

# The Science of Natural Dyes

by Catharine Ellis

**Natural dyes are experiencing a great resurgence of interest in the textile world.** They are considered eco-friendly and nontoxic, fitting nicely into similar trends of repurposing, up-cycling, and local food. We are all becoming more aware of how we as individuals can affect our environment. Yet natural dyeing has also suffered from bad press. In the past, toxic mordants, metallic salts that help bind dye to fiber, were used regularly without any safety precautions. When fugitive dyes (made from non-dye plants) are used, the color fades quickly or disappears completely from textiles—leaving all natural dyes to take the blame.

At first glance, “natural” might seem a simplistic approach to dyeing, but there is a great deal of scientific information involved to process: What is the best mordant to use for protein (wool and silk) or cellulose (cotton and paper)? What are the best natural dyes? Can we print with them? The answers to many of these questions are grounded in science, fact, experimentation, and history.

Before British chemist William Perkins invented chemical dyes in the middle of the 19th century, all textile dyeing was done with organic materials—plants, lichens, or insects. Both artisans and industry had to be skilled in mordant applications and knowledgeable in the choice of dyes. Each plant has specific dye components that determine its shade of color and fastness to light.

Pre-Columbian and 5th century Coptic textiles in museum collections show how these dyes have stood the test of time. Reds made from cochineal insects and yellows from plants, such as weld and fustic, remain vibrant. The indigo of ancient Egypt is still the only natural source of blue dye.

Chemical dyes became available during the industrial revolution; as more cloth was being produced, more dye was needed. The ease of application and unlimited palette made them very appealing to industry, and artisans soon followed. The downside to innovation was worker exposure to harmful chemicals and the pollution of water and ground. This has been the reality for over a century in spite of the development of sophisticated treatments to counteract contamination.

Another price to pay for the use of chemical dyes was knowledge. In cultures where natural-dye information was verbally passed down from one person to another, it took only a generation for skill and information to be lost. Today, people like Charlotte Kwon of Maiwa Textiles in Canada and Michelle Whipplinger of Earth Hues in Seattle have done important work in helping small groups of indigenous artisans around the world to relearn the process of natural dyeing. Recently, Maiwa brought renowned French scientist and natural-dye expert Michel Garcia to West Bengal, India, to teach a natural dye class. I participated with a group of 18 master



*ABOVE: CATHARINE ELLIS's madder-dyed handwoven cloth with madder seeds.*  
*LEFT: CATHARINE ELLIS Deep Roots Detail, jacquard woven shibori, cotton, ferrous and alum mordants, madder dyed.*  
*BELOW: An array of naturally dyed textiles by JAY RICH. Photos by the artists.*



dyers from all over India and Ethiopia. Although very skilled, each of these dyers welcomed the opportunity to learn more about the science of their dye processes and how to troubleshoot solutions.

As a professional educator, weaver, and shibori dyer, I have successfully used acid dyes, fiber reactive dyes, vat dyes, and disperse dyes for many years. But when my dye operation returned to my home studio with a shallow well and a fragile septic system, it was time to try a different approach. Exposure to Garcia's methods and the work of others has opened my eyes to the possibilities of using mordant chemistry and careful dye selection to achieve results that are exciting as well as environmentally sound. My cotton fabrics, all naturally dyed woven shibori, are becoming more complex and rewarding than I ever thought possible.

In recent years, a group of colleagues formed to work with natural dyes—to test, question, brainstorm, experiment, and learn together. Sara Goodman invited a group of eight textile artists (Lisa Grey, Ana Lisa Hedstrom, Joan Morris, Elin Noble, Jay Rich, Valerie Walker, Bhakti Zeik, and me) to a week-long dye retreat in Fall 2011 at her New Hampshire studio. Last year, the group met in Montreal at the studio of Valerie Walker. New works of textile art informed by these collaborations will be on display in the exhibit *Earth Friendly Alchemy: Explorations in Natural Dyeing* during the upcoming SDA Conference in San Antonio, Texas.

Jay Rich's green walnut hull tests produced an encouraging range of greens and browns. "In today's high-expectation fast-results dye world, it slows us down to accept 'what is' from a natural dye pot." He said, "It was reassuring to be with other experimental artists, respectful of the ancient history of dyes, curious about living closer to nature, and simply being open to what happens."

