Mycopigments: Exploring Mushroom and Lichen Dyes

with Alissa Allen

Brief History of Fungal Dye

The use of natural dyes has been traced back 10,000 years or more. These early dyes were derived from various sources including plants, minerals, invertebrates, insects, and lichens. Fungal dyes, however, are surprisingly missing from written, spoken, and archaeological accounts.

In the late 1960s Miriam Rice, an artist and natural dyer, was encouraged by friends to attend a mushroom foray led by Dr. Harry Theirs. Miriam had been using plants to dye wool – and when introduced to the world of fungi, she naturally started to experiment - the results were immediately impressive and led to decades of experimentation, teaching, and inspiring dyers, artists, and mushroom hunters alike.

In the 1970s she met scientific illustrator and natural dyer Dorothy Beebee and together they published *Let's Try Mushrooms for Color*. Over the years her experiments with fungus derived color continued. She led workshops, organized art exhibits, and inspired others who contributed to this newly discovered art. In 1980 she published *Mushrooms for Color*. Later that year, the first International Mushroom Dyes Textiles Show was held in Mendocino, California. This led to the start of the International Fungi and Fiber Symposium which is held every other year in places all over the world.

In 2007 at 90 years of age, Miriam published her last book *Mushrooms for Dyes, Paper, Pigments and Myco-Stix*. This book is the culmination of her work and discoveries utilizing mushroom pigments. It is the most comprehensive mushroom dye and craft book available in the English language. This book is available from Fungi Perfecti.

In 1998 Arlene and Alan Bessette published *A Rainbow Beneath My Feet*. It has wonderful photos and detailed descriptions of dye fungi, the dyeing process, and the much-appreciated list of "dye-duds".

Mushroom dyeing in modern times

Thanks to social media and my efforts as a full-time mushroom dye missionary, mushroom dyeing in North America is experiencing a renaissance. ***Mushroom and Lichen Dyers United,*** an international discussion group I started on Facebook, has reached over 27,000 members – and is full of exciting experimentation and gorgeous dye projects. ***The Mushroom Dyer's Trading Post*** is another group I started; it is a resource for acquiring dye fungi through trade. Mushroom and lichen identification groups and citizen science groups are reaching member numbers in the tens of thousands. These are exciting times for natural crafts and amateur mycology. As interest in mycology surges, it is my hope that we will all work together to try to protect these disappearing habitats from further destruction. When you choose to work with nature's bounty you assume responsibility to protect it as well.

Mushroom and Lichen Dyers Code of Ethics

- Practice ethical harvest by learning all you can about fungal and lichen organisms; their growth and life cycles, morphology and their rarity and abundance. For mushrooms, that means sticking to harvesting fleshy fungi and by being aware of protected habitats. For lichens, only work with abundant species that have become detached from their happy growing place. Many lichens take decades to grow, and their habitats must be protected. Purchasing lichens for dyes supports unethical practices and is best avoided.
- Join a mycological society. Most clubs have nominal dues and the level of experience you gain from walking and talking with seasoned mushroom hunters is well worth every penny. Most mushroom clubs offer identification workshops and hands on learning in the field. Best of all, there are relatively few dyers in these clubs and people will gladly share their bounty with you.

There is still much to learn about mushroom dyeing, from the basic chemistry to the effects of pH modification, to recipe development and more. I hope you too will be inspired by the beautiful range of color and contribute to protecting and developing this fascinating art and science. Best wishes for bold and beautiful color!

Mushroom Dyeing Basics

Using mushrooms to dye wool and silk can be as simple as adding mushrooms, fiber and tap water to a pot and bringing them to a simmer for about an hour. However, taking the time to test wild mushrooms for color potential will save you from wasting time and fiber. There are a few things you should know before you get started, like what you'll need, how to work with fiber and the basic procedure for working with mordants.

You'll also want to know a little bit about mushrooms, like what role they play in the environment, how to process them for dyeing and how to observe, photograph and describe them for identification purposes.

