Life History of a Tree

N°. 44

INTERMEDIATE

Science

LESSON SUMMARY

Students will interpret the life history of a tree and to understand some of the factors that affect tree growth by examining tree cross-sections.

FORESTS ONTARIO

Focus on Forests

Activity Information

Grade Level:	Intermediate
Estimated Duration:	1 to 2 hours
Materials:	Tree discs (illustrations or real discs), ruler, sandpaper, pencil, hand lens, sheet of white paper, copies of activity sheet (one per student)
Setting:	Indoors
Key Vocabulary:	Cambium, springwood, summerwood, annual ring, heartwood, sapwood, inner bark, outer bark, phloem, tree disc, dendrochronology, increment borer, extractor

Background Information

An old tree can tell you what the weather was like in the spring of 1904 and how big it was when your grandparents were children. It can even tell you about forest fires or outbreaks of forest pests that occurred during its life. It can do this because each tree carries inside it a detailed history of its growth.

A tree grows in girth each year by building up a new layer of wood from a thin layer of cells called the cambium. The cambium is located just beneath the bark (see illustration). Each spring, the cells of the cambium divide rapidly and produce a layer of large, thin-walled cells that make up the springwood. As the year progresses, the cells divide and grow more slowly, and the wood tissue produced over the summer is made up of smaller, thicker-walled, tightly packed cells. These form the summerwood. By early winter, cell growth stops altogether. When growth resumes the next spring, a clear boundary line separates the old and new growth. The springwood and summerwood together, sandwiched between boundary lines, represent one year's growth, or an annual ring.

A look at the cross-section of a mature tree trunk reveals not only the annual rings, but five different layers between the centre and the outside. The centre of the trunk, called the heartwood, is made up of the older, inactive cells that give the trunk its strength. Surrounding the heartwood is a band of younger cells that make up the sapwood. It is through these tissues that water is conducted from the roots up the trunk to the branches and leaves. As the older sapwood cells die and become part of the heartwood, more sapwood is produced by the cambium - the thin layer that surrounds it.

Besides producing sapwood cells to the inside, the cambium also gives rise to the layer around it, called the inner bark. This region is made up of phloem cells, which carry food made in the leaves to the rest of the living tissue in the tree. The layer around the outside of the trunk is the outer bark. This protective layer is made up of old phloem tissue from the inner bark. As the tree trunk expands, the outer bark splits and cracks, but is constantly replaced by more tissue pushed out from the inner bark.

The annual rings and the different layers can be clearly seen in a cross-section of the trunk or stump after a tree is cut down. A slice of wood taken from across the trunk of a tree is called a tree disc. The study of tree rings in order to learn about the past history of the tree is called dendrochronology (from the Greek words dendros meaning tree and chronos meaning time). The number of rings tells us the age of the tree. The thickness of the rings tells us how much growth took place in a given season; wider rings mean more growth.

A good dendrochronologist can interpret many stories in the pattern of rings. A series of several narrow rings together, for example, indicates several successive years with little growth. This may have been the result of a severe drought that lowered the water table or an infestation by insect pests or low soil fertility or suppression by shade or crowding from surrounding trees. The actual years in which the poor growth occurred can be discovered simply by counting the number of rings from the outside bark back to the narrow rings. This tells us how many years ago the growth of the narrow rings took place. By looking at weather records for those years or data on level of pest infestations, the poor growth may be correlated with one or the other of these causes. Other changes in ring pattern are caused by fire, which leaves blackened scar tissue. Bending pressure from prevailing winds or a fallen neighbouring tree causes uneven growth, which produces rings that are wider on the side of the tree opposite to the source of pressure. It is not necessary to chop a tree down in order to read its rings. To read the rings of a living tree, foresters take a sample of the trunk using an increment borer. This is a hollow metal tube, sharpened and threaded at one end. The tube is screwed into the tree trunk towards its centre. An extractor, shaped like a long curved metal spoon, is forced down the hollow tube, and a wooden core from the trunk is removed when the extractor is pulled out. The rings can be seen along the length of the cylindrical core.

Growth ring analysis is not only useful for reading the past. It is a valuable tool for monitoring the growth rates of trees and predicting the future size of trees.