Elin Noble enjoyed the differences in process. "With chemical dyes, I can see the adding and subtracting of color and make decisions accordingly. With natural dyes there is a 'blind' component as I apply mordants first and the dye later. Working with a mixture of experience and chance is fascinating."

For others like Ana Lisa Hedstrom, new

connections resulted in new discoveries. "The use of *Kakishibui* [made from fermented persimmons]," she explained, "is one of the new applications I added to my studio work with the help and research of Chris Conrad [www.kakishibui.com]. As always, I experiment, experiment, experiment!"

"My association with our group of natural dyers led me to explore Michel Garcia's mordanting techniques," added Sara Goodman. "I began my own direct study with Michel in Oaxaca, Mexico, where we worked with plants that were natural bio-accumulators of aluminum for mordanting fibers. Michel and I are now involved in a collaborative project with Threads of Life Foundation to write a recipe booklet for western dyers to use *Symplocos* (a significant bio-accumulator plant from Indonesia) as an alternative to metallic salts. We hope to be importing it in the near future."



Without mordants, most dyes will wash right off the cloth. For printing on fabric, I use mordant applications with aluminum acetate, ferrous (iron) acetate, and titanium. Naturally occurring alum and ferrous are the traditional and least toxic mordants. When converted into acetates, they bind especially well to cellulose plant fibers, which are more difficult to dye than animal protein fibers. Alum results in the truest, brightest color of the dye, while ferrous saddens or mutes it.

Traditionally used in industry, printing with acetates is a relatively new application introduced to contemporary makers in *Natural Dye Workshop with Michel Garcia: Colors of Provence Using Sustainable Methods* (Slow Fiber Studios, 2012), the first in a series of comprehensive DVDs produced by Yoshiko Wada. Titanium, historically used in the tanning industry, is a recent discovery of Garcia's that brings out brilliant yellow tones when combined with tannins. These mordants are often combined to achieve different shades with a single dye bath; they can also be discharged on cloth with lemon juice. My fabrics now have a complexity of color and depth of layers I previously thought could only be accomplished with chemical fiber reactive and vat dye combinations.

Another of Garcia's earth-friendly innovations is an indigo vat reduced with natural fruit waste, henna, or fructose. Maintained for months



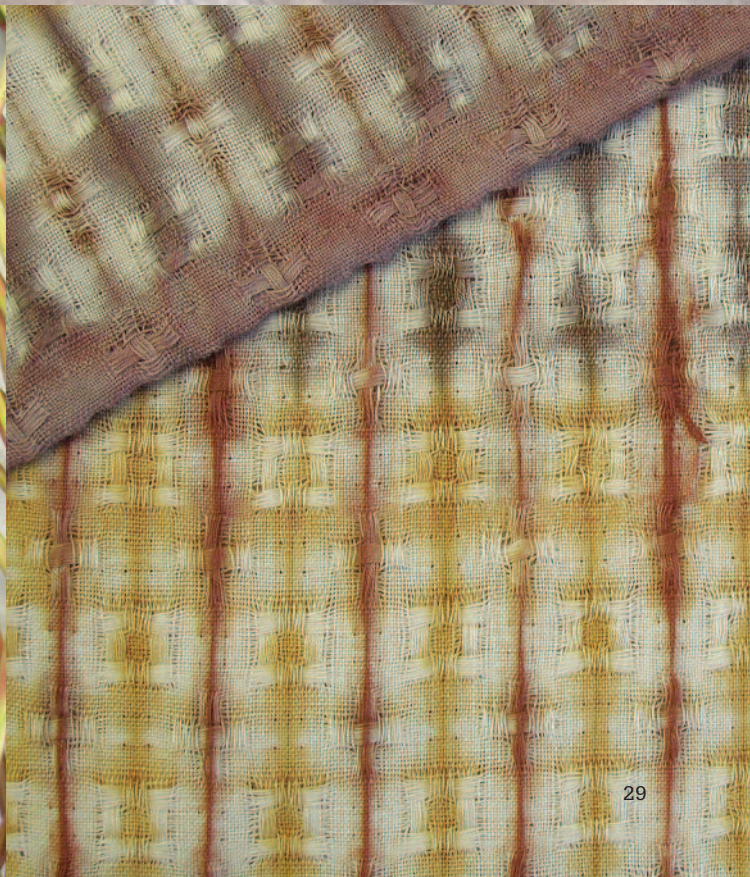
**ABOVE: LISA GREY Leaf print #7** Alum, copper, and iron mordants applied directly to leaves and paper, folded, clamped, bundled, and placed in dye baths of leaves, bark, tea, and vegetable skins, 22" x 15", 2011.