It's important to recognize that fungi are wild and variations in your results are to be expected. There are many contributing factors to the ultimate dye results, including the age and condition of the fungus, the temperature of the dye bath, the type of fiber, the ratio of fungus to fiber and so on. Minimizing these variables will help you achieve more consistent results. Again, testing in advance is the key to minimizing waste, and avoiding disappointing results.

Necessary Supplies

- Mushrooms
- Fiber – Protein based
- A dedicated dye pot
- Fiber wash – pH neutral
- pH modifiers: Ammonia and vinegar
- pH papers 1-14
- Thermometer
- Mordants: Alum and Iron

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About Fiber

Mushroom and lichen dyes work best with protein fibers like wool and silk. Cotton, linen, and hemp are cellulose based fibers and do not take the dye well (or at all in most cases). When working with protein fibers, start by gently washing out lanolin and chemical residues. These substances can repel mordants and dyes. Add a minimal amount of fiber wash to a generous amount of hot water. Gently lift and lower fiber to wash but avoid agitation as fiber may felt. Rinse thoroughly.

About Mordanting

A mordant is a mineral salt (sold as a powder) that is used to bring about color change. Most mushroom dyes are enhanced by mordants, some dyes work best without, and others require mordants to achieve any results at all. Each mushroom species works a little differently, only testing and experience will tell you which mordants work best.

Mordant Recipe:	
Alum (aluminum sulfate) 15% of dry weight of fiber	Iron (ferrous sulfate) - 2% of dry weight of fiber

Alum (aluminum sulfate) and iron (ferrous sulfate) are the most readily available and safest mordants to use. **Alum tends to brighten dye colors,** bringing out reds, oranges, yellows and brighter blues. **Iron tends to darken them**, bringing out greens, dark blues, violets and dark browns. Other mordants sometimes used are copper and tin; both have their issues, either with mild toxicity, regulated disposal, or unimpressive results. Natural dyers have distanced themselves from using chrome as a mordant due to its known toxicity. So, stick with alum and iron to get started.

Alum and iron are easy to use and recommended for most dyeing. There are a few ways to go about mordanting fiber: before, during and after. I prefer to work with pre-mordanted fiber for most fungal dyes; red, orange, blue-green and some purple. Pre-mordanting lends the fiber to more even dye coverage and stronger colors - at least in recipes where mordants are recommended. Note there are many mushrooms that work just fine by adding the mordant directly to the dye pot, this is called **simultaneously mordanting**: yellow, gold and brown dyes work fine this way.

Pre-Mordant Procedure

Hot Method

1. Dissolve measured amount of mineral salt into a pot of simmering water and stir. Use enough water to thoroughly cover your fiber, with ample room for fiber to get exposed to mordant bath.
2. Add wet wool or silk to pot and gently stir for even coverage.
3. Let simmer for 1 hour
4. Remove from water and hang to dry.
5. If you plan to use pre-mordanted fiber in a dye pot with other types of pre-mordanted fiber, wash thoroughly with Synthropol to minimize cross-mordant contamination. For best results, let dry and rewet before use.

Cold Method

1. Dissolve measured amount of mineral salt into a small amount of hot water, stir.
2. Add these dissolved mineral salts to a bucket of water – enough water to thoroughly cover your fiber.
3. Add wet wool or silk to bucket and stir several times throughout a 24 hour time period.
4. After 24 hours, remove from water and hang to dry.
5. If you plan to use pre-mordanted fiber in a dye pot with other types of pre-mordanted fiber, wash thoroughly with Synthropol to minimize cross-mordant contamination. For best results, let dry and rewet before use.

About pH Modifiers and Mushroom Dyes

Some fungi require pH modification to achieve optimal color saturation. Any acid or base can be used, but **vinegar**, citric acid, cream or tarter are the commonly used acids and ammonia and **washing soda** are the commonly used bases. I prefer working with washing soda for mushroom dyes because there is no odor.

