating
We can show patterns by....

Measuring

Classifying
The properties are...

Inferring
It looks like water...

Defining Operationally
A pendulum is...
The variables are...

Predicting
I think...

Investigating

Making Models
The model is like a real...

State the question
Hypothesize
Design investigation
Collect data
Report data
Compare results
Come to conclusion

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OBSERVING

We observe when we use one or more of our senses to find out about objects, events, or living things. An observation is a fact learned directly through the senses.

Sight
Touch
Smell
Taste

I can use instruments to make more detailed observations.
- magnifier
- satellite
- telescope
- stethoscope
- microscope

How do I make accurate observations?

1. Use as many senses as you can when you observe. Never taste unless you are told to taste something.

2. Think about how you can use your senses to obtain information about an object or event. Pick up an object, feel it, smell it.

3. Describe only what you observe directly with your senses.

4. Notice things that are changing. Include observations before, during and after the change.
We communicate when we give or receive information. Precise language is needed for describing an observation, reporting a measurement or interpreting data.

How do I communicate?

1. Observe, then describe enough properties of an object or event so someone can identify it.
2. Describe changes in the properties of an object or event.
3. Describe and order changes in the properties of an object or event.
4. Use diagrams, charts, graphs, writing, speaking, visuals, and photos to communicate.
MEASURING

We measure when we compare something to standard or nonstandard units. The basic units for measuring are length, mass and time. All units come from these three.

Direct Measurements:
- Temperature: measure the length of a column of alcohol.
- Force: measure the length of a stretched spring.
- Area: measure the length and width and find the product. \( \text{length} \times \text{width} = \text{area} \)

Derived Measurements:
- Volume: measure length, width and height and find the product. \( \text{length} \times \text{width} \times \text{height} = \text{volume} \)
- Speed: divide distance by time. \( \frac{\text{distance}}{\text{time}} = \text{speed} \)
- Density: divide mass by volume. \( \frac{\text{mass}}{\text{volume}} = \text{density} \)

How do I measure?

1. Estimate the measurement.
2. Compare to standard or nonstandard units.
3. Be as accurate as possible.
4. Calculate for derived measurements.
CLASSIFYING

We classify when we use observations to group objects or events according to similarities and differences. Classification schemes can be one-two- or multistage.

How are these alike and different?
size
luster
mass
shape
chemistry

How do I classify?

1. Observe a set of objects or events. Think about their properties.

2. Divide the set into 2 or more groups based on one observable property.

3. Divide the group(s) on the basis of a second observable property.

4. Continue to divide the groups on the basis of observable properties.

5. Put the properties used into an outline or diagram.
INFERRING

We infer when we use our past experiences to draw conclusions and make explanations about events not directly observed.

Inferences are based on observations.

An observation is a personal experience obtained through one or more of the senses.

I can make more than one inference to explain an observation.

How do I infer?

1. Make an observation of an object or event.
2. Use your past experiences. Think of several inferences.
3. Decide what new observations would support those inferences.
4. Make new observations to determine if each of the inferences is an acceptable explanation.
DEFINING OPERATIONALLY

We define operationally when we write a definition of an object or event based on our experiences with it. It is a doing definition.

An operational definition describes how to measure a variable.

A pendulum is ....

It states what operation will be performed and what observations will be made.

How do I write an operational definition?

1. Observe an object or event. Test or investigate.
2. Think about those observations.
3. Describe what you can do and what you can observe.
4. Write an definition that communicates what the object does.
Predicting

We predict when we make a forecast about what will happen in the future. Predictions are based on prior knowledge gained through experiences and data that is collected.

How do I make accurate predictions?

1. Make observations and/or measurements. Recall past experiences.
2. Use your knowledge to search for patterns in the data. Make inferences.
3. Make predictions about future events. Use your inferences.
4. Test those predictions to determine validity.
5. After testing, revise predictions if necessary.
MAKING MODELS

We make models when we develop a physical or conceptual representation to explain an idea, object or event. Anything that is not real but is a representation of an actual thing can be called a model.

How do I make a model?

1. Find out about an object or event.
2. Think about what you could do to represent the object or event.
3. Construct the model.
4. Compare your model to the actual object or event. How are they alike? different?
INVESTIGATING

How do I investigate?