**INSET: ANA LISA HEDSTROM** Paper portfolio covers dyed with *Kakishibui* (fermented persimmon). Photo by the artist.

**BELOW LEFT:** Sumac leaves stripped for dyeing. Photo: Catharine Ellis.

**BELOW RIGHT:** CATHARINE ELLIS Detail of woven shibori cotton fabric dyed with lac and sumac leaves, mordanted with alum, ferrous and titanium. Photo by the artist.

**LEFT:** Natural dyes chemist and expert MICHEL GARCIA presenting mordant printing techniques during the filming of his natural dye workshop DVD. Photo: Catharine Ellis.





*ABOVE:* Morinda-dyed threads with *Symplocos* leaves used in the mordant process. Photo: Sara Goodman.

*BACKGROUND:* *Symplocos* leaves. Photo: Jean Howe.

*RIGHT:* Detail of **SARA GOODMAN's** shibori and printed patterns on silk, naturally dyed with weld, osage, fustic, marigold, chestnut, and cutch; mordanted with *Symplocos*, alum and ferrous acetate. Photo: Sara Goodman.



at a time, the vat is sweet smelling and gives me great color. To gain a better understanding of how all the components work together, I have learned the subtleties of “reading” my vat, knowing when to add lime to adjust the pH or sugar to increase the reduction.

Color can come from nearly any plant, but not all will give a good dye that holds fast to light and washing. Dyestuffs that have been used historically with industrial applications are a good place to start. Cochineal (insects), cutch (bark), madder (root), pomegranate (fruit peels), and weld (plant and seeds) have all passed the test of time and many are being raised today for the dye industry.

I use a number of purchased dye extracts that are sustainably grown in addition to harvesting from my own garden. A bed of madder root provides deep orange reds. Weld planted from seed and dried for year-round dyeing offers the clearest and most lightfast of yellows. Anything remaining in a dyepot is used to water the garden. This is very different than using chemical dyes where it is important to balance pH and treatment of water and waste. It simply feels better to be working this way.

The transition to natural dyes has taken a lot of work and research. Having completed hundreds of dye and mordant tests, I still discover new things in the studio every day. Some elements are out of my control, such as the quality of plant or the time of year it is harvested. As an artist, I choose processes that fit my work. As a teacher, it is important to broaden the scope of my own understanding of what is possible and why it happens.

There is great excitement circulating right now about natural dyes in university textile

programs, in workshop classes, in publications, and exhibitions. Yet it will take study, experimentation, and commitment on the part of textile artists to turn this from a passing interest to a serious change in the field. As we wrestle with permanent solutions to our global environmental challenges, it seems right that this should extend to the artist’s studio. Small groups are coming together to learn process. We are consulting with sympathetic chemists and botanists who help us to understand the science of our process. We need mentors and we need to become mentors—generous with both information and results. It is a dynamic time in the field of natural dyes.

Catharine Ellis will teach natural dye workshops this summer at Penland School of Craft (with Joy Boutrup) in North Carolina, [www.penland.org](http://www.penland.org); and Arrowmont School of Arts and Crafts in Gatlinburg, Tennessee, [www.arrowmont.org](http://www.arrowmont.org).

To read a review of the *Natural Dye Workshop with Michel Garcia* DVDs from Slow Cloth Studios, turn to page 70. To learn more about the *Symplocos* plant, contact Sara Goodman at [sara.goodman@valley.net](mailto:sara.goodman@valley.net).

*Earth Friendly Alchemy: Explorations in Natural Dyeing* will be on display June 1–30, 2013, at the International Center Gallery in San Antonio, TX. Participating artist Ana Lisa Hedstrom will present a lecture on *Kakishibui* during in•ter•face, the 17th International Surface Design Association Conference in San Antonio, TX (June 6–9, 2013). To read the brochure and register online, visit [surfacedesign.org/2013conference](http://surfacedesign.org/2013conference).

—Catharine Ellis is a weaver, dyer, teacher, and author of *Woven Shibori* (2005, *Interweave*). Her jacquard and dobby fabrics, woven at the Oriole Mill in North Carolina, are natural-dyed. [www.ellistextiles.com](http://www.ellistextiles.com)