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The Power of Plants: Introducing Ethnobotany & Biophilia into Your Biology Class

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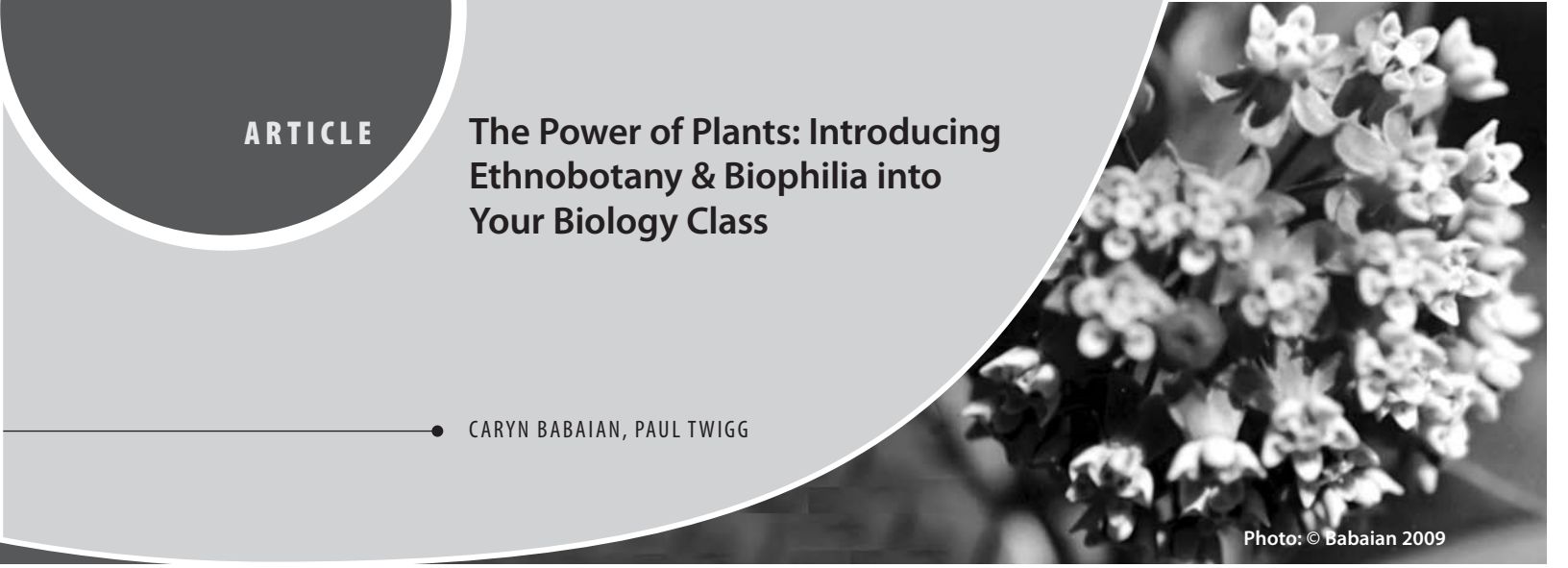

Abstract

We examine the interdisciplinary nature of ethnobotany from a broad perspective and consider its application to the biology classroom and lab. The concept of biophilia and students' relationships with plants are integral components. Botanical nature journaling, discussion of diverse cultural practices, and collection of plants are used to encourage students' interest in local plants. Interwoven with these topics is a plant/microbial lab, which focuses on the local environment and the potential antimicrobial properties of plant parts.

Key Words: *Ethnobotany; biophilia; botanical illustration; cultural practices; interdisciplinary; symbiotic relationships.*

○ Introduction to Ethnobotany

Ethobotanical topics and labs add a unique perspective to the way students view the natural world and living systems. Ethnobotany is the study of relationships between plants and people and of how various cultures use their local plant communities, especially as medicines. Ethnobotany can engage students in multidisciplinary activities that involve human interactions in ecosystems and connect them with their own local plant communities. Ethnobotany can also help develop a student's sensitivity to life. "Biophilia," the concept of innate attraction to living systems developed by Harvard biologist E. O. Wilson, is a powerful tool for engaging students in the life sciences at a deeper, more personal level. Many biology teachers have noted that students do not typically find plants exciting. According to a review of the book *Botany for Everyone*, "Plants are the most important, least understood, most taken for granted of all living things" (Wilkens, 1988). Students can gain an increased sense of biophilia toward plants by engaging in activities like nature journaling that reveal plant complexity and develop "whole brain" thinking toward living systems. Studying plants, their habitats, and interactions through ethnobotanical activities introduces a multitude of interlacing concepts about life.