1. State the question or problem you are investigating.

2. Write an If…. then…. statement (hypothesis) that tells what you think the answer is to the question or problem.

3. Describe the design of the investigation:
   • the manipulated variable (what you will change and how you will change it)
   • the responding variable (what you will observe/measure)
   • the controlled variable (what you keep the same)

4. Carry out the investigation according to your design.

5. Report the data you collect in a table.

6. Construct a graph to show your data.

7. State the relationship you observed between the variables.

8. Compare your results to your hypothesis.

9. State if your hypothesis was supported or refuted by your investigation.
From the ERIC database

**Students' Responses during Discrepant Event Science Lessons.**

*Appleton, Ken*

**Abstract:** This study explored the cognitive responses of students to science lessons incorporating discrepant events. Three pedagogically different teaching strategies using the same discrepant event were taught to six upper elementary classes, and case studies describing 18 students' cognitive responses during the lessons were constructed from videotapes of the lessons, stimulated recall interviews with the students, and field notes. A common set of cognitive responses were identified for most students for all three teaching strategies. A small number of responses seemed to depend on the student. However, the teaching strategy also seemed to influence the responses used by students, in that some types of responses were encouraged by a particular teaching strategy, and the use of other responses was inhibited by a particular teaching strategy. The significance of the social context in influencing the students' access to information and their progress toward scientific explanation is highlighted. The results provide some indications as to how a more effective teaching strategy might be developed which increases the number and range of cognitive responses used by students. Contains 51 references.

(Author)

**Title:** Students' Responses during Discrepant Event Science Lessons.

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http://SearchERIC.org/ericdb/ED393696.htm
DISCREPANT EVENTS

1. The Disappearing Coin:

This demonstration would be used to introduce the children to the concept of light refraction. Refraction (or bending) occurs when light travels at an angle from one medium to another. The sharper the angle, the more refraction. If the coin is viewed from above, there would be no refraction. But when viewed from the side, the light from the coin must travel through the glass, the water, and the glass again and consequently is bent inwardly creating the illusion that the coin disappears.

Place a coin under a clear glass. One can easily see the coin. Next, pour water slowly into the glass. When viewed from the side, the coin will disappear.
2. Pouring Air:

This activity would be used in conjunction with the study of air and air pressure. The concept is that air is a real substance and it occupies space.

Using two glasses, have the children attempt to pour air from one glass container into another. After they have tried this several times, claiming that it can't be done, place the two glasses, inverted, into a tank of water. Now, tilt one glass so that the air can escape up into the other glass. Observe the air bubbles being transferred from one glass to the other.
3. Make the Water Bend

The concept demonstrated in this experiment is that of static electricity. Some things can gain electrons easily while others tend to lose them easily. Hence, when two different substances are brought close to each other (e.g., by rubbing) the electrons move from one substance to the other.

Have a very thin stream of water run from a faucet. Rub a comb with some wool and hold it close to the stream of water. The water will bend towards the comb. In other words, the negatively charged comb attracts the uncharged stream of water.
4. The Baffling Bottles:

When exploring a unit on sound, this activity may be used to introduce the concept of the greater the mass, the lower the sound; and conversely the smaller the mass, the higher the sound.

Fill one bottle one-half to two-thirds full of water and leave an identical bottle empty. Blow across the mouth of the empty bottle and listen to the sound created. Have the children predict if the sound from the bottle containing the water will be higher or lower. Then blow across that bottle; the sound will be higher. Repeat several times. Next, instead of blowing across the bottles, tap them on the side using a metal spoon. The results are just the opposite, the empty bottle produces the higher sound and the bottle containing the water produces the lower sound. How come? Blowing across the top of the bottle, only the air produces the sound. Both the bottle and their contents produce the sound when striking them on the side.
5. Reverse the Flame:

During an investigation about flight, this demonstration teaches the concept of air currents and the affect that different shapes have upon them.

Place a bottle in front of a lit candle. Then blow air across a bottle towards the flame of the candle. Observe the flame moving away from the air source. Next, place an index card in front of the same lit candle. Now, blow again and observe the flame moves in the opposite direction or towards the air source. This is an example of how shapes can affect drag. When the bottle is used, air goes around it and continues towards the flame, perhaps even putting it out. On the other hand, when using the index card, the air travels around the card and actually turns back, forcing the flame towards the air source.
6. Concept of Number:

The "concept of number" would be used during a unit about the universe and is a devise to encourage children to think about the vastness of space. In this verbal discrepant event, ask the students what is wrong with the following statement? "The Griffith Park Observatory has finally completed a new star atlas that lists all of the stars in the heavens."