Acids are generally added to yellow and orange dye producers as a brightening agent and can be used with or without mordants. The result can be astonishing. There are several dye types that will be destroyed by acidity, so again testing is essential.

Alkaline extraction and pre-mordanting is required for blue-green dye. Care must be used when working with alkaline modifiers as they can destroy the fiber if too concentrated. Aim for a pH of 9-10. When working with alkaline modifiers for blue-green results, it is important to monitor the pH closely and boost if it falls below 9. Watch the colors and pull the wool when desired color is achieved; leaving it in too long can cause the blues to turn brown.

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Testing mushrooms for dye potential

Testing is a simple way to answer some basic questions before wasting time and money on fiber or inadequate dye species. Testing will tell you if a mushroom is worthy of collecting for dye and will guide you to the best method of extraction to get optimal results.

Testing checklist

- A handful of abundant fungi
- A small pot (1 qt)
- 3 labeled jelly jars (pH 4, 7, 9)
- Vinegar, ammonia, water
- 3 pre-mordanted tester bundles
- Notebook for preserving test results

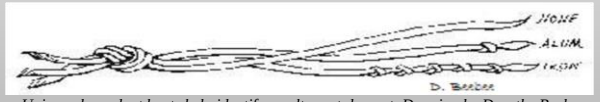
First, you are going to want to spend some time making tester bundles of **premordanted** fiber. You can identify the mordants using the knotting system shown in the illustration by Dorothy Beebee below, or you can make your own system. I prefer to cut my mordant strands at different lengths, long for alum, medium for iron and short for unmordanted.

Gather a handful of abundant fungus to be tested. In a small pan, simmer the fungus in a few cups of water for about an hour. Pour off equal amounts of the dye extract into 3 small jars. Modify one jar with vinegar to pH4, and another with ammonia to pH 9, leave the third jar neutral, with only the dye extract. Place one premordanted tester bundle in each jar and simmer in a water bath for 1 hour. Check alkaline pH as the fiber is simmering, as it tends to neutralize with heat and time.

When your test is done, you will have answered whether the fungus is worthy of collecting, and what mordants and modifiers you need to get the best color. Keep your testers in a notebook with your field notes, and a photo.

Mushroom testing procedure

1. Simmer a handful of mushrooms for one hour.
2. Pour dye extract into 3 labeled jars – eyeball for equal amounts.
3. Modify pH per label (4, 7, 9) using vinegar and ammonia.
4. Add a tester bundle to each jar and return jars to original pot in a water bath (double boiler). Simmer for one hour, dry and evaluate.
5. Store samples in notebook.



Universal mordant knots help identify results post dye-pot. Drawing by Dorothy Beebe

Measuring

First, measure your fungi to wool. I start with 1:1 fungi to fiber ratio when working with dried material. If you are lucky enough to be able to start at 2:1, then do. Your first bath should be nice and strong. You can always dye more fiber in the second and third exhaust baths – or until dye is all used. If working with fresh fungi, start with 2:1 fungi to fiber by volume (not weight). Again, use 3:1 if you have abundance of dye fungi.

Pre-dye soaking

When starting with dry wool, you will need to allow time for a thorough soaking. Soak overnight if time allows. If short on time, just soak in hot water; gently knead the air bubbles out. Soaking dried mushrooms will lead to a more thorough extraction, so again if time allows, weigh and soak them the night before.

Heat and time

Successful dyeing has a couple requirements: heat and time. Both must be present to bring about the chemical bond that happens between fiber and dye – that makes a lasting result rather than a mere stain. Dyeing is best done on the stove; a burner will give you predictable results in a short amount of time. However, in hot climates, solar dyeing is an option. Solar dyeing has not been tested on all species, so your experiments in the arena may be the first. It also comes with some unpredictable variables, including cold or cloudy weather, bacterial effects on pH and odiferous complications.

