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dear *reader*

In this issue, we explore the sustainable production of one of the most commonly used traditional medicines in Latin America: *sangre de drago*, or dragon's blood. This medicinal tree's characteristic red latex is the source of the first FDA-approved oral botanical drug. We appreciate longtime ABC Advisory Board Member Steven King, PhD, and his five co-authors for their article describing the sustainable management, by Napo Pharmaceuticals and others, of dragon's blood in the Peruvian Amazon. I remember being in Peru in the mid-1990s on one of ABC's "Pharmacy from the Rainforest" eco-tours, and the late Jim Duke showed me that if I rubbed the red latex in my hands for a few moments, it turns into a white powder. It was like doing a magic show in the jungle! The late Professor Varro E. Tyler, a renowned pharmacognosist, accompanied us on some of those trips. We are pleased to announce that Napo Pharmaceuticals has been named the recipient of the 2019 ABC Varro E. Tyler Commercial Investment in Phytomedicinal Research Award. More on that in the next issue.

Also in the domain of sustainability, many people are aware that many or even most flowering plants depend on pollination by animals, importantly including honeybees. But now, a combination of stresses, including disease, is killing billions of bees and threatening the future supply of food and medicinal plants. Enter mycologist Paul Stamets — North America's, and possibly the world's, most well-known advocate of medicinal fungi. *HerbalGram* Assistant Editor Connor Yearsley presents a comprehensive overview of Stamets' research and development of fungal extracts as a potential antidote to the viruses that are decimating bee colonies and may be a factor in colony collapse disorder.

Many herbalists in North America have been inspired by Rosemary Gladstar, referred to by some as the "godmother of American herbalism," whose books and courses helped fuel the herbal renaissance over the past 30-40 years. In winter 1979-1980, Gladstar concocted a recipe that she called "fire cider": a mixture of apple cider vinegar and various herbs, including garlic, onion, horseradish, and ginger, among others, depending on the formula. In 2012, a New England company called Shire City Herbals obtained a US trademark registration for "Fire Cider," and the company enjoyed considerable success, selling its fire cider at craft fairs, health food stores, online, and, eventually, in mass-market retail stores. Members of the herbal community objected to what some considered an expropriation of a traditional name and began a campaign to keep the name "fire cider" generic. Herbalists Mary Blue, Katheryn Langelier, and Nicole Telkes — who became known as the "Fire Cider Three" — were sued by Shire City for trademark infringement and fought back, eventually prevailing in court and helping to keep the name "fire cider" generic. *HerbalGram* Associate Editor Hannah Bauman has summarized their noteworthy efforts. And, the Fire Cider Three are the recipients of the 2019 ABC Mark Blumenthal Herbal Community Builder Award.

Iboga is a shrub from western Africa that has been used traditionally as a medicine and sacrament for centuries. Ibogaine, the primary alkaloid, shows potential for substance use disorders, but the compound's psychoactive properties have led to its strict regulation in the United States. Contributor Karen Raterman documents the curious case that started in late 2018 at Miami University in Ohio. The university suspended two professors following the discovery of an iboga shrub's being cultivated in the school's conservatory. Just before press time, one of the professors was reinstated, but the status of the other is still uncertain. The case raises compelling questions about academic freedom and to what extent a university will allow researchers access to psychoactive medicinal plants.

This issue's herb profile covers birch and the varied traditional uses of its bark and leaves. The pleasant-smelling birch leaf oil contains methyl salicylate and has been used topically as a substitute for wintergreen oil for many years. Birch leaf is used in medicinal teas, and preparations made of compounds from birch bark are the subject of many scientific studies demonstrating future research-and-development opportunities. Our thanks to contributors Josef Brinckmann and Thomas Brendler. Both have been named recipients of the ABC Champion Award for their extensive volunteer contributions to *HerbalGram* and other ABC research and educational projects, Brendler receiving his recognition this year. HG

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HERBALGRAM
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Honeybee *Apis mellifera*
Photo ©2018 Richard Bartz

departments

On the Cover

Top photo:
Honeybees *Apis mellifera*
Photo ©2020 Kuttelvaserova Stuchelova

Bottom left photo:
Fire cider ingredients in a mason jar.
Photo ©2020 Gayle Engels

Bottom right photo:
Dragon's blood *Croton lechleri*
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Birch

Betula lenta, *B. papyrifera*, *B. pendula* (syn. *B. verrucosa*), and *B. pubescens* (syn. *B. alba*)
Family: Betulaceae

By Josef Brinckmann and Thomas Brendler

INTRODUCTION

The Betulaceae family includes an estimated 150 to 200 species of trees and shrubs,[1] and, depending on the author, the *Betula* genus includes about 30 to 60 of those species. *Betula* species are deciduous trees or shrubs and are monoecious (they have both male and female catkins, spike-like inflorescences of unisexual flowers). Authorities differ on the precise number of *Betula* species. This is likely because birches hybridize easily, which confounds species delineation.[2]

In Europe, the main species used in herbal medicinal products, foods, and beverages are downy birch (*B. pubescens*) and silver birch (*B. pendula*), and their hybrids and subspecies. *Betula pendula* is a fast-growing tree that can reach up to about 25 m (82 ft) and occurs more or less continuously from Europe and northwestern Africa (e.g., Morocco) into parts of Asia,[3] including Kazakhstan, Mongolia, western Siberia (Russia), and the Altai Mountain area of northwestern Xinjiang Uyghur Autonomous Region.[1] *Betula pubescens*, reaching up to 20 m (65.6 ft), occurs on the islands of Newfoundland (Canada), Greenland (Danish territory), Iceland, Ireland and Great Britain (United Kingdom), and throughout most of continental Europe (except for the very south), into western Asia (Turkey and the Caucasus), and northeast to the Lake Baikal region of Siberia.[4]

In North America, two main birch species are used in cosmetics, dietary supplements, foods, and natural health products: paper birch (*B. papyrifera*) and sweet birch (*B. lenta*). *Betula lenta* grows in the eastern United States and Canada; it is a common tree of northern hardwood forest ecosystems in the Appalachian Mountains.[5] *Betula papyrifera* is distributed widely in North America, including most of Canada and the northern United States extending south to high-altitude forests of the southern Appalachian Mountains.[6] Natural ingredients obtained from Himalayan birch (*B. utilis*) also are imported and used in North America.[7]

Sweet birch *Betula lenta*
Photo ©2020 Steven Foster

Almost all birch plant parts are harvested, including the inner or outer bark (Betulae cortex), flowers (Betulae flos), leaf buds (Betulae gemmae), leaves (Betulae folium), and sap (Betulae succus).[8,9] Medicated wines (Betulae vinum) are also made from the leaves[10] or sap.[11] Essential oil is distilled from the bark (Betulae cortex aetheroleum)[12] or from the leaf buds (Betulae gemmae aetheroleum),[13] and a rectified oil of birch tar (Oleum betulae empyreumaticum rectificatum) is obtained from the bark and wood.[14] Triterpenoids (e.g., betulin, betulinic acid, lupeol, and betulin caffeates) are also isolated from the outer bark of *B. papyrifera*[15] and have been the subject of clinical trials.[16] The sugar replacement compound xylitol, which is used in chewing gums, dental hygiene products, and pharmaceuticals, can be produced from birch tree fiber but can also be produced from less costly sources such as corn (*Zea mays*, Poaceae).[17]

Betulae folium is defined by the *European Pharmacopoeia* as the dried leaves of *B. pendula* and/or *B. pubescens* as well as hybrids of both species.[18] The *State Pharmacopoeia of the Russian Federation* more specifically prescribes use of the dried leaf buds of either species, collected from wild trees in the winter-spring period (January to April) prior to blooming, as well as leaves of either species collected from wild trees from June through July.[19]

The commercial supply of birch plant parts and products of *B. pendula*, *B. pubescens*, and their hybrids or subspecies comes mainly from wild collection in Europe, especially Belarus,[7] Bosnia and Herzegovina,[8,20] Bulgaria (both cultivated and wild),[21] Croatia,[20] Finland,[22]

Hungary,[22] North Macedonia,[7] Poland,[22,23] Romania,[11,22,24] Russia,[25] Serbia,[26] and Ukraine.[25] The supplies of *B. lenta* and *B. papyrifera* come from the United States and Canada, and *B. utilis* from Nepal.[7]

HISTORY AND CULTURAL SIGNIFICANCE

The genus name *Betula* is not derived from Latin but more likely stems from the Celtic word *betu*, meaning "birch."[27,28] The English word birch likely stems from the Proto-Germanic "berkjon" (*Birke* in modern German), which refers to a slender forest tree with white bark. Swedish botanist Carl Linnaeus (1707-1778) named a North American species *B. lenta* in his 1753 work *Species Plantarum*, wherein he wrote that the species' habitat was Virginia and Canada.[29] In 1785, American botanist and plant dealer Humphry Marshall (1722-1801) named another North American species *B. papyrifera*, which he called white paper birch, in the publication *Arbustrum Americanum*.[30] German botanist Albrecht Wilhelm Roth (1757-1834) named *B. pendula* in the 1788 publication of *Tentamen Florae Germanicae*.[31] In Latin, *pendula* means "drooping" or "hanging down," referring to the branches of this species. In 1789, German botanist Jakob Friedrich Ehrhart (1742-1795) named the species *B. pubescens*.[32] *Pubescens* means "downy" or "hairy" in Latin, referring to the twigs of this species.