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In this particular lesson, ethnobotany is used to introduce a laboratory experiment involving the antibacterial properties of "weedy plants." In an integrated art component of the lesson, students keep a botanical journal and use drawing as a tool to investigate structure and reflect on plant relationships. Students should be introduced to the topic of ethnobotany prior to the lab and be given examples through narrative. I have used a really wonderful and comprehensive film entitled "The Story of Bitterroot." Another film, "Earth After People" by National Geographic, offers a shift in perspective regarding the power of plants and our relationship with them; it is an especially significant movie for urban and suburban settings.

○ Plants to Promote Biophilia in the Classroom

Biophilia, as Wilson has posited, is our attraction to, and desire to affiliate with, other living things. Engaging students in this concept in the biology classroom is best achieved by incorporating multiple disciplines. When students take other points of view and experience other ways of knowing, their concept of what biology *is* and *what it can be* changes. In many ways, ethnobotanical practices encourage students to develop "other ways of knowing" and promote the formation of objective as well as personal relationships with nature.

The lesson-plan ideas presented here were developed for a course called "The Art of Science and Nature," in which ecology, culture, and biophilia are the main themes. One focus of the course is common "weedy" species, the kinds of plants that grow around train tracks in fragmented ecosystems like cities and areas of suburban sprawl. Our perceptual challenge is to examine plants as sophisticated chemists that have evolved a cornucopia of compounds because of interactions with other life forms and to examine our cultural biases against plants we don't like, such as dandelions. "Weed" is often a negative and misleading term for a plant that can be a powerful medicinal

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and an integral part of the process of succession (Stepp, 2004). Dispelling the myth of the weed is a step toward biophilia and critical to a true appreciation of the kingdom of plants.

○ Exploring Plant Communities in the Rhizosphere with Students

Before exploring the plant itself, we start with the soil it's anchored in and the interactions around the roots in that "underground universe." It is truly amazing that most of us in the modern world walk the earth and never speculate, consider, or recognize the soil beneath our feet. Dirt is often seen as something undesirable and a place where dead things go, but once students study it, the mystery in the world of soil is revealed. "Rhizosphere interactions are based on complex exchanges that evolve around plant roots…. Root exudates play an active and relatively well-documented role in the regulation of symbiotic and protective interactions with microbes" (Bais et al., 2004). Root and microbe interactions are a communication system in a symbiotic space that can lead to a highly evolved defense response. Some bioactive compounds include ferulic acid, butanoic acid, transcinnamic acid, p-hydroxybenzamide, p-coumaric acid, and vanillic acid. One of our plants of interest that grows locally and is found in both wooded areas and the city is pokeweed (*Phytolacca americana*). This particular plant's roots have been reported to secrete defense proteins, including ribosome-disruptive proteins called RIPs (Park et al., 2002). Dormant life forms, from seeds to insects, await timed signals to germinate and transform in the rhizosphere. Roots carry on sophisticated interactions with bacteria, harnessing and fixing atmospheric nitrogen, active esters, terpenes, and various poisons that produce zones of protection, while mycelial networks create a superhighway of nutrient flow. The rhizosphere is an excellent place for students of both microbiology and biology to study by means of microscopic illustration. Describing the soil as an "underground universe," both visually and verbally, and getting students to see the characters in this dynamic medium sets the stage for discovering why plants have many of the properties they do.