Teaching Notes

1. Tree rings are used here to illustrate growth rates and patterns, but can easily be used as a link to other topics. An historical look at forests, for example, can emerge from linking events to the rings of an old tree. Consideration of the grain patterns caused by annual rings can lead to a discussion of the uses of wood in fine furniture. The growth information derived from dendrochronology is a tool used in forest management; signs of growth retardation caused by fire or pests can be used to introduce these topics.
2. If appropriate, use the school woodworking shop to study wood grains and tree cross-sections.

Advance Preparation

1. Tree discs may be obtained from old Christmas trees (a cross-section from near its base), fire logs, or lumber. The clarity of annual rings depends on the species of tree and condition of the wood. Rings should be counted from the centre to the outside, and it is useful to mark each tenth ring with a pencil mark. If rings are indistinct in some parts, a careful estimate may be made. If sufficient samples are not available, you (or your students) may make a rubbing of the ring pattern by placing a sheet of white paper over the wood and lightly rubbing the sheet with the edge (not the point) of a soft lead pencil. If the ring pattern shows up clearly on the rubbing, measurements can be taken from the paper.
2. Make copies of the activity sheet for Activity #5 (one per student).

ACTIVITY #1

1. Introduce the idea that examining tree rings may be looked at as a detective story. Students can find clues to deduce what happened in the past and match deductions to facts researched elsewhere. Distribute the tree discs or tree disc illustrations, and have students examine them closely and then describe the characteristics they see. Students could develop hypotheses for how these characteristics came about or what they may indicate about the tree. Have students design their own charts to list and describe the characteristics of the tree disc and give a possible cause for each characteristic.

2. Discuss the scientific terminology used to describe what they have observed, and introduce some of the background information that explains why the characteristics developed in the manner they did (e.g., what students probably called bark is known as "outer bark"; it is split and cracked as a result of the tree trunk expanding).

3. Then have students use sandpaper to clean the surface of the wood sample and make the rings as clear as possible. Beginning at the centre, have students measure and record the number of rings and the distance of each ring from the centre, using pencil marks to keep track of their count.

4. Discuss the appearance and key characteristics of springwood and summerwood. Note that summerwood appears as the darker lines and is easier to use in ring counting.

5. Have students construct graphs to show their data: plot a growth ring number (or age of tree) on the horizontal axis and distance of ring from centre (or amount of growth) on the vertical axis. Join the points with a smooth line.

6. Discuss some of the following questions:

   - Between what ages was the growth rate of the diameter most rapid?
   - At what age did growth slow down?
   - Are there any signs of unusual growth patterns (e.g., uneven growth, scars, periods of little growth)? If so, how might they be explained?

7. Have students compare their results with each other. In what ways are the results the same? In what ways are they different?

ACTIVITY #2

Discuss with students the recent discovery of the more than 700-year-old eastern white cedar trees along the Niagara Escarpment in southern Ontario. Point out that scientists are excited by the research potential of these trees, which normally live up to only 400 years. It is reported the scientists will study the year-to-year variations in the tree rings to reconstruct past climatic conditions. Ask students to re-examine the tree disc and have them indicate what characteristics might be related to past climatic conditions and then speculate what the climatic conditions might have been and how they affected the tree's growth and development (e.g., very narrow rings indicate that very little growth occurred that year; extremely low temperatures or lack of moisture are two factors that limit tree growth). Assist them by providing further information from the background. If you know where the tree that provided your tree disc grew, see if students can find any climatic data about the area that confirms their observations and speculations. Ask students to consider why scientists are interested in knowing more about climatic changes and their effects on plant life? (It may help them predict how plants will react to the general warming of the planet, or greenhouse effect, that is occurring now as a result of the buildup of carbon dioxide in the atmosphere.) Information gained from studying tree rings may have global environmental implications.

ACTIVITY #3

Ask students how they could determine the age of a tree without cutting it down. Tell how there were once two 4,500-year-old bristlecone pines in California until one was cut down to determine its age. Have students use library and other information resources to write a brief report on the history and development of the various practices of aging trees, including a description of an increment borer in use today.

ACTIVITY #4

Have students draw a hypothetical cross-section of a tree and write an account of its history, indicating significant occurrences (such as fire) and showing the effect (fire scar) on the cross-section. They should include at least three unusual growth patterns, determine the age of the tree and, working from the outside in, mark the rings that grew in years that are significant to the students and his or her family, local community, and/ or the country.