Archaeological evidence indicates that Neanderthals, which are believed to have gone extinct about 39,000 years ago,[33] burned birch tree bark to produce birch tar used for hafting of tools.[34] Birch bark tar sealings also have been identified among archaeobotanical grave materials in Nordic Iron Age (ca. 500 BCE to 800 CE) burial sites, as well as in earlier Nordic Bronze Age (ca. 1700 to 500 BCE) coffins and "tar decorations used for inlays and appendages on grave gifts."[35] Recently, a human genome (set of genes) and oral microbiome (collective genome of microorganisms that reside in the oral cavity) were analyzed from a piece of chewed birch (*B. pendula*) bark pitch, found in southern Denmark, which was determined to be about 5,700 years old (from about 3680 BCE at the onset of the Neolithic period in Denmark). The individual who chewed the pitch was a female hunter gatherer, likely with dark skin, dark brown hair, and blue eyes.[36]

One of the oldest known Hungarian words (5,000 to 6,000 years old) is *nyír*, meaning "birch." The Csángós and Székelys peoples, Hungarian ethnic groups, brought their traditional knowledge of birch on their migration to settle around birch forests in Transylvania, Romania.[13] Hungarians invaded and conquered this part of present-day Romania between 895 and 907 CE, and the culturally isolated Csángós and Székelys still live there.[37] To this day, they harvest birch tree sap, which they call *nyírvíz* (meaning "birch water"), then cook or ferment it to prepare wine, beer, syrup, or vinegar.[13] The Csángós people reportedly apply freshly collected birch leaves as a diaphoretic foment spread on bedding. They also relieve painful legs by filling their trousers with birch leaves during the day or by lying in a bed of birch leaves to treat rheumatism.[13]

Sweet birch *Betula lenta*
Photo ©2020 Steven Foster

Paper birch *Betula papyrifera*
Photo ©2020 Steven Foster

There is a long tradition of extracting birch sap in eastern Europe, especially Belarus, Hungary, Poland,[38] Romania, Russia, Slovakia, and Ukraine, as well as in parts of northern Europe, including Denmark, Estonia, Finland, Latvia, Lithuania, and Sweden.[39] As early as 921, people of the Turkic Bulgar tribes living along the Volga River in present-day European Russia were observed to prepare fermented birch sap.[39] In 1772, a monograph for birch sap appeared in the *Pharmacopoea Danica*, the first Danish pharmacopeia. Up until the early 20th century in Poland, spring birch tree sap was commonly drunk, usually fresh, but sometimes concentrated or fermented. In the 21st century, the tradition of drinking fresh birch sap in Poland is experiencing a revival due to reported health benefits.[38] In Russia, birch sap is drunk fresh, but also fermented by adding malt, wax, beans, or rye (*Secale cereale*, Poaceae) bread.[25] An alcoholic beverage called birch beer is also made from the American species *B. lenta* by fermenting the stem sap in the spring.[40]

Birch leaf wine traditionally is used in Germany as a diuretic in urinary tract disorders.[10] In Romanian traditional medicine, fresh birch sap is used for anemia, infusion of the leaves as a tonic and for hair growth, infusion of the leaf buds as a diuretic and anti-inflammatory for edema and urinary disorders, and decoction of the bark as an anti-inflammatory, diuretic, febrifuge, and cardiotonic.[41] There is also a centuries-long use of birch bud preparations in traditional Russian medicine. Besides uses as a diuretic, expectorant, cholagogue, diaphoretic, blood purifier, and analgesic, birch bud tea infusions and decoctions are used in Russian stomatology (medicine of the oral cavity) and otolaryngology (ear, nose, and throat medicine) for their anti-inflammatory action.[42]

In the first edition of the *Dispensatory of the United States of America* (USD I, 1833), a monograph titled "OLEUM GAULTHERIA. U.S. Oil of Partridge-berry" noted that, while the *Pharmacopoeia of the United States of America* (USP I, 1830)[43] prescribed preparation of the oil from the leaves of *Gaultheria procumbens* (Ericaceae), an oil prepared from the bark of *B. lenta* could be considered as comparable and interchangeable. Pharmacist William Procter Jr. (1817-1874) published a paper asserting that the oils of *Betula* and *Gaultheria* were identical in composition.[44] In 1890, a monograph for Betulae oleum, the essential oil obtained by maceration and distillation of the bark of sweet birch (*B. lenta*), entered the seventh decennial revision of the *Pharmacopoeia of the Unites States of America* (USP VII).[45] In the subsequent USP VIII of 1900, a monograph for Methyl Salicylate also referenced Betulae oleum as a source material for the drug.[12] In the USP IX of 1910, the Methyl Salicylate monograph was revised to state: "It is produced synthetically or is obtained by distillation from *Gaultheria procumbens* or from *Betula lenta*. The label must indicate whether the methyl salicylate has been made synthetically or distilled from either of the above mentioned plants."[46]

The use of European *B. pubescens* (then referred to as *B. alba*) entered the American medical literature in the mid-19th century. A monograph titled "BETULA ALBA. Common European Birch," appearing in the 10th edition of the *Dispensatory of the United States of America* (USD X, 1854), stated that the inner bark was bitter and astringent and employed for treatment of intermittent fever. The USD also referred to the leaves, prepared as an aqueous infusion, for treating gout, rheumatism, dropsy, and cutaneous diseases, and furthermore reported:

> The same complaints, particularly dropsy, are said to have been successfully treated by enveloping the body in the fresh leaves, which thus applied excite perspiration. When the stem of the tree is wounded, a saccharine juice flows out which is considered useful in complaints of the kidneys and bladder, and is susceptible, with yeast, of the vinous fermentation. A beer, wine, spirit, and vinegar are prepared from it, and used in some parts of Europe.[47]

Regarding an American species, *B. papyrifera*, the USD monograph stated: "The bark of *B. papyrifera* is employed by the Northern Indians for making canoes; and thin layers of the epidermis are placed inside of boots to prevent the access of moisture." In the early 20th century, a monograph for Rectified Oil of Birch Tar entered the fourth edition of the *National Formulary* (NF IV, 1916), defined as the oil obtained by the dry distillation of the bark and wood of *B. alba*, rectified by steam distillation.[14]

In 1986, the German Commission E published a positive monograph for birch leaf (*Birkenblätter* – "Betulae folium"), prepared as powdered leaf, dry extract for making tea, or fresh-pressed plant juice. The juice, powder, and tea were indicated for use as a diuretic drug in "irrigation therapy for bacterial and inflammatory diseases of the urinary tract and for kidney gravel; supportive therapy for rheumatic ailments."[48] In 2007, and in its 2014 revision, the European Medicines Agency (EMA) published a labeling standards monograph for birch leaf that superseded the German Commission E monograph for purposes of product marketing authorization in the European Union (EU).[49] In Canada, a labeling standards monograph for both European species (*B. pendula* and *B. pubescens*) was published in 2008. In subsequent revisions, a separate *B. pendula* monograph was published in 2018[50] and a *B. pubescens* monograph followed in 2019.[51] The only known official quality standards monographs for birch plant parts are published in the *European Pharmacopoeia*[18] and the *State Pharmacopoeia of the Russian Federation*.[19] Monographs for xylitol appear in currently valid editions of the *Food Chemicals Codex* (FCC 11)[52] and *National Formulary* (NF 37).[53]

CURRENT AUTHORIZED USES IN COSMETICS, FOODS, AND MEDICINES

In the United States, birch plant parts may be used in dietary supplement products, which require FDA notification within 30 days of marketing if a structure-function claim is made and product manufacturing that adheres to current Good Manufacturing Practices (cGMPs).[54]

In Canada, the leaves of European species of birch (*B. pendula* and *B. pubescens*) are regulated as active ingredients of licensed natural health products (NHPs), which require pre-marketing authorization from the Natural and Non-prescription Health Products Directorate (NNHPD). Licensed NHPs prepared from pharmacopeial quality birch leaf may be labeled and marketed for use as diuretic drugs, in dosage forms including (a) powdered leaf, (b) dry extract, (c) fluidextract, (d) tincture, (e) aqueous decoction, or (f) aqueous infusion.[50,51] The essential oil of sweet birch (*B. lenta*) bark is permitted as a non-medicinal fragrance ingredient of licensed NHPs for its odorous, odor-enhancing, or blending properties (to impart a unique aroma or mask a malodor).[55]

