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Reading the Cookie: A Study of Tree Anatomy, Physiology and Wood

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An independent study project report by The Walter W. Root Memorial Endowed Arborist Intern (2012-2013)

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Abstract
This project seeks to educate and inspire wonder in the hearts and minds of the public for the biological practices of 'our tall brothers,' through the display and interpretation of prepared anatomical samples extracted from removed trees at the Arboretum. Included samples were selected for visual appeal, clearness of anatomical features, and illustrative character. Each sample was removed and shaped by a chainsaw. The internal surfaces were brought into focus with a planer and/or belt sander, and finished, if applicable, with shellac. Each sample was selected and prepared to help illustrate concepts about tree anatomy and physiology.

As a whole, these concepts serve as a fundamental basis of knowledge that enables one to 'read the cookie' as it were. By understanding these concepts we can begin to see the internal history of trees; we can know their struggles and understand the forces that shaped them.

As a product, this project is a tool intended for use in various educational scenarios. The samples can be displayed on their own, or used supplementally, for illustrative purposes, for any of our educational or outreach programs. Most likely, only the anatomy samples will be useful with small children, but they are designed for use with children or adults, the depth of discussion can be determined by the instructor accordingly. Several pieces were selected for their small size, enabling them to be handled and passed around easily in the classroom.

To facilitate explanation, the concepts were described in educational PowerPoint slides complete with photos, illustrations, and notes from various sources. Both the slides and the samples could be used together or separately as fits the educational scenario best.

Disciplines
Horticulture

Comments
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Date: **March 7, 2013**

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INTRODUCTION

The Morris Arboretum features wonderful educational infrastructure and programming. The *Out on a Limb* exhibit provides a great macro view of forest ecology and canopy habitat structures, not to mention a totally unique perspective, and our classes and volunteer guides provide students and visitors with a solid base of knowledge about trees: how they grow and evolve, their place in the ecosystem as organisms and as habitat, and what we can do for them to be good stewards. I believe an appropriate addition to our arsenal of instructional materials dealing with trees is something that addresses their internal anatomy and physiology. These subjects are often difficult to illustrate in a way that grabs the viewer's attention, and much of the terminology can be cumbersome. However, as the arborist intern, I am exposed to the internal anatomy of trees frequently, and so I decided to take advantage of this by extracting woody samples to serve an educational purpose.

The idea for this project came from a desire to show people what the internal history of trees looks like, and how to read it. I became interested in the subject myself during pruning and removal operations. There can be so much learned about a tree when one dismantles it.

Accompanying the collection of samples, I've prepared a PowerPoint presentation. The samples and PowerPoint could each be used on their own, or together, as needed by the instructor. The basic intent is that the samples give the students something real that they can hold, look at, and hopefully wonder about, while the PowerPoint can help define as well as expand what they find in the samples. However, I further hope that whoever uses these materials is able to find ways to modify and adapt these samples and slides to serve them better as a learning tool; for I am not a professional educator and I am sure there are elements that I have missed.

RESULTS

A "cookie" is a cross section of a woody stem whose diameter is larger than its length. By examining a cookie, many things about the woody plant's life can be determined: years when it was young and grew fast, years when there was a drought, or a fire, years when it was wounded, by a sapsucker or a buck for instance, or years when it grew slower... Much can be learned, but one needs to know how to look. This project serves as a tool that can help build a fundamental base of knowledge that students can use to read a woody plant's cookie, or other anatomical samples. I believe this educational tool is useful because it provides another way for visitors to learn about trees, a critical part of our natural world. In addition to cookies, I prepared several other types of samples using radial and tangential cross-sections. These cuts help display other features like branch attachment or decay columns.

Anatomy Samples

The prepared samples were selected for visual appeal, clearness of anatomical features, and illustrative character. Some are labeled, but others are intentionally left blank, this way, the instructor can use them in some type of activity in which the students are required to do their own identification of features. They've been cut to a size that should be convenient to store and handle, but still gives enough illustrative character to be useful. When features in the wood needed to be brought out better, the piece was sanded for better definition.

I have experimented with using shellac to finish and help preserve the pieces, but wonder about other finishes like linseed oil or polyurethane (shellac was selected to make the colors "pop," but perhaps linseed oil, which shows off the grain better, or polyurethane, which finishes the wood true to color, could work better). Some pieces or surfaces of pieces were left unfinished in order to show the student the contrast between prepared and unprepared surfaces.