Stove top dyeing method

Fill pot with enough water to fully submerge the fiber and fungi and bring it up to a simmer. Add fungi contained in a mesh bag and any modifiers, either pH or mordants. Allow mushrooms to extract at 180°f for one hour. The dye will start to strike the fiber as soon as contact is made, so be sure to add all the fiber at once and get it submerged quickly (yet gently, to avoid felting). Once fiber is dyed, allow to cool for rinsing. Rinse in several baths to remove mushroomy odor and residual debris. Again, handle wool gently. Swing excess water out or press between towels, hang to dry. Dilute dyes occur when too much wool is added to the dye bath, or with successive dye baths. Depleting dye baths can lead to some interesting results though, so keep going if you like what you see until pigments are depleted.

Solar dyeing

Solar dyeing is similar in all ways to stove top, except rather than putting the mushrooms, modifiers, and fiber in a pot; you put them in a clear container with a loose-fitting lid. Make sure there is ample room for the fiber to move freely and that the lid is loose in case of pressure build-up. Let fiber steep for at least one week in direct sunlight, or longer if desired. Stir or shake container throughout. I have extracted some of the best colors using solar method, but again, heat and time are essential.

Mushroom dyeing procedure

1. Start with 1-part dried mushroom to 1 part dry fiber by weight, or 2 parts fresh mushrooms to 1 part fiber (by volume).
2. If fungi are dried, soak fiber and fungi separately overnight, otherwise just soak fiber.
3. Heat enough water to cover mushrooms and fiber to 180°f. Add solvents such as ammonia or vinegar if desired (requires testing). Aim for a pH no higher than 10 for an alkaline bath, and 4 for an acidic bath. Simmer fungi and modifiers for an hour.
4. Add soaked fiber to dye bath, simmer for 1 hour; gently stirring for even coverage.
5. Remove from dye bath and let cool. Rinse thoroughly or wash with a few drops of fiber wash to remove mushroom bits and any residual odor. Hang to dry.

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Lichen dyeing basics

Start by looking for common lichens in your area. No need to know their names yet; you can learn them while you discover their dye potential, or while you wait for them to ferment. It is important to practice ethical harvest with lichens. Unlike mushrooms, lichens take years and sometimes decades to grow. For this reason, common **lichens should only be ethically harvested from areas where they have become detached from their growing habitat**. Look for lichens on wind fallen branches after a storm. Never harvest lichens directly from their happy growing place – including gravestones, rocks, fences and trees.

To perform the C-test

1. Scratch away a section of the thin green skin of the lichen (the cortex) to reveal the white inner flesh (the medulla).
2. Place a drop of bleach on the medulla and watch for a blood red reaction. This color may only last for only a few seconds.
3. If you do not get the red flash, the optimal dye color will be best extracted in boiling water.

Boiling Water Test

1. Simmer a handful of lichens in a few cups of water for about an hour.
2. Add a 12" strand of wool or strip of silk.
3. If you get a desirable color, proceed with the recipe in the table (BWM).

Testing lichens for color

Some lichens give a dye by simply simmering them in water with fiber for an hour – this is referred to as the boiling water method of extraction or **BWM** for short. Most lichens fall into this group. Other lichens have the potential and chemistry to make purple or color changing dyes - after a 3 month soak in ammonia. This extraction technique is referred to as the ammonia method or **AM** for short.

Boiling Water Method (BWM)

Dyeing fiber with water extracted lichen dyes is one of the simplest methods for dyeing. No mordants are necessary. Start with abundant lichens, as it takes up to 5 parts lichen to one part fiber to get saturated color with some species. I recommend starting with 2:1lichen to fiber by dry weight.

Boiling Water Method for Extraction

1. Simmer 2 parts lichen to dry weight of fiber.
2. Use enough water to cover lichen and fiber with room for fiber to swim freely in the pot.
3. Stack the color by cooling and reheating the fiber in the dye bath until all color is exhausted.