In the EU, birch (*B. pendula* or *B. pubescens*) leaf may be used as an active ingredient of registered traditional herbal medicinal products (THMPs) labeled with the therapeutic indication "to increase the amount of urine to achieve flushing of the urinary tract as an adjuvant in minor urinary complaints." For this use, the birch may be prepared in the forms of (a) powdered leaf, (b) aqueous dry extract (drug-to-extract ratio [DER] range 3-8:1), (c) liquid extract prepared from fresh leaves (DER 1:2-2.4), or (d) liquid extract prepared from fresh leaves stabilized by 96% ethanol vapors (DER 1:1).[49] The dried leaf used for production of registered THMPs must conform to the quality standards monographs of the *European Pharmacopoeia* (Betulae folium PhEur).[18] There is also an authorized prescription-only topical drug preparation, Episalvan gel (Amryt AG; Niefern-Öschelbronn, Germany); 1 g gel contains 100 mg refined dry extract of birch bark (from *B. pendula*, *B. pubescens*, or hybrids), equivalent to 0.5-1 g birch bark, corresponding to 72-88 mg betulin. Episalvan gel is indicated for treatment of partial thickness wounds (i.e., wounds in which upper layers of the skin have been lost, such as burn or skin grafting wounds).[56]

MODERN RESEARCH

According to the *European Pharmacopoeia* monograph, birch leaves should contain not less than 1.5% flavonoids, expressed as hyperoside.[18] Flavonoid content of the leaves

Paper birch *Betula papyrifera*
Photo ©2020 Steven Foster

can be as high as 3.5% with, next to hyperoside, other quercetin glycosides (avicularin, quercetin-3-*O*-glucuronide, quercitrin), kaempferol, and myricetin glycosides as the most prominent.[57-64] Other compounds from birch leaf include caffeic and chlorogenic acids, malonyl esters of dammarane-type triterpenes, lignans, and diarylheptanoids.[57,58,62,65-71] Birch leaves also contain proanthocyanidins,[72,73] varying amounts of lipids and fatty acids,[74] and 0.05-0.1% of essential oil.[75] Birch bark contains betulin, betulinic acid, lupeol, and esters of these triterpenes, and birch tar contains creosol and guaiacol. Depending on the region and climatic conditions, the main components of essential oil distilled from *Betula pendula* flower buds may vary; for example, α-betulenol and 14-hydroxy-4,5-dihydro-β-caryophyllene are present in oil from Turkey,[76] but α-copaene, germacrene D, and δ-cadinene are present in German birch bud oil.[77]

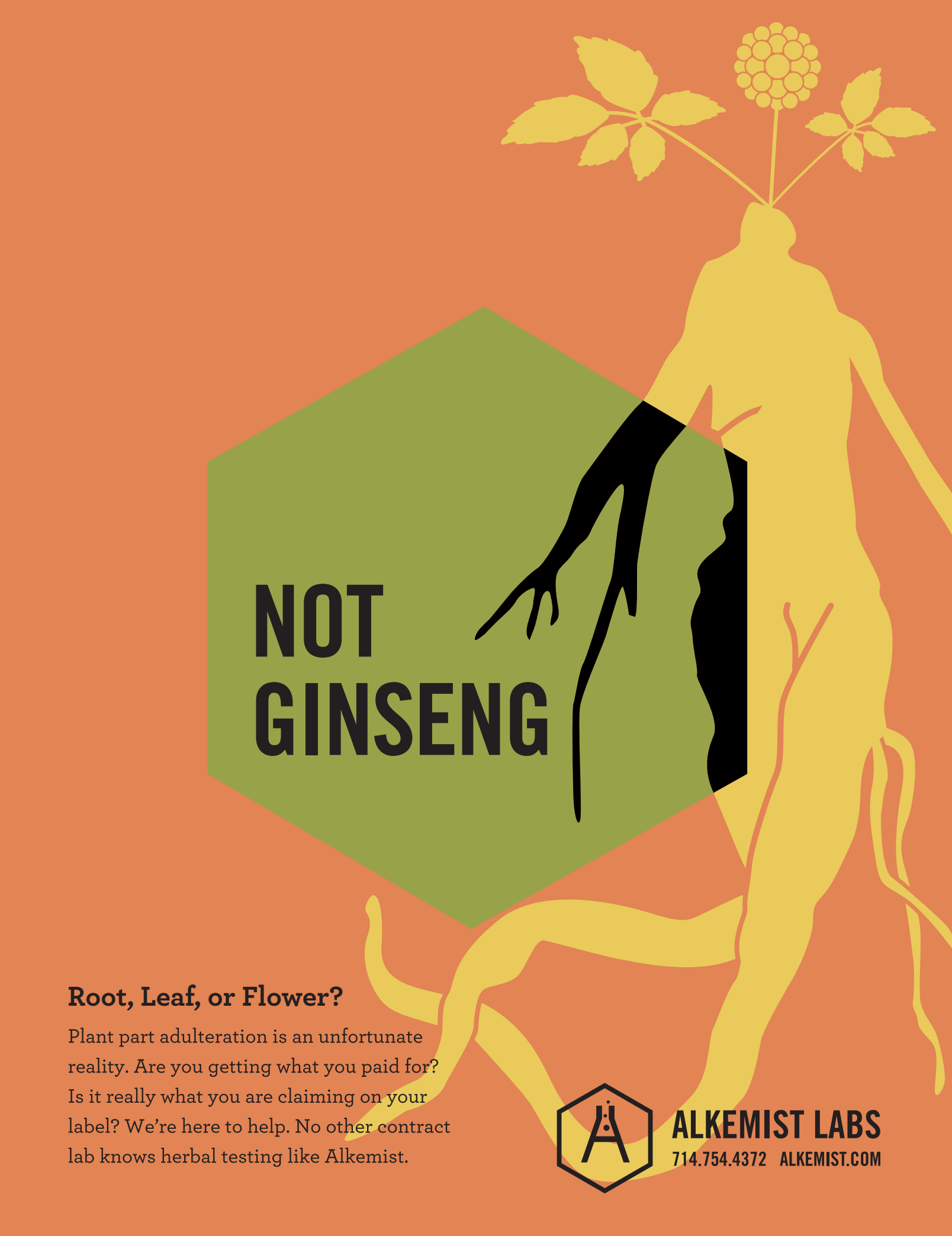
Oral administration of birch leaf preparations has been shown to increase the volume of urine excretion in rabbits and mice,[78] dogs,[79] and rats[80-83] in a dose-dependent manner. The impact of an aqueous birch leaf extract on *E. coli* biofilm formation was investigated by Wojnicz et al (2012).[84] Rafsanjany et al (2013) reported anti-adhesive effects of a birch leaf hydroalcoholic extract against uropathogenic *E. coli* in human bladder cancer cells.[85] Though a reduction of *E. coli* motility was observed, biofilm inhibition was comparatively weak. Adhesion inhibition, however, was shown to be significant (IC_{50} = 415 µg/mL). An acetone extract of birch leaf showed significant in vitro effects against *Staphylococcus aureus* but not against other bacteria or fungi.[86] Virostatic (virus-inhibiting) and cytostatic (cell-inhibiting) effects of birch leaf preparations were reported by Petkov (1988).[87] These results support the traditional use of birch leaf preparations as a mild aquaretic (an agent that promotes excretion of water), while antiallergic, anti-inflammatory, antimicrobial, antioxidant, antiproliferative, antirheumatoid, antiviral, gastroprotective, and uteroprotective activities have been shown for various isolates.[64,88,89]

Safety and toxicity data for birch are scant. No signs of dermal irritation or sensitization from a decoction of birch leaves in a cream base were detected in rabbits, rats, and mice.[90] Quercetin was suspected to be responsible for a very weak mutagenic response in the Ames test.[91] However, quercetin showed no carcinogenicity in other investigations.[92] Birch sap, leaf, and pollen have caused allergic reactions.[93] Birch pollen has been studied in extensive pre-clinical and clinical allergen research (see below). Clinical investigation of a birch leaf dry extract reported mild adverse events, including allergic systemic reactions and skin, gastrointestinal, and metabolic reactions.[94] Other than birch's allergenic potential, no immediate risks are expected from any known birch (leaf) constituent.

Few clinical trials have investigated endpoints related to the traditional use of birch leaf. Of the approximately 1,100 registered medicinal birch products (not counting homeopathics) in the German market (Arzneimittelinformationssystem [AMIS] German Drug Information System Database, accessed December 2019), close to 1,000 are medicinal teas (mono-preparations and combinations), with the remaining products being mostly anti-allergens, topical products in combination, and a handful of solid dosage forms (capsules, tablets, and granules), all using the same aqueous birch leaf dry extract (DER 4-8:1) at varying dosages. Sublivac Fix (HAL Allergy B.V.; Leiden, the Netherlands), a liquid oral preparation of *B. pendula* pollen extract for sublingual immunotherapeutic treatment of allergic rhinitis/rhinoconjuctivitis induced by birch pollen, has gone through phase I, II, and III clinical trials. Other prominent manufacturers that have sponsored clinical research in that segment include ALK-Abelló A/S (Denmark), Lofarma S.p.A. (Italy), and Allergopharma GmbH & Co. KG (Germany).