Sanding can be tedious, but I found that the work on smaller samples was carried out easier by turning the belt sander upside down, balancing it against the ground, and bracing it between my knees. This way, I could run the sample against the sander with more control. This is an inherently dangerous activity however, so make sure one is aware of the risks and wears proper PPE (gloves, eye and ear protection, sturdy pants).

Concepts

Whether presented on their own, or integrated into a larger lecture, I have arranged the concepts in a specific order in the PowerPoint presentation. The reasoning for this is that each subsequent concept is meant to further extrapolate a former concept, allowing the student to learn more from the things they already know. For example, most people know something about a tree's annual rings; it is probably the first thing they imagine when they think of a tree's insides. Thus it is the first

concept.

Some concepts are presented in a twofold fashion, such as sapwood and heartwood, because their definitions can be understood as difference, i.e. both sapwood and heartwood are made of the same tissue, xylem, but sapwood is still conductive, while heartwood is not. These concepts of sapwood and heartwood, which themselves are commonly known, function to organize the former concept, annual rings, into two distinct zones. Xylem and phloem, as concepts, divide the concept of annual rings a second time, and introduce two botanical terms. Shigo's theory of C.O.D.I.T. is famous among anyone that works with trees in a professional capacity, but for the average person it is most likely unknown. However, it is connected to the first concept in that the second wall is an annual ring, and the fourth wall is the additional annual ring that is formed when the tree lays down new wood the following spring after wounding.

Some concepts depicted in the slides, like the cellular structure of wood, or the strategies of the different types of wood decay, are most likely too complicated for younger audiences. But these concepts could be explained simply through the use of the anatomical samples, using the activities listed below.

Activities

Because each sample piece can illustrate multiple concepts, it is probably best to review the concepts if they are not already familiar, before going into activities.

Like most things, activities are limited only by imagination.

I am assuming a small group of six to fifteen individuals, ages ranging from four or five years and upwards, with twenty to thirty minutes of activity time. Below, I list a few ideas. The configuration of each assumes a small to medium sized group with a time slot of twenty to thirty minutes, but, through modification this time frame can be reduced or enlarged.

1. Pass out samples of wood rots. Larger pieces can be broken so that everybody has a crumb. Start with brown rots. Have the students write down (if they can write, otherwise they can do it verbally) descriptive terms as they observe and dissect the samples in their hands. Move on to white rots (soft rots won't be included because texturally they are too similar to brown rots) and repeat procedure. Discuss contrasts and then introduce lignin and cellulose, explaining how, because the fungus breaks down components selectively, the rots result in different textures. Finish with a discussion of what might happen when these rots grow in standing trees.

2. Pass out various samples showing scars and stubs. Talk about how a tree might be mechanically injured (do not forget lightning strikes). Ask the students to describe what they think is happening in the samples. If they are on the right track, give them a cookie (woody or otherwise). Facilitate the explanation by pointing out key features if the student seems stuck.

Talk about the differences between scars and stubs, in terms of what patterns of decay these injuries may induce in the tree. Finish with a talk about how a hollow tree forms. Does it start from a stub or a scar? How does it form (get bigger)? What stops it? You could go on to talk about the animals that live in hollows and why they are critical for the ecosystem.

3. Pass out gnarly samples and ask students to guess what caused these injuries. If the wound was older, ask them to find out how old. Get them to calculate how old they were when the wound occurred (if they can). Did any of the wounds occur before a student was born? Next have them look at growth increments. See if they can tell when a tree was growing at its fastest, slowest, are there any rings missing sides? Talk about why a tree grows fast, whether that's good or bad; why a tree grows slowly or not at all, etc. Ask them whether they would rather be a tree that grows slow or fast, giving examples (slow like an oak/ginkgo/beech or fast like a tulip poplar/willow/tree of heaven). Give them a breakdown of the pros and cons of growth rates.

4. Pass out samples that depict compression wood and ask the students what they think caused the rings to form like that. Facilitate with questions that help focus their attention if necessary. Once they have discovered that it is because a stem was leaning as it grew, ask them to show which way the stem was leaning using the sample. Talk about how compression wood forms, and if they know about lignin and cellulose, include that in the explanation. Ask them to identify the year in the stem's life that it began to lean. Have them brainstorm what causes woody stems to lean. Finish with a distinction between tension wood and compression wood.

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