Of course there are too many stars to ever all be counted and listed. One might use the old cliche that equates the number of stars with the amount of grains of sand on all the beaches in the world. Children always want to talk about aliens and the concept of life on other planets. Another way to examine the "concept of number" would be in the use of mathematical possibilities. For example, if only one in a million stars had a set of planets, and if only one in a million of those sets of planets had a planet like Earth, then there would still be billions of planets with conditions like ours.
7. The Convection Contradiction:

This verbal discrepant event would be used in a study about weather and climate and explores the concept of air temperature variation. Present this paradox to the class. If air rises when it is heated and descends when it is cooled, why is it colder at the top of a mountain where the warm air goes and warmer at low altitudes where the cold air goes?

![Diagram of mountain range with arrows indicating warm and cold air movement]

First, the sun's energy is turned into heat only when it comes in contact with something that is not transparent. Therefore, the heat from the sun passes through the air without heating it, but does heat the surface of the Earth. Consequently, the land is warm because the sun heats it.

Secondly, air heats as pressure is increased and cools as pressure is decreased. As warm air rises, the pressure decreases, the air expands and cools. By the time the air gets to the stratosphere it becomes extremely cold. Hence, cold air at high altitudes keeps the tops of mountains cold.
8. Invisible Light:

When teaching a unit about light, the concept demonstrated in this activity is that light is invisible as it travels.

First, paint the inside of a shoebox (or similar box) with black paint. Next, cut holes on either end of the box and one on the top of the box as well. Finally, shine a flashlight through the two holes on the ends and have a student look through the hole on the top. The observation is that the beam of light is not visible, even though it is only a few inches away. You may extend this event by lifting the flashlight and your hand up. Now, shine the flashlight at your hand. The source of the light is visible, (the flashlight); and the reflected object is visible, (your hand); but the light beam itself will still be invisible.
9. Mixed-up Tastes

This activity is designed to explore the correlative qualities between the sense of smell and to the sense of taste while developing a unit about nutrition.

First, cut several cubes of apples, pears, potatoes, and onions. Place a toothpick into each cube. Next, have student volunteers close their eyes and pinch their nose tightly shut. Then place one of the cubes on the tongue of the each student volunteer "taster." If the nose is held tightly shut, the student will have great difficulty identifying which cube is being tasted.

For a variation, blindfold the "taster" and place a cube of pear or potato on their tongue, while holding a cube of onion or apple close to their nose. Again, the student should have difficulty identifying what is on their tongue because of the confusion of the senses.
10. Fill the Balloon with an Empty Bottle:

While investigating air pressure, this activity is designed to demonstrate how air molecules expand and rise when heated.

Show the class a large "empty" bottle. Have several students verify there is "nothing" in the bottle. Next, place a small balloon over the opening of the bottle. Ask the class to predict if the balloon can be expanded by using the "empty" bottle. After their predictions, place the bottle into a container of hot water. (Do not disclose to the class that the water in the container is hot). The balloon will begin to stand. Why?

As the air in the bottle heats from being in the hot water, the air begins to rise and consequently, expands the balloon.
Bibliography

Crazy About

CRAYFISH

Using crayfish to teach habitats, adaptations, and inquiry

By Anna Endreney

What breathes and eats in water, dramatically clamps down on students' pencils, carries eggs that hatch to produce many offspring, excites students tremendously, does not die easily and stink up a classroom, and—most importantly—is able to teach students about habitats, adaptations, and inquiry investigations? The answer: crayfish.

Crayfish, also known as crawfish or crawdads, are easy to keep in the classroom, and with patience and luck, your students will observe the complete life cycle of the crayfish. They will also learn about aquatic animals and habitats and get to conduct inquiry experiments about animal behavior. My third-grade students loved learning about and caring for these animals. I encourage you to consider crayfish observations in the classroom for the enriching learning they provide.
Home for Crayfish
Before I brought any crayfish into the classroom, students learned about habitats so they could identify the different elements in a habitat that an animal may need to survive, such as plants, animals, water, air, sunlight, and soil. You can use your social studies curriculum to introduce students to different habitats, such as deserts, mountains, and oceans. Part of our third-grade social studies curriculum involves learning about different natural locations, and we aligned our study of crayfish with a study of rivers. We discussed local rivers, their surrounding culture, and the types of animals and plants in them, which included crayfish.

In addition to this social studies connection, I took the students outside to look at a habitat within a hula hoop. After placing the hula hoop on the ground, students listed all of the plants, animals, rocks, and other various items within the hoop. We discussed which items were living and which were nonliving. The students had interesting debates about this. For example, when one of the students felt that something was living because it moved, another student replied, “But, a cloud moves and it is not living.”