To date, no published clinical trials affirm the effects of birch leaves and preparations thereof, other than two early 20th-century reports,[95,96] which failed to demonstrate increased diuresis after administrations of a 1:10 infusion of birch leaf. The first report described a small randomized, double-blind, placebo-controlled pilot study[97] in which three out of seven patients with urinary tract infections (UTIs) were symptom-free after 20 days of four cups of birch leaf tea per day vs. one out of six in the control group. The second report described a non-interventional study[98] with 1,066 subjects suffering from UTIs, cystitis or other inflammations, irritable bladder, stones, and other complaints. All subjects received aqueous birch leaf dry extract at varying doses (180-1,080 mg), 56% of the UTI group received additional antibiotic treatment, and the treatment period averaged two to four weeks. Symptoms subsided in all groups (in 80% of subjects co-treated with antibiotics and in 75% without co-treatment). A 2002 dissertation reported on a pilot study with 14 healthy subjects comparing urine volumes after administration of birch leaf tea and water, respectively. No increase in urine volume could be shown.[99]

Apart from birch products based on traditional use claims, Episalvan gel is a licensed new drug in Europe. The public assessment report of the EMA lists three phase III trials treating split-thickness skin graft wounds (two trials) and grade 2 burn wounds (one trial). A total of 217 skin graft patients received treatment and wound dressing on one half of the wound and dressing only on the other half. Wound closure occurred significantly faster with Episalvan (average time from surgery to wound closure was 17.1 days for the wounds treated with standard wound dressing only and 15.5 days for the wounds also treated with Episalvan). In 57 subjects with partial-thickness burn wounds, using the same methodology, wound closure occurred in 7.6 days vs. 8.8 days.[56] Some data from these studies were published subsequently.[100-102] Furthermore, more than 2,500 papers have been published on the pharmacological actions of selected triterpene compounds (e.g. betulin, betulinic acid, and lupeol), extracted and isolated from the outer bark of *Betula* species, for a wide range of human health applications (Brian Garhofer [president and CEO of The Actives Factory] email to T. Smith, January 16, 2020).



Root, Leaf, or Flower?

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ADULTERATION

Adulteration of official Betulae folium in Europe is rare.[103] Occasional confusion with the leaves of *Populus tremula* (Salicaceae) has been reported.[104] According to *Flora of China*, *B. pendula* may easily be confused with *B. platyphylla* (now considered to be *B. pendula* subsp. *mandshurica*). The branches of *B. platyphylla*, however, are not pendulous (do not hang down). The name *B. alba* (syn. *B. pubescens*) is also reported to be persistently misapplied to *B. pendula*.[1] *Betula pubescens* trees also differ from *B. pendula* because their branches usually stand upright (are not pendulous).[105]

SUSTAINABILITY AND FUTURE OUTLOOK

All *Betula* species discussed in this article have been assigned to the conservation category of Least Concern (LC), as assessed according to the International Union for Conservation of Nature (IUCN) Red List categories and criteria. The assessment of LC is based on their widespread distribution with no known significant threats in the foreseeable future.[3-6] Climate change, however, is expected to extirpate the two North American species, *B. lenta* and *B. papyrifera*, at the southernmost part of their distribution, but it is believed that this may be offset with an expansion of their northern range limits in Quebec and Ontario.[5,6] Wild *B. pendula* is, however, a protected species in some regions, such as North Macedonia.[106] Wild *B. pubescens* is also classified as LC overall, even though it is considered threatened in some areas. For example, the species is classified as Critically Endangered in Croatia, Vulnerable in Hungary and Bosnia and Herzegovina, and Near Threatened in Luxembourg.[4]

Sweet birch *Betula pendula*
Photo ©2020 Steven Foster

Estimates of birch leaf wild-collected annually range from one to five tons in Finland,[22] five tons in Croatia,[20] 80 to 100 tons in Bosnia and Herzegovina, and 200 tons in Romania.[20] For the five-year period 2001-2005, Bulgaria's Ministry of Environment and Water reported an average annual export of 72,760 kg of Betulae folium (both cultivated and wild collected) and 802 kg of Betulae cortex.[21] In 2005, an estimated 1,668,700 hectares (6,443 square miles) were registered for certified organic wild-collection of *B. pendula* leaves globally.[107]

Given the expansive distribution area of birch trees, their conservation status as not threatened at this time, coupled with evidence that collection is occurring increasingly under organic wild-crop harvesting rules (especially in Belarus, North Macedonia, Poland, and Ukraine), and that some of the supply is also being cultivated, the continued use of birch ingredients in natural products appears to be sustainable if monitored and managed. HG

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Rough Horsetail
Equisetum hyemale

natural™ REMEDIES

Licorice
Glycyrrhiza spp.

valensa

Saw Palmetto
Serenoa repens

NATUROPATHICA® HOLISTIC HEALTH

Arnica
Arnica montana

FUTURE CEUTICALS

Coffee Fruit
Coffea spp.

Teawolf — Natural Extract Solutions

Guayusa
Ilex guayusa

Gaia Trading Company, Inc.

Hops
Humulus lupulus

THE ACTIVES FACTORY

Birch
Betula spp.

Natac — Science to Market

Olive
Olea europaea

Grape
Vitis vinifera

ECOSO DYNAMICS

Devil's Claw
Harpagophytum spp.

Terry Naturally — EuroPharma

Turmeric
Curcuma longa

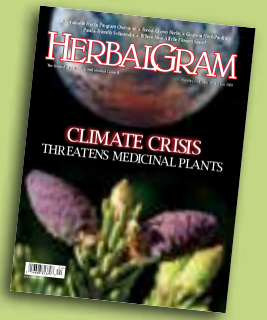
A Decade of Achievements at ABC

The American Botanical Council (ABC) is committed to its role as an agent of change, working to increase awareness and understanding of — and appreciation for — the valuable role that scientifically documented medicinal and other beneficial plants can, do, and should play in health care and self-care for people across the globe.

Below are highlights from the past decade.

2019

- ABC-AHP-NCNPR Botanical Adulterants Prevention Program (BAPP) receives the NutraIngredients-USA **Editors Award for Industry Initiative of the Year**. According to NutraIngredients-USA, "BAPP is an exemplary educational resource about adulteration in the botanical supply chain, with its growing body of peer-reviewed [publications]."
- BAPP publishes its **55th peer-reviewed document** and updates its **draft "Best Practices Standard Operating Procedure** to Prevent Resale of Irreparably Defective Articles."
- The Sustainable Herbs Program **(SHP) creates advisory group**; publishes new videos on FairWild certification, forest botanicals, and sustainability practices; adds a new website section focusing on sourcing of specific plants in commerce; and much more.
- ABC publishes a **special *HerbalGram* issue on** sustainability and conservation highlighting the threat of the **climate crisis** on medicinal and aromatic plants.
- HerbalEGram features **57th article in ABC's Food as Medicine series** on the health benefits of specific foods.
- ABC publishes its popular annual **Herb Market Report** showing an increase in herb retail sales in the United States of 9.4% in 2018.



- The **71st herb is adopted** through ABC's Adopt-an-Herb Program, which supports ABC's HerbMedPro database.
- ABC Chief Science Officer **Stefan Gafner, PhD, is appointed** to the Society for Medicinal Plant and Natural Product Research (GA) Advisory Board, the *Planta Medica* Editorial Advisory Board, and secretary general of the International Council for Medicinal and Aromatic Plants (ICMAP).
- ABC **publishes** four issues of ***HerbalGram***, 12 issues of **HerbalEGram**, 51 issues of **Herbal News & Events**, 360 **HerbClips**, three **Botanical Adulterants Monitor** newsletters, two **Laboratory Guidance Documents**, and four **Botanical Adulterants Prevention Bulletins**.
- ABC **trains nine pharmacy and dietetic interns** from graduate dietetic and sixth-year pharmacy programs, introducing many for the first time to the science behind botanicals and herbal medicine for potential inclusion in their future practices.
- ABC staff gives **20 presentations** throughout the year, many at scientific conferences.
- ABC **awards six Botanical Excellence Awards** to individuals and companies for their valuable contributions to the herbal community.
- ABC issues **28 press releases**. As a reliable third-party educational resource, ABC helps the media better understand and interpret scientific, regulatory, and market data.
- ABC hosts more than **600 visitors at its historic 2.5-acre headquarters** in Austin, Texas. These visitors included schoolchildren, seniors, college students, garden club members, herbalists, health care providers, and more.

2018

- ABC celebrates its **30th anniversary**.
- ABC **launches the SHP partnership** to educate about and help secure a more sustainable and regenerative herb value network with the goal of ensuring that the herbs we rely on now are available in the future.
- ABC **creates the Fredi Kronenberg Award** for Excellence in Research and Education in Botanicals for Women's Health.
- ABC publishes its **7,000th HerbClip**.

2017

- ABC Founder and Director Mark Blumenthal receives the Society for Ethnopharmacology-India's **Outstanding International Ethnopharmacologist Award**.