Ammonia Method (AM)

C+ lichens require an ammonia extraction to transform the dye pigments into purple. This process takes a while, but with patience, the results are worth the wait. Important ingredients for this transformation are: ammonia, water and oxygen. Lichens usually need to soak for at least 3 months in the ammonia water mixture and get oxygenated regularly for best results. After 3 months, you should see a deep, dark, juicy purple or magenta color. If you neglect your jars and the liquid looks brownish, don't immediately give up - the extract is extremely resilient and can usually be brought back. The result of this transformed liquid is called the dye liqueur. The dye liqueur is the extract you use to dye your fiber. It is very alkaline straight, so must be diluted or otherwise brought to an acceptable pH to be used on fiber.

Ammonia Extraction (step one)

1. Fill a quart mason jar about half-way with lichen
2. Pour clear household ammonia to just about the halfway mark on the jar
3. Top with water, leaving a little space for air.
4. Shake container daily (or when you think about it)
5. Open to the air weekly, for at least an hour

Using Extract as a Dye (step two)

1. Dilute one cup of ammonia dye liqueur into enough water to thoroughly cover your fiber, with ample room for fiber to get exposed to the dye bath.
2. Bring dyebath to 180° and add 1oz fiber. Simmer at 180° for 10 minutes; reduce to 160° for the remainder of an hour.
3. Stack the color by letting fiber cool in the dye pot, and then reheat as though dyeing again. Repeat this as many times as you can – over the course of a week if possible.
4. Rinse thoroughly when finished; use a drop of pH neutral fiber wash only if necessary.

Yellow-orange lichens like *Xanthoria* and *Teloschistes* also require an ammonia ferment. The solution will develop much like the purple dye lichens, but the dyeing is done cold. Once the fiber is removed from the dye bath, while still wet, will change color when exposed to sunlight. Depending on the intensity of the sun, the fiber will shift from pink to slate blue – sometimes within seconds. Once dry, the color is more stable.

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Mushroom Dyers' Resources:

Mycopigments.com:

Pictures, descriptions, and upcoming events

Social Media:

FB: Mycopigments, IG: @mycopigments

Mushroom and Lichen Dyers United Facebook discussion group on all things mushroom and lichen dye

Mushroom Dyers Trading Post Resource for acquiring dye mushrooms and lichens on Facebook

Articles by Alissa Allen:

Exploring Lichens for Dyes: An Easy and Ethical Approach Nature's Colorways Long Thread Media

Regional Palettes: A Closer Look at Northern California Dye Mushrooms NorCal Fibershed

Getting Started with Lichen Dyes FUNGI Magazine Volume 7:2-3 Summer 2014

Online Learning:

Dyeing Fibers with Mushrooms: https://www.midwestwomensherbal.com/product-page/mycopigments-dyeing-fibers-with-mushrooms-alissa-allen

Interviews:

Mushroom Revival: https://www.audible.com/pd/Mycopigments-Dyeing-with-Mushrooms-Alissa-Allen-Podcast/B08PJFYFLN

True Colors: page 125 Recker (2019) Thrums LLC

Books:

Mushrooms for Color Rice (1980) Mad River Press.

Mushrooms for Dyes, Paper, Pigments and Myco-Stix Rice (2007) Mushrooms for Color Press.

Rainbow Beneath My Feet Bessette & Bessette (2001) Syracuse University Press.

Lichen Dyes: The New Source Book **Casselman** (2011) Studio Vista Publications.

Lichens of North America Brodo, Sharnoff & Sharnoff (2001) Yale University Press

Mushrooms Demystified Arora (1986) Ten Speed Press

Supplies:

maiwa.com Fair-trade supplies:

dharmatrading.com Dye Supplies: Including scarves and mordants

Mushroom identification/data/community science - on the web:

iNaturalist **-** iNat.org

Mushroom Observer **-** mushroomobserver.org

Mycological Societies

North America Clubs http://www.namyco.org/clubs.php

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