○ Plants as Medicines

Ethnobotany is re-emerging in the modern world as we begin to recognize that growing populations, chemical control of disease-causing organisms, and pharmaceutical drugs negatively affect individual bodies and ecosystems. In fact, most people around the world are dependent on plants for their medicines (Martin & Ernst, 2003). The medicinal qualities of plants have been documented for thousands of years, but students of biology may be unaware of this. Hundreds, perhaps thousands, of plant species are used worldwide in traditional medicine, many to treat bacterial infections through the production of secondary metabolites. In one controlled clinical trial, the Australian tea tree plant (*Melaleuca alternifolia*) was used to treat impetigo skin infections, with positive results (Martin & Ernst, 2003). Tea tree oil can be used as a test product in the classroom or lab. Most students are unaware that common foods like onions, garlic, turmeric, and lemons are used to treat a variety of illnesses and that local plants are often the medicine cabinet in other cultures. Exploring the medicinal properties of plants allows students to see a bigger picture of the role of plants in human life. You may want to include a discussion on noted ethnobotanist Mark Plotkin, who has described many medicinal plants used by indigenous peoples of the Neotropics and has fostered conservation efforts and preservation of indigenous cultures in those areas.

○ Cultural Perspectives

A holistic approach to learning about plants as medicines can be taken through the route of other cultures and the theme of "connectedness to place," which is often a universal concept, embodied by this Australian Aboriginal thought: "The real beauty of the landscape lies in one's belonging to it" (McLuhan, 1994). Cultures from around the world have a rich history of relationships with plants that can broaden a student's perspective. The importance of plants in rituals and in other aspects of life is very visible in everything from the leafy temple columns of ancient Greece to the sacred lotus of a Japanese water garden. Quotations, sayings, and traditional wisdom can furnish insights into scientific study and an introduction to the lesson. An example is this piece of Japanese wisdom: " Stand like a shakuyaky (herbaceous peony), sit like a peony; as you walk, imagine you are a lily" (McLuhan, 1994). Ask your students to write their own poetry regarding their plant encounters and to keep it in their journals. It is from these artistic endeavors that ethnobotany takes its roots. Aboriginal botanists, South American shamans, Chinese herbalists, nomadic Bedouins, and Native American healers can be integrated into the learning experience and appreciated as possessing "ways of knowing" and feeling that inform the ethical values (ecological conscious) that are deeply rooted in various indigenous populations. The wonderful aspect of teaching ethnobotany in the biology classroom is that it includes many different cultural views, emotional and spiritual attachment to plants (biophilia), and comprehensive perspectives on interdependency in ecosystems. The intolerance toward many medicinal and native plants like dandelions make excellent examples for discussions about our own cultural views; why are highly valuable, edible plants often despised, poisoned, even feared?

○ Plants & Bacteria

Once plant root systems and the complex, symbiotic world of the rhizosphere have been examined, the students can take a more focused view of the literature, depending on the grade level and how the instructor wishes to tailor the lesson plan. Many bacteria form intimate associations with plants, and two types of bacteria (photosynthesizing chloroplasts and heterotrophic mitochondria) are inextricable parts of plant cells. Discussions on evolution and on groups of bacteria that have coevolved symbiotically with plants may be of interest. Horizontal gene transfer, shared genes, defensin proteins, and the acquisition of new virulence factors make for interesting discussions on evolution and symbiosis between plants and bacteria. The success of some plants over others may be considered a result of their symbiotic relationships or their secondary allelopathic root exudates. For example, the "novel weapons hypothesis" raises the possibility of an "allelopathic advantage" (Callaway & Ridenour, 2004).

○ Combining Art, Cultural Perspectives, & Local Plant Life

Drawings of plants have been produced since Paleolithic times. Some of the earliest flower drawings and paintings were made for healers looking for medicinal plants. In the 17th century, artists were required to record rare plants as part of their work, and botanical specimen drawing and texts were in high demand by the 18th century. Many herbal manuscripts from Europe, Greece, and Egypt are filled with detailed drawings of plants that were soon to be medicines (Blunt, 1994). The function of the botanical illustrator has remained relatively unchanged, even with the advent of photography.

Drawing is an amazing tool. It literally "draws" us into a relationship with what we are attempting to illustrate and allows us to "stay in

the moment." Drawing increases biophilia by bringing a student to a more intimate level with the plant. Figures 1–5 show a detailed drawing of the plant of interest, some insects in the area, a description of the local spot, and an illustration of a few of the secondary metabolites that give the plant its medicinal properties. As part of their nature journal, students can also write down their collection procedures, paste in photographs, and draw other natural objects that are part of the ecological area they are studying. This journal is an experience in observation and a personal reflection of the relationships students have with "getting to know" plants, as well as an experience in botanical drawing.