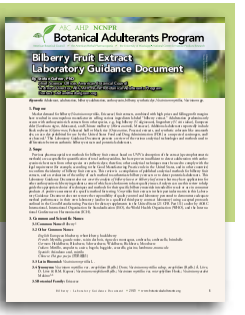
2016

- *Nutritional Outlook* magazine names **BAPP the "Best of Industry"** for its "industry-advancing contributions" against accidental and intentional adulteration of botanical products.
- ABC publishes **first Botanical Adulterants Prevention Bulletin**, which are concise documents on specific herb adulteration issues.

ABC AHP NCNPR Botanical Adulterants Program
BOTANICAL ADULTERANTS BULLETIN

2015

- ABC **creates the Food as Medicine initiative** to increase awareness of the medicinal and nutritional benefits of many common fruits, vegetables, nuts, and other plant foods.
- BAPP publishes its **first Laboratory Guidance Documents**.
- ABC **creates the ABC Champion Award**.



2014

- ABC **launches the Botanical Adulterants Monitor** newsletter to provide up-to-date information on adulteration issues.

ABC AHP NCNPR Botanical Adulterants MONITOR

- ABC receives *Nutrition Business Journal*'s **2013 Education Achievement Award**.

2013

- ABC celebrates its **25th anniversary**.
- *HerbalGram* celebrates its 30th anniversary and the publication of its **100th issue**.
- ABC creates the Mark Blumenthal **Herbal Community Builder Award**.

American Botanical Council 25 YEARS of Herbal Excellence

2012

- ABC **launches Herbal News & Events**. Published weekly, this electronic newsletter gives ABC members a quick look at the latest headlines, plus conferences and events around the world.

herbal News & Events
Your source for reliable herbal medicine information

2011

- ABC, the American Herbal Pharmacopoeia (AHP), and the National Center for Natural Products Research (NCNPR) at the University of Mississippi **establish BAPP**. Since its inception, BAPP has **published 56 peer-reviewed documents** including Laboratory Guidance Documents, Botanical Adulterants Prevention Bulletins, newsletters, white papers, and more.

ABC AHP NCNPR Botanical Adulterants Prevention Program

2010

- Blumenthal receives the prestigious **Varro E. Tyler Prize** from the American Society of Pharmacognosy.
- Blumenthal **co-creates and records "Herbal Insights"** segments for *Healing Quest* on PBS.

Thank you to all of ABC's supporters for making these achievements possible.

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Members in more than **80 countries**

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National Association for Holistic Aromatherapy Adopts True Lavender through ABC's Adopt-an-Herb Program

By Connor Yearsley

The American Botanical Council (ABC) welcomes the National Association for Holistic Aromatherapy's (NAHA's) adoption of true lavender (*Lavandula angustifolia*, Lamiaceae) through ABC's Adopt-an-Herb botanical research and education program.

NAHA's adoption supports ABC's extensive HerbMedPro database, ensuring that this unique research and educational resource remains up to date for researchers, health professionals, industry members, students, consumers, and other members of the herbal and dietary supplement and natural medicine communities.

HerbMedPro is a comprehensive, interactive online database that provides access to important scientific and clinical research data on the uses and health effects of more than 265 herbs, spices, medicinal plants, and fungi.

NAHA's mission is to advance the knowledge of the medicinal use of aromatic plants and essential oils and to support aromatherapy as a holistic professional art and science. "Our adoption of true lavender will help educate practitioners and the public alike, helping realize our mission for this iconic aromatic plant," wrote Annette Davis, president of NAHA (email, November 21, 2019).

Davis hopes that more people will realize the healing properties of aromatic plants like true lavender, rather than simply viewing them as perfumes or fragrances. "We also want people to become more aware of applicable safety recommendations," she wrote.

Lavender *Lavandula angustifolia*
Photo ©2020 Steven Foster

"NAHA is pleased to support ABC by adopting true lavender, which is one of the brightest stars of aromatherapy," Davis added. "Its use can be documented from the tombs of Egyptian pharaohs, to the pharmacopeias of ancient Greek and Asian physicians, to the courts of French kings and English queens, to the prescription pads of modern-day healers."

Stefan Gafner, PhD, ABC's chief science officer, said: "Lavender has a long and rich history of medical and cosmetic use. Its anxiolytic effects have been investigated in more than a dozen clinical trials. We are deeply grateful to NAHA for its adoption of true lavender, which supports ABC's HerbMedPro database and allows us to make the science behind this popular ingredient available to a wider audience" (email, December 16, 2019).

About True Lavender

The lavender genus (*Lavandula*) belongs to the mint family (Lamiaceae) and includes 25-30 species or more. Although it is also called English lavender, true lavender (*L. angustifolia*) is actually native to the low mountains of the Mediterranean basin. This small, brittle, semi-woody subshrub can grow to three feet tall and has narrow gray-green leaves and small bluish-purple flowers.

A common ornamental plant and mainstay of herb gardens, true lavender is known for its clean, powerful, and pleasing aroma. The essential oil (EO) from its flowers has sweet overtones and is used widely in perfumes, soaps, shampoos, and other products. Lavandin (*L.* × *intermedia*), a hybrid of true lavender and spike lavender (*L. latifolia*), is cultivated more widely and exceeds true lavender in EO production, but true lavender is widely thought to have a finer fragrance. The flowers of true lavender also are used in baking, sachets, and potpourris.

It often is thought that both the genus name *Lavandula* and the common name "lavender" derive from the Latin *lavare*,

meaning "to wash." But, some sources claim that no evidence suggests that the flowers or EO were used in baths in ancient Rome. It may be more likely that the genus and common names derive from the Latin *livere*, meaning "to be livid or blue." The species name *angustifolia* owes to the plant's narrow leaves.

In ancient Greece, Persia, and Rome, lavender was valued for its antiseptic properties. The plant later spread to India and Tibet, where it was used to ease anxiety. In the Middle Ages, it was used for colds, coughs, infections, rheumatic aches, and wounds; and as a strewing herb (an herb that is strewn over floors of buildings and is usually fragrant or astringent). In the 1790s, Thomas Jefferson reportedly planted lavender at Monticello.

True lavender EO reportedly has antibacterial, anticonvulsant, antifungal, anti-inflammatory, antioxidant, and anxiolytic effects. It is used as a calming sedative and to treat anxiety, headaches, insomnia, melancholy, nervousness, and skin ailments. Studies show that true lavender EO may also improve balance and prevent falls in elderly people. Compounds in true lavender EO, like linalool and linalyl acetate, are absorbed rapidly through the skin or mucous membranes.

About the National Association for Holistic Aromatherapy

NAHA, which was established in 1990 and has offices in Pocatello, Idaho, is a nonprofit association with more than 5,000 members worldwide. It is devoted to the holistic integration of aromatherapy into a wide range of complementary health care practices, self-care, and home care. NAHA offers scientific and empirical information about aromatherapy and essential oils to the public, practitioners, businesses, product manufacturers, writers, educators, health care professionals, and the media.

NAHA is actively involved with promoting and elevating academic standards in aromatherapy education and practice standards for the profession. It also is dedicated to increasing the public's knowledge and understanding of aromatherapy and its safe and effective application in clinical practice and everyday life.

Member benefits include a subscription to NAHA's e-journal, access to recordings of more than 80 webinars about aromatherapy, a calendar of event postings, and more. For more information, visit www.naha.org.

About Adopt-an-Herb and HerbMedPro

NAHA is one of 65 US and international companies and organizations that have supported ABC's educational efforts to collect, organize, and disseminate reliable traditional and science-based information, including clinical studies, on herbs, medicinal plants, and other botanical- and fungal-based ingredients through the Adopt-an-Herb program. This program encourages companies, organizations, and individuals to "adopt" one or more specific herbs for inclusion and ongoing maintenance in the HerbMedPro database. To date, 73 herbs have been adopted.

Each adopted herb is researched continuously for new scientific articles and botanical, chemical, pharmacological, toxicological, and clinical studies, ensuring that its HerbMedPro record stays current and robust. Access to the studies is organized conveniently by publication type, with each study condensed to a one-sentence summary with a link to the study's official abstract on PubMed (the US National Library of Medicine's free-access database) or other publicly accessible database.

HerbMedPro is available to ABC members at the Academic level and higher. Its "sister" site, HerbMed, is available to the general public at no cost, with access to 25-30 herb records from the larger HerbMedPro database. In keeping with ABC's position as an independent research and education organization, herb adopters do not influence the scientific information that is compiled for their respective adopted herbs. HG

New Botanical Adulterants Prevention Bulletins Review Evidence of Oregano and Olive Oil Adulteration

By ABC Staff

The ABC-AHP-NCNPR Botanical Adulterants Prevention Program (BAPP) recently published Botanical Adulterants Prevention Bulletins (BAPBs) on oregano herb and essential oil and olive oil. These are the 19th and 20th publications, respectively, in the program's series of BAPBs.