As a class we then came up with additional criteria for living and nonliving. For example, living things “eat” (obtain nutrients in some way) and grow; they also respond to their environment, breathe (or take in oxygen in some manner), excrete, and reproduce.

Once students were comfortable with the idea of habitats, I told students that they would be working in groups and observing crayfish in the classroom. Next, using internet and print resources, each group of students researched crayfish care and then designed a habitat for their crayfish using materials that I supplied—small plastic shoeboxes, rocks, plastic pots, plants (Elodea), and water. Students spent about one hour researching and designing their crayfish habitat and about 30 minutes actually putting it together. When each group’s habitat was complete, I gave them a crayfish to observe.

Addressing Misconceptions
Several misconceptions surfaced in the course of the study. At the beginning of the unit, the students thought of food sources for animals as prepackaged food from the supermarket, not real plant and animal sources. The cat food we fed the crayfish in their artificial habitats reinforced this misconception. Thus, it was important to discuss the food sources that are available to crayfish in their natural habitat, such as fish, insects, and other crayfish, as well as plants. Students read crayfish resources to learn about their behaviors in their natural habitats (see Resources).

Another misconception was that students did not identify “air” as a necessary part of habitats, especially if the habitat was aquatic. To help them understand this, I encouraged students to observe the bubbles in the water and to hypothesize what is in the bubbles and where they come from. Students guessed that the bubbles were related to crayfish breathing, but they weren’t sure what was inside the bubbles. I explained that oxygen is dissolved in water, and crayfish breathe in oxygen and breathe out carbon dioxide, as do animals on land. The carbon dioxide is in the bubbles.

The book resources we used also reinforced this knowledge. By the end of the unit, the students were regularly identifying plants; animals, water, and air as parts of different animal’s habitats.

Structures and Functions
The students observed the crayfish, drew them, and made predictions about the functions of the crayfish’s various structures. With their curiosity now piqued, students returned to their resources to learn the crayfish structure’s names and functions. Soon they were correctly labeling their illustrations of crayfish and using terms appropriately in discussion.

At first, students did not understand that a structure’s design often reflects or suggests its function. Having students describe the function of each structure and then asking questions about how the structure’s shape might help with its function enabled students to connect the two concepts—How does the shape of their claws help them catch prey? How does the shape and structure of their legs help them walk around rocks?

The structure-to-function connection was especially evident to students when describing the female crayfish structures. The female has an egg pore and swimmerets on the bottom of her tail. Students observed that the swimmerets are designed like a basket to hold their eggs close to their body for protection. As one student explained, “the female has more swimmerets; if an egg falls, it would be caught by another one of these swimmerets.”

Students also observed another adaptation—crayfish molting. In order to grow, crayfish need to shed their hard exoskeleton and expose a soft exoskeleton underneath. It took about two days for the exoskeleton to become hard. Students left the exoskeletons in the water because through their research students had learned that crayfish sometimes eat their exoskeleton for extra calcium.

Crayfish Inquiries
As students continued to observe the crayfish, they had lots of questions. What colors do crayfish like? Do crayfish like music? Why do crayfish lift their pincers? After recording students’ questions on a large flip chart, we sorted the questions into categories—testable questions and those that were best answered by other means such as observing the crayfish or researching the work of other scientists (i.e., the library, scientific journals, etc).

Most of the testable questions had to do with behav-
Crayfish concept map.

Assessment Ways

For assessment, I reviewed students’ labeled drawings of crayfish and their habitats. I also evaluated students’ journals and presentations and considered conversations I had with the students.

Students completed concept maps several times throughout the unit (Figure 1). To teach the concept mapping skill, I first explained the “parts” of a concept map, including concepts, linking words, and putting the most important things higher in the concept map. Then, we reviewed a teacher-made concept map together.

As students became comfortable with the process, they did concepts maps on their own, drawing concept maps for different animals of their choice. For example, next to a drawing of an animal and its habitat, students created a concept map including structures (body parts), behaviors, and habitat. Concept maps were graded using the rubric in Figure 2.

Crayfish Kudos

Crayfish are exciting animals that will teach your students about aquatic habitats, animal adaptations, and life cycles. They can be kept in your classroom with

Figure 2.

Rubric for concept map.

Objective

Student identifies that an animal’s behavior has functions that help it live in a particular habitat.

Student identifies that an animal has structures that help it live in a particular habitat.