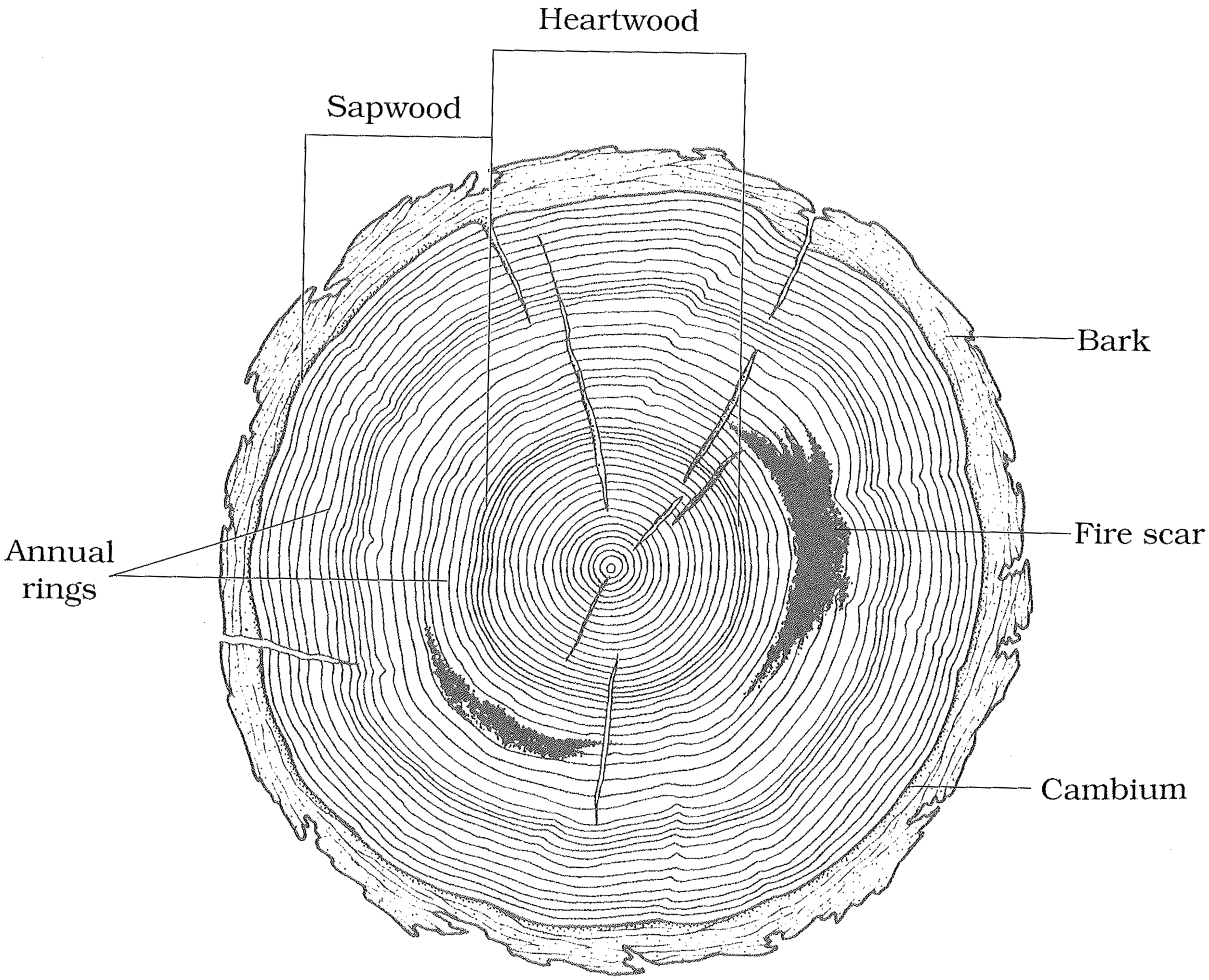
ACTIVITY #5

Distribute copies of the activity sheet (one per student) and assist students in examining the graph and in discussing the questions. Using the sample tree disc, have students write a brief historical account of the life of the tree from germination to maturity, including incidents that had an impact on the tree's growth, such as fire, insects, disease, and drought. The account should include a graph (with a similar set -up as the graph shown on the activity sheet) that supports the account.

Resource

Morrison, G.R. A Forestry Manual Jar Ontario Secondary School Teachers. Willowdale: Ontario Forestry Association, 1983.

Cross-section of a Tree Disc



Tree and Area History