The goal of the BAPBs is to provide accounts of ongoing issues related to botanical identity and adulteration. The bulletins allow quality control personnel and lab technicians in the herbal medicine, botanical ingredient, dietary supplement, cosmetic, herbal tea, conventional food, and other industries to stay informed about adulteration problems that may be widespread or imply safety concerns.

Oregano Bulletin: Inappropriate Substitution and Mislabeling Are Common

Oregano (*Origanum vulgare* subsp. *hirtum* and *O. onites,* Lamiaceae) is one of the most popular culinary herbs worldwide, especially in Europe, North Africa, North America, and the Arabian Peninsula. Powdered oregano herb, herb extracts, and oregano essential oil are also popular as dietary supplement ingredients. In 2018, oregano dietary supplements ranked 10th in the US natural retail channel with sales totaling almost $10 million according to the American Botanical Council's (ABC's) 2018 Herb Market Report.[1] Oregano essential oil is also used in the perfume and cosmetic industries.

ABC AHP NCNPR
Botanical Adulterants Prevention Program
BOTANICAL ADULTERANTS PREVENTION
BULLETIN

Adulteration of
Oregano Herb
and Essential Oil

By Ezra Bejar, PhD

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Correspondence: email

Oregano *Origanum vulgare*
Photo ©2019 Steven Foster

Citation (JAMA style): Bejar E. Adulteration of oregano herb, and essential oil of oregano. *Botanical Adulterants Prevention Bulletin*. Austin, TX: ABC-AHP-NCNPR Botanical Adulterants Prevention Program; 2019.

Keywords: Adulteration, essential oil, *Lippia graveolens*, Mediterranean oregano, Mexican oregano, oregano, oregano leaf oil, *Origanum onites*, *Origanum vulgare* subsp. *hirtum*

Goal: The goal of this bulletin is to provide timely information and/or updates on issues of intentional and accidental adulteration and mislabeling of oregano herb and essential oil (EO).* It provides information on issues of adulteration and mislabeling of oregano (*Origanum vulgare* subsp. *hirtum, O. onites*) herb used as a spice and herbal remedy, in particular with winter savory (*Satureja montana*, Lamiaceae) herb, sweet marjoram (*Origanum majorana*, Lamiaceae) herb, *Cistus* spp. (Cistaceae) leaf, olive (*Olea europaea*, Oleaceae) leaf, thyme (*Thymus* spp., Lamiaceae) herb, summer savory (*Satureja hortensis*, Lamiaceae) herb, strawberry (*Fragaria* spp., Rosaceae) leaf, sumac (*Rhus* spp., Anacardiaceae) leaf, hazelnut (*Corylus avellana*, Betulaceae) leaf, myrtle (*Myrtus communis*, Myrtaceae) leaf, and colored wheat (*Triticum aestivum*, Poaceae) bran. Additional species in the family Lamiaceae from the genera *Origanum, Thymus, Poliomintha, Plectranthus, Monarda*, and *Hyptis* or in the family Verbenaceae from the genera *Lippia, Aloysia*, and *Lantana* are known to have "oregano" as part of their common name, and may thus be mistaken for oregano by purchasing personnel who lack proper training.

The bulletin also addresses adulteration of oregano (*Origanum vulgare* subsp. *hirtum*) EO, in particular with *Origanum* and *Thymus* species, Spanish thyme blend, and synthetic carvacrol and thymol. This bulletin may serve as guidance for quality control personnel, the international herbal products industry and the extended natural products community in general. It is also intended to present a summary of the scientific data and methods on the occurrence of species substitution, adulteration, the market situation, and economic and safety consequences for the consumer and the industry.

1. General Information

1.1 Common name: Oregano[1-2†]

1.2 Other common names[2-5]

Greek oregano:
English: Wild marjoram
Danish: Almindelig merian, merianurt
Dutch: Oregano, wilde marjolein
French: Origan, origan commun
German: Dostenkraut, gemeiner Dost, Oregano, wilder Majoran
Greek: Ρίγανη (rigani)
Italian: Maggiorana selvática, origano, origano comune,
Norwegian: Bergmynte, oregano
Portuguese: Orégano, orégão
Spanish: Orégano

* Some authors differentiate the volatile oil obtained by steam distillation from essential oil. For the purpose of this document, no such distinction has been made.

† The common name "oregano" is used for both, *O. vulgare* subsp. *hirtum* and *O. onites*. However, *Origanum vulgare* subsp. *hirtum* is also known as *Greek oregano*, while *O. onites* is commonly referred to as Turkish oregano (see section 1.6).

Oregano Herb and Essential Oil - Botanical Adulterants Prevention Bulletin • *Oct 2019* • www.botanicaladulterants.org

1

Numerous plant species include "oregano" as part of their common name and therefore can be mistakenly sold instead of oregano. Some of these species are legally allowed to be used interchangeably, depending on whether they are sold as a spice, dietary supplement, or cosmetic ingredient, while others are considered to be adulterants. The substitution of oregano herb with undeclared lower-cost plant materials to add volume (bulking agents; see Table 1) also has been confirmed. Such inappropriate substitution and mislabeling appear to be fairly common according to multiple articles published over the last decade, many of which are referenced in the new bulletin.

Oregano *Origanum vulgare*
Photo ©2020 Steven Foster

Oregano oil is made by distilling the naturally occurring essential oil in oregano leaves and other aerial parts. Information on oregano essential oil adulteration is less common than evidence of adulteration of the herb itself. However, there are published reports of admixture of other, lower-cost essential oils with oregano oil, as well as the addition of the pure compounds carvacrol, thymol, or limonene (naturally occurring characteristic compounds in true oregano essential oil, which are sometimes made by chemical synthesis).

Table 1. Reported Oregano Herb Adulterants

Plant Material	Latin Binomial
Various *Cistus* species (leaf)	*Cistus* spp., Cistaceae
European hazel (leaf)	*Corylus avellana*, Betulaceae
Strawberry (leaf)	*Fragaria* spp., Rosaceae
Myrtle (leaf)	*Myrtus communis*, Myrtaceae
Olive (leaf)	*Olea europaea*, Oleaceae
Sweet marjoram (herb)	*Origanum majorana*, Lamiaceae
Sumac (leaf)	*Rhus* spp., Anacardiaceae
Summer savory (herb)	*Satureja hortensis*, Lamiaceae
Winter savory (herb)	*Satureja montana*, Lamiaceae
Thyme (herb)	*Thymus* spp., Lamiaceae

Olive *Olea europaea*
Photo ©2020 Steven Foster

The new bulletin, written by Ezra Bejar, PhD, an expert in botanical research, lists the known adulterants, summarizes current analytical approaches to detect adulterants, and provides information on the nomenclature, supply chain, and market importance of oregano. It also discusses safety aspects of the known adulterants. The BAPB was reviewed by 19 experts from the nonprofit research sector, contract analytical laboratories, and the herb industry.

Stefan Gafner, PhD, chief science officer of ABC and the technical director of BAPP, commented: "In the past, researchers have mainly investigated the authenticity of oregano as a spice, wherein the addition of other undeclared plant materials appears to be quite widespread. It is not clear if these practices are also occurring in the dietary supplement supply chain, which is dominated by extracts and essential oil products. If so, we hope that the oregano bulletin will provide companies in the oregano trade with helpful information to enable the detection of adulterated raw materials."

Olive Oil Adulteration: A Common Food Fraud

The oil of the olive (*Olea europaea*, Oleaceae) fruit is one of the most popular culinary oils. In dietary supplements, olive oil is used as a carrier oil, or excipient, for fat-soluble vitamins and saw palmetto (*Serenoa repens*, Arecaceae)

ABC AHP NCNPR
Botanical Adulterants Prevention Program
BOTANICAL ADULTERANTS PREVENTION
BULLETIN

Adulteration of
Olive (*Olea europaea*) Oil

By Rodney J. Mailer, PhD,[a] and Stefan Gafner, PhD[b]

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Correspondence: email

Citation (JAMA style): Mailer RJ, Gafner S. Adulteration of olive oil. *Botanical Adulterants Prevention Bulletin*. Austin, TX: ABC-AHP-NCNPR Botanical Adulterants Prevention Program; 2020.

Keywords: Olea, *Olea europaea*, olive, olive oil, huile d'olive, virgin olive oil, extra virgin olive oil, adulteration, fraud, traceability

Goal: The goal of this bulletin is to provide general information about olive oil and possible causes of adulteration, mislabeling, counterfeiting, and fraud of the product. The guidelines for genuine olive oil are adapted from the International Olive Council (IOC; Spanish – Consejo Oleicola International [COI]) and other legitimate, appropriate sources. The contents provide information on possible adulterants in olive oil, the underlying causes of adulteration, and how to test for the presence of these adulterants. The bulletin also serves as a summary of the relevant scientific information available, bearing in mind that the amount of published literature on olive oil is extensive. Data on trade and market dynamics are included. Extracts made from olive leaves, which are popular ingredients in dietary supplements, are not covered in this bulletin. Similarly, this bulletin will focus primarily on the current deceptive practices in the global olive oil trade rather than historical adulterations.