Student identifies the parts of a habitat that an animal needs to live: food from plants and other animals, water, and air.

3—complex understanding

Student identifies a behavior, connects it to a function, and connects this function to a particular feature of the habitat.

Student identifies a structure, connects it to a function, and connects this function to a particular feature of the habitat.

Student identifies four of the four items.

2—understands but needs more connections

Student connects behavior to function but not to habitat.

Student connects structure to function but not to habitat.

Student identifies two to three of the four items.

1—beginning to understand

Student identifies behavior only.

Student identifies structure only.

Student identifies one of the four items.
Crayfish Care

Crayfish can be obtained from biological supply companies (see Internet Resources). I ordered enough crayfish so that each group of four students could observe their own crayfish. Plan to keep your crayfish for several months, as it may take six weeks or more for eggs to hatch.

When you have completed classroom investigations, do not release crayfish into any bodies of water unless they come from them. They may not be native to your region and could cause harm to a local river. You could keep the crayfish as a classroom pet, thus ensuring opportunities to view the crayfish molt and reproduce. Crayfish live for several years, so you could also continue this project with other classes.

Keeping crayfish in the classroom is relatively easy as long as you have space for two large (10-gallon capacity) plastic boxes, about the size of large kitty litter pans. The containers should be filled with 3–4 cm of water that has sat out for a couple of days in order to remove the chlorine. You can also use distilled water. Crayfish survive at room temperature (65–77°F/18–25°C); however, they are able to tolerate temperatures colder and warmer than this range.

I also brought in shoebox-size plastic containers so that the crayfish could be separated for feeding and observation by groups of students at their desks.

In addition to water, Elodea, a common aquatic plant found in pet stores, should be placed in the containers. This provides food and shelter for the crayfish. The crayfish are fed a one square piece of dry cat food daily (about one cm in diameter) when they are in separate containers. It takes them at least 30 minutes to consume this food; do not be concerned if on certain days they do not eat it at all.

I had great success with my crayfish living throughout the unit. All five of the other third-grade teachers in the school also had success and some of their crayfish even reproduced! When this happens, the mother will carry an egg sac close to her body. Eggs will often hatch unexpectedly and a large number of baby crayfish will be in the water. The babies may eat each other, so make sure that there are plenty of places for the babies to hide such as plants, rocks, plastic objects. Instead of cat food, feed them a pinch of ground-up fish flakes.

Crayfish are a safe animal for students to work with as long as they follow safety rules for handling the crayfish (from behind on the carapace, or shell) so that they don’t get pinched. Students should wash hands before and after handling crayfish. Not all children will feel comfortable handling the crayfish. If a child does not want to handle the crayfish, he or she will be able to complete meaningful observations without touching the crayfish. They can also observe while other children hold the crayfish.

Finally, it is also important that you talk with the students about respecting animal life in the classroom before the unit begins. A teacher could do this by having the students help define “respect.” This could include examples such as do not touch the crayfish except to hold and observe, do not poke the crayfish, do not yell and scream around the crayfish, do not put unapproved things into the crayfish water. My students never had a problem following these rules, probably because this is an activity in which they were all eager to participate.

Anna Endrey (endreyn1@esf.edu) is a project staff associate at State University of New York—Environmental Science and Forestry, in Syracuse, New York. She would like to thank Kelly Neuberger, a third-grade teacher in Readington Township, New Jersey, for sharing her ideas on teaching this unit.

Resources


Internet
Carolina Biological Supply
www.carolina.com
FOSSWeb: Crayfish
http://lhsfoss.org/fossweb/teachers/materials/plantanimal/crayfish.html
International Association of Astacology
http://147.72.68.29/crayfish/IAA

Connecting to the Standards
This article relates to the following National Science Education Standards (NRC 1996):

Content Standards
Grades K–4
Standard A: Science as Inquiry
• Abilities necessary to do scientific inquiry
Standard C: Life Science
• The characteristics of organisms
  • Life cycles of organisms
  • Organisms and environments

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# WEATHER

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O wind, that sighs so loud a song!
O wind, a-blowing all day long,
—Like ladies' skirts across the grass,
And all around I heard you pass,
And blow the birds about the sky,
I saw you toss the kites on high.

O wind, that are so strong and cold,
O wind, a-blowing all day long,
—No just a stronger child than me?
Are you a beast of field and tree?
O blower, are you young or old?
O wind, that sighs so loud a song!
Evaporation

Precipitation

Collection

Condensation