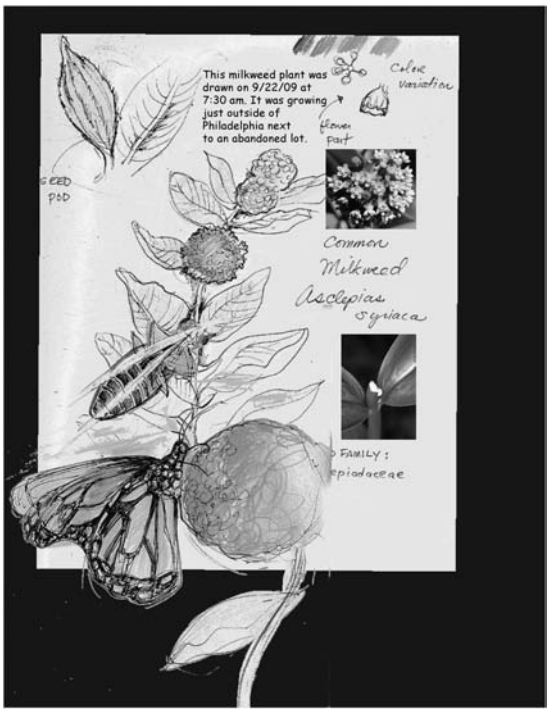

Figure 1. Sample page from an ethnobotanical journal (© Babaian 2009).

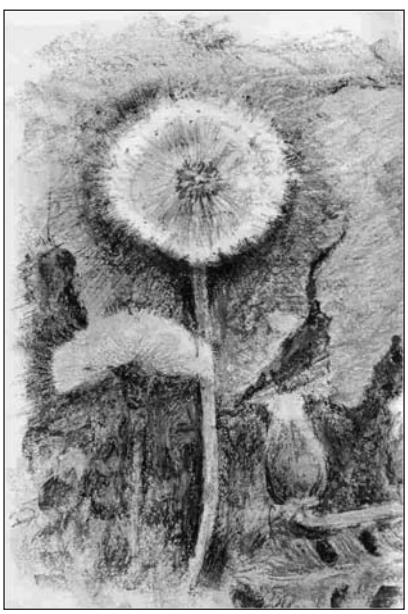

Figure 2. A single dandelion study (© Babaian 2009).

○ Nature Walks & Gathering Plants

For the nature walk, students should wear clothing appropriate for being outdoors and carry Ziploc bags, scissors, scalpels for scraping off bark, and small shears. They will need to take pictures of the area and make notes on the weather, the climate, the season, and the plants growing around their plant of interest. Students may also want to take soil samples back to the lab and bring field guides for identification. If possible, they should make loose sketches or small detailed drawings on the spot in their journals. According to the book *Natural Products from Plants*, it is also appropriate to "thank the plant" after spending time with it and removing your samples. This is in keeping with ethnobotanical practices and biophilia. Students should be appreciative of the experience and leave the area as they found it.

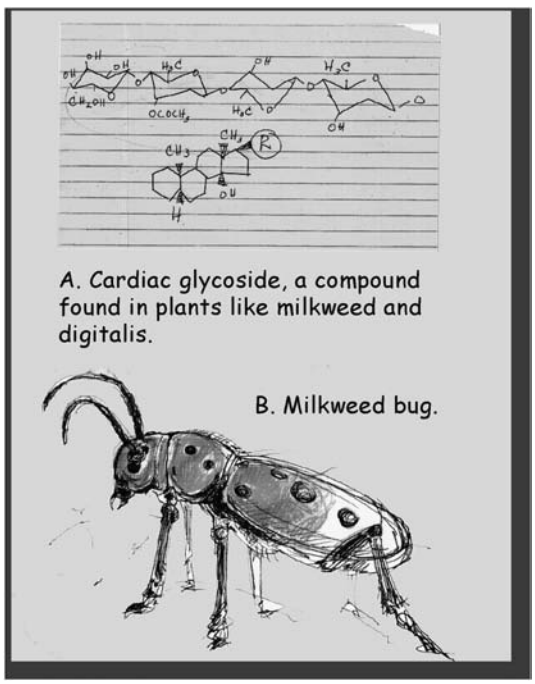

Figure 3. (A) Cardiac glycoside, a compound found in plants like milkweed and digitalis. The top molecule is the sugar portion or Glycone with the "R" group that makes it unique. The lower molecule is the Aglycone portion. The Aglycone is a steroid; together they affect the depolarization of cardiac tissue. **(B)** This is a milkweed bug; they love to hang out in large groups. This one was spotted on 23 September in a very sunny position. It was pretty warm that day – about 75°C. The milkweed plant is an entire ecological community, filled with biodiversity (© Babaian 2009).