Definitions:

Olive: Olive is the fruit of the olive tree (*Olea europaea*, Oleaceae). The fruit is an oval-shaped drupe composed of a pericarp (skin and flesh) and the endocarp (seed or pit). The seed contributes 15-30% of the weight of the olive depending on the cultivar. The olive contains around 50% water and 20% oil, although these proportions vary widely among olive cultivars and the environmental conditions in which they are grown. There are many cultivars grown worldwide and although around 600 can be found in the literature, the precise number is unknown. IOC has published a World catalogue of

Olive *Olea europaea*
Photo ©2020 Steven Foster

Olive (*Olea europaea*) Oil - Botanical Adulterants Prevention Bulletin • *Jan 2020* • www.botanicaladulterants.org

1

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in the international herb and natural products/natural medicine community.

Become a valued underwriter of the ABC-AHP-NCNPR Botanical Adulterants Prevention Program, a multi-year, supply chain integrity program providing education about accidental and intentional adulteration of botanical materials and extracts on an international scale.

Botanical Adulterants Prevention Program

For more details on joining the program, and access to the free publications produced to date, **please see www.botanicaladulterants.org or contact Denise Meikel at denise@herbalgram.org.**

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VitaQuest International
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XYMOGEN
ZMC-USA

Trade Associations

American Herbal Products Association (US)
Australian Self Medication Industry (Australia)
Australian Tea Tree Industry Association (Australia)
British Herbal Medicine Association (UK)
Canadian Health Food Association (Canada)
Complementary Medicines Australia (Australia)
Consumer Healthcare Products Association (US)
Council for Responsible Nutrition (US)
Global Curcumin Association (GCA)
International Alliance of Dietary/Food Supplement Associations (IADSA)
National Animal Supplement Council (US)
Natural Astaxanthin Association (NAXA)
Natural Products Association (US)
Natural Health Products New Zealand (NZ)
United Natural Products Alliance (US)

Nonprofit/Professional Associations

Academy of Integrative Health & Medicine
American Association of Naturopathic Physicians
American Herbalists Guild
American Society of Pharmacognosy
AOAC International
Council of Colleges of Acupuncture and Oriental Medicine
Homeopathic Pharmacopoeia Convention of the United States
Integrative Healthcare Policy Consortium
Irish Register of Herbalists (IRE)
National Institute of Medical Herbalists (UK)
Natural Health Products Research Society of Canada (NHPRS Canada)
Personalized Lifestyle Medicine Institute
Society for Medicinal Plant and Natural Product Research (GA)
US Pharmacopeia (USP)
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berry extract, for example, and as a dietary ingredient alone or in combination with fish, flax (*Linum usitatissimum,* Linaceae), borage (*Borago officinalis,* Boraginaceae), and other oils to supply balanced amounts of fatty acids to the human diet. Olive oil is also a popular ingredient in topical formulations such as lotions, creams, ointments, and lip balms. Global production of olive oil has averaged more than three million metric tons for the past two years.

Olive oil adulteration is listed frequently among the most common food frauds worldwide. In 2014, *The New York Times* published an online slideshow of infographics to explain the problem in simplified terms.[2] The fraud, which appears to be ongoing, includes mainly substitution with lower-cost vegetable oils, lower-grade olive oils such as refined olive oil or pomace oil (the pomace is the solid material remaining after pressing the fruit) and inaccurate country-of-origin labeling.

The new bulletin was written by Gafner and Rodney J. Mailer, PhD, an expert in vegetable oil production and analysis and former head of the New South Wales Department of Primary Industries' edible oil research program in Wagga Wagga, NSW, Australia. It defines the various olive oil grades, lists known adulterants, summarizes current analytical approaches to detect adulterants, and provides information on the supply chain, pricing, and market importance of olive oil. The olive oil bulletin was reviewed by 14 experts from the nonprofit research sector, consulting businesses, contract analytical laboratories, and the vegetable oil, dietary supplement, and cosmetic industries in the United States and other countries.

Gafner commented: "While the adulteration of olive oil has been widely known for many years, we were initially uncertain whether to produce an olive oil bulletin, since it is not normally considered a primary dietary ingredient in the dietary supplement industry. However, due to olive oil's widespread use as an excipient in the dietary supplement industry and as a significant ingredient in the cosmetic and personal care industries, and its high frequency of adulteration, we concluded that this document could benefit many industry members and consumers."

Mark Blumenthal, founder and executive director of ABC and BAPP, elaborated: "It is important to realize that the scope of BAPP, as well as ABC and our partners at AHP and NCNPR, goes beyond the use of botanical ingredients in dietary supplements. We research and publish on botanicals and botanical ingredients used in conventional foods, cosmetics, and even pharmaceutical drugs. So, the widespread adulteration of olive oil is a long overdue subject for BAPP's research and publications."

About the ABC-AHP-NCNPR Botanical Adulterants Prevention Program

The ABC-AHP (American Herbal Pharmacopoeia)-NCNPR (National Center for Natural Products Research at the University of Mississippi) Botanical Adulterants Prevention Program is an international consortium of nonprofit professional organizations, analytical laboratories, research centers, industry trade associations, industry members, and other parties with interest in herbs and medicinal plants. The program advises industry, researchers, health professionals, government agencies, the media, and the public about the various challenges related to adulterated botanical ingredients sold in commerce. More than 200 US and international parties have financially supported or otherwise endorsed the program.

As of January 2020, the program has produced 56 extensively peer-reviewed publications, including *HerbalGram* articles, BAPBs, Laboratory Guidance Documents, and Botanical Adulterants Monitor e-newsletters. All of the program's publications are freely available on the BAPP website (registration required). HG

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American Herbal Pharmacopoeia Publishes Boneset Monograph and Therapeutic Compendium

By Connor Yearsley

In October 2019, the American Herbal Pharmacopoeia (AHP) released a monograph containing quality control standards and a therapeutic compendium (as one document) for boneset (*Eupatorium perfoliatum*, Asteraceae) aerial parts.[1]

AHP claims that this is the first formal monograph on boneset, which may be one of the most effective anti-influenza plants in the North American *materia medica*. The monograph's development involved original, in-depth analyses of boneset's chemistry, which confirmed the presence of potentially toxic pyrrolizidine alkaloids (PAs) in the plant. This suggests the need for a more rigorous risk-benefit assessment or the creation of PA-free preparations of boneset.

AHP monographs establish identification, purity, and quality standards for botanical raw materials and preparations. The therapeutic compendia provide a comprehensive review of pharmacological and safety data, including medical indications and evidence from clinical, animal, and in vitro studies; modern and traditional uses; pharmacokinetics; pharmacodynamics; and guidance for structure and function claims. The compendia also cover dosages, interactions, side effects, contraindications, toxicology, and more. This information can be used by individuals in the herbal community, from consumers and health care practitioners to industry members like quality control personnel, purchasing agents, and dietary supplement manufacturers.

The boneset monograph was a collaboration among AHP and researchers at Westfälische Wilhelms-Universität in Münster, Germany. Chemical analyses of boneset were performed by Steven Colegate, PhD, Dale Gardner, PhD, and Kip Panter, PhD, of the United States Department of Agriculture's (USDA's) Poisonous Plant Research Laboratory and Joseph Betz, PhD, of the National Institutes of Health's (NIH's) Office of Dietary Supplements. In all, 12 authors contributed to the monograph, and 18 experts in the fields of herbal medicine, botany, chemistry, pharmacognosy, pharmacology, and boneset cultivation reviewed it before publication. Work on the monograph began in 2014.

According to Roy Upton, RH (AHG), DipAyu, president of AHP and editor of the monograph, AHP began developing the monograph due to boneset's reported high degree of efficacy during flu epidemics of the 1800s and early 1900s. "Boneset is one of few herbs whose efficacy was compared against conventional treatments at the time, and it was clearly saving lives when conventional therapies of the day were failing," Upton wrote (email, November 14, 2019). "It was also one of the most widely used herbs by herbal physicians and practitioners of the time for flu. Considering that flu is always a public health issue, the need for effective medicines is apparent. We thought more people should know about boneset."

Besides AHP's cannabis (*Cannabis* spp., Cannabaceae) monograph, which was published in 2014, the boneset monograph was the most difficult to develop, according to Upton. In 2015, far into the monograph's development, researchers at the University of Mississippi unrelatedly reported the presence of potentially toxic PAs in boneset.[2] Though common in other *Eupatorium* species, these compounds had never before been reported in boneset specifically, Upton explained. But, the researchers analyzed only one sample, including the root, even though the flowering tops were most often used traditionally.

At AHP's request, PA analytical experts at the USDA analyzed the flowering tops of three boneset samples and found a wide range of PA variability among them. AHP then gathered, pressed, and identified more than 40 boneset specimens and sent them to USDA analysts, along with blinded controls (both positive and negative) that included herbs known to possess potentially toxic PAs, such as comfrey (*Symphytum* spp., Boraginaceae) and coltsfoot (*Tussilago farfara*, Asteraceae); herbs that contain non-toxic PAs, such as echinacea (*Echinacea* spp., Asteraceae); and herbs not known and unlikely to contain PA, such as stinging nettle (*Urtica dioica*, Urticaceae), among others. Some commercial boneset tinctures also were included, and the

analysts were told how to make an infusion and decoction at dosages consistent with traditional use, since, historically, boneset was prepared mostly as tea.