Figure 4. Basic shapes in drawing a leaf (© Babaian 2009).

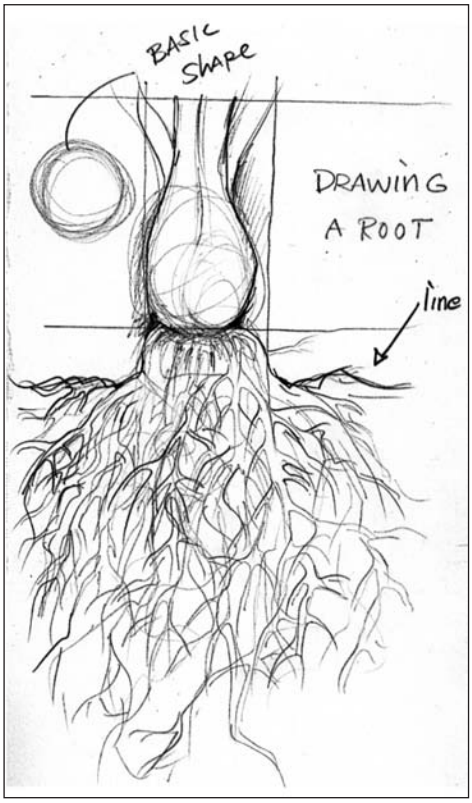

Figure 5. Study of a root (© Babaian 2009).

If the students are going to make chemical extractions as a lab activity, the extraction should immediately follow the nature walk in order to maximize the retention of bioactivity; if this is not possible, the plant parts should be placed in Ziploc bags and frozen immediately. Follow the standard extraction procedures for your plant products with ethanol as the solvent, or perform a simple decoction or infusion, as if making tea. Follow standard microbiology protocol for growth media, plating, incubation, and examining zones of inhibition (see references).

○ Learning Objectives for the Ethnobotanical Lesson Plan & Lab

At the end of this lesson, the students should be able to

- define the concept of *ethnobotany*
- describe various cultural attitudes toward their local plant communities
- develop an intuitive as well as an academic relationship with local plant communities
- list and identify a number of local plants in the surrounding area
- recognize the use of drawing and other art techniques as descriptive tools in the study of living systems
- produce a journal consisting of images, drawings, thoughts, feelings, and data regarding the plant life in the community
- describe the *rhizosphere*
- define *symbiosis* as it relates to plants and microorganisms
- compare and contrast the allopathic system of medicine with herbal medicine
- recognize the importance of bacterial relationships with plants and recognize the dependency of humans on plant communities
- state and describe the concept of *biophilia*
- prepare basic traditional plant collections and extraction methods

○ Conclusion

Students can benefit enormously from an ethnobotanical lesson plan. The benefits include being outside in nature, getting close and personal with plants, staying focused, developing observational and drawing skills, seeing the "big picture," learning about symbiosis, examining the role of bacteria in plant defenses, exploring how other cultures have come to know plants in their healing traditions, and exploring the complexity of plant chemistries. The lesson plan can span an entire month or just 2 days, is relatively inexpensive, and gets students interested in their local environments, whether they be urban, suburban, or rural, encouraging biophilia and a greater sense of connectedness to the planet.

○ Resources for Ethnobotanical Plant Lesson Plan

Looking Glass Films, "The Story of Bitterroot"
The History Channel, "Earth After People"
National Audubon Society Field Guide to North American Wildflowers
The Art of Botanical Illustration: An Illustrated History by Wilfrid Blunt
Urban Wilds (The American Wilderness/Time Life Books)
The Way of the Earth: Encounters with Nature by T. C. McLulan
Biophilia by E. O. Wilson
Naturalist by E. O. Wilson
Earth in Mind by David Orr
The Lost Language of Plants by S. H. Buhner
The Secret Teachings of Plants by S. H. Buhner
Natural Products from Plants, 2nd Ed. by L. J. Cseke et al.

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