To AHP's dismay, all authenticated boneset samples and the teas and tinctures tested positive for the potentially hepatotoxic PAs lycopsamine and intermedine. Though the observed concentrations of these PAs in boneset were very low, according to Upton, they still exceeded interim rules established for herbal medicinal products (HMPs) in the European Union (EU).

The monograph was delayed for about two years while AHP gathered the samples, conducted the analyses, interpreted the data, and published the results.[3] AHP also immediately reported its findings through its *Herbal QRS Bulletin*, and some companies removed boneset from their products, even though the risk of hepatotoxicity is likely low in general, according to Upton. Plus, boneset often is used only for short periods of time. Still, some populations, such as fetuses, infants, and people with already-compromised livers, are potentially sensitive to these PAs. Also, because PAs are cleared through hepatic glutathione systems, clearance may be less efficient or may not occur if these systems are compromised.

Upton noted that commercial honey is one of the greatest exposure risks for potentially toxic PAs[4] and typically contains much higher PA concentrations than boneset does, but the EU has not established PA limits for commercial foods like honey. PAs in honey may be a potential contributor of hepatic disease of unknown origin. Other evidence suggests that, over millennia, humans have adapted to deal with exposure to the less toxic PAs.[5] In any case, formal toxicology studies are needed to determine if the PA concentrations in boneset, given at the dosages typically administered, are toxic. AHP could have conducted animal

Boneset *Eupatorium perfoliatum*
Photo ©2020 Steven Foster

toxicology studies to help determine this, but it chose not to deviate from its longstanding no-animal testing policy.

Because of the PA issue, AHP "had to wrestle with whether" to publish the monograph, but after consulting with some of its primary advisors and longtime members, "all agreed that it was important to publish this," Upton wrote. "We hope that regulators will use the information in the monograph as a way to set rational limits for boneset and other herbs that contain low levels of these compounds."

In an AHP press release about the monograph, Upton was quoted as saying: "Because of the high degree of efficacy that [past] physicians reported regarding boneset, it is not an herb that should be lost from the *materia medica*. Perhaps it should no longer be used in common herbal bitters formulas, which are consumed more freely and frequently, but if I had a flu, I would not count out boneset."

The boneset monograph is the 40th monograph published by AHP since 1998. It is available for purchase through AHP's website[1] and was made possible by the financial support of EuroPharma USA, Nature's Way, NOW Foods, Planetary Herbals, and Traditional Medicinals.

About Boneset

Native to eastern North America, boneset is a clump-forming perennial in the sunflower family (Asteraceae). It prefers shady, moist areas and reaches four to six feet tall, with flat-topped clusters of small, fluffy, white flowers.[1,6] Boneset provides nectar for butterflies like the white-M hairstreak and bronze copper butterflies.[7] The species name *perfoliatum* means "through the foliage," because the plant's hairy stem appears to perforate the bases of its wrinkled, opposite, lance-shaped leaves. All parts of the plant are bitter.[1,6]

Accounts vary on the origin of the name boneset. In the 1800s, the plant was used for "breakbone fever" (a name that refers primarily to dengue fever) and "intermittent fevers" (a telltale symptom of malaria). Both dengue and malaria can cause joint and bone pain. Boneset sometimes was used as a quinine substitute. Native American tribes have used boneset as an antipyretic (to reduce fever) and cold remedy. They also have soaked broken bones in boneset tea. Native American use of boneset led to its introduction into American allopathic, Eclectic, and Thomsonian medical practices. The Eclectic physicians used boneset as a diaphoretic (to induce perspiration) and emetic (to induce vomiting). Modern naturopaths and herbalists still use boneset for flu, cough, and pain, as well as for its laxative and diaphoretic effects.[1] HG

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Bacopa: Therapeutic Potential for Alzheimer's Disease?

Reviewed: Abdul Manap AS, Vijayabalan S, Madhavan P, et al. *Bacopa monnieri*, a neuroprotective lead in Alzheimer [sic] disease: A review on its properties, mechanisms of action, and preclinical and clinical studies. *Drug Target Insights*. 2019;13:1-13. doi: 10.1177/1177392819866412.

By Heather S. Oliff, PhD

In Ayurvedic medicine, bacopa (*Bacopa monnieri*, Plantaginaceae) is called *brahmi* and used as a brain tonic to enhance cognitive function and prevent memory loss. *Bacopa monnieri* extract (BME) has antioxidant and neuroprotective properties and, in clinical studies, has been found to improve aspects of cognitive function and memory in both healthy participants and patients with cognitive impairments. The purpose of this literature review was to summarize the experimental and clinical evidence supporting the therapeutic potential of BME for Alzheimer's disease (AD). Various formulations of BME were used in the studies reviewed by the authors.

Study Details: At a Glance	
Study Design	Literature review
Included Studies	In vivo/in vitro research and 15 human clinical trials
Interventions	Various bacopa extracts
Controls	Various
Disclosures	None declared

Mechanisms of Action

In animal and cell studies, BME has been shown to decrease oxidative stress by inhibiting lipid peroxidation, scavenging free radicals, inhibiting the generation of reactive oxygen species (ROSs), and upregulating antioxidant enzymes, among numerous other mechanisms. BME also has been found to ameliorate mitochondrial and plasma membrane damage, protect against cytotoxicity, and inhibit necrotic changes and aggregation of lipofuscin (a pigment associated with cell aging) in rat brains.

In vitro, BME also has been found to enhance the synthesis of acetylcholine, increase acetylcholine concentrations, decrease acetylcholinesterase (AChE) activity, and modulate the metabolism of monoaminergic neurotransmitters. In rats with induced cognitive impairment, BME appeared to have a significantly greater effect when combined with the AChE inhibitor rivastigmine.

BME protected neurons in vitro from amyloid-beta (Aβ)-induced cytotoxicity, and bacoside A (a group of chemicals from bacopa) significantly inhibited Aβ-induced cytotoxicity, fibrillation, and Aβ membrane interactions. In rodent models of AD, BME has been shown to improve learning and memory, improve cognitive ability and antiamnesic activity in aged mice, reverse retrograde and anterograde amnesia, increase discrimination of new objects, and improve spatial learning in amnesiac mice.

In rats, BME has been shown to downregulate the expression of intestinal P-glycoprotein and liver cytochrome P450 3A enzymes, which regulate the absorption and metabolism of many drugs. This suggests a potential for herb-drug interactions, but the clinical significance is unknown.

Human Clinical Studies

The authors briefly describe 15 clinical trials, including 12 double-blind, placebo-controlled (DBPC) studies in adults, one placebo-controlled study in healthy children, one open-label study in children requiring educational support, and one open-label study in participants with AD. The number of participants was only reported for some of the studies; based on the data provided, sample sizes ranged from 17 to 98 participants. BME doses ranged from 150 mg/d to 640 mg/d, with 300 mg/d used in seven studies. One study evaluated a combination product that contained 320 mg BME, 30 mg saffron (*Crocus sativus*, Iridaceae) stigma, vitamins, and minerals. Although all of the studies assessed various aspects of cognitive function, such as attention, learning, and memory, the results cannot be directly compared due to the high degree of heterogeneity among the outcome measures.

In 40 healthy children (6-8 years old) treated with one teaspoon of bacopa syrup (equivalent to 350 mg of "crude Brahmi") or placebo three times daily for three months, no improvements were observed in the placebo group, while the bacopa syrup treatment group had strengthened exploratory drive, improved perceptual images of patterns, and increased perceptual organization and reasoning ability. In an open-label study, children requiring individual educational support who were treated with 225 mg/day BME for 16 weeks experienced significant improvements compared to baseline in working memory, spatial working memory, short-term verbal memory, logical memory, visual memory, and auditory memory.

Most of the DBPC trials enrolled healthy middle-aged and elderly adults. All of the studies reported improvement in various aspects of cognitive function, most commonly heterogeneous measures of memory function, learning, attention, and speed of processing. The study that assessed the cognitive effects of acute doses in 17 young adults (mean age of 25 years) one and two hours after ingestion found significant improvements in information processing speed at both time points.

Only one trial evaluated patients with AD. The open-label study evaluated BME for six months in 39 patients (60-65 years old), and improvements were observed in some aspects of the Mini-Mental State Exam, including orientation, attention, and language comprehension.

The AD open-label study and 10 of the DBPC trials assessed CDRI-08, a bacoside-enriched standardized BME originally developed by the Central Drug Research Institute in Lucknow, India (produced under license by M/s Pharmanza Herbal Pvt. Ltd. [Gujarat, India] and sold under various trade names) or a comparable standardized BME. In these studies, 300-600 mg/d for 12-24 weeks significantly enhanced some aspects of cognitive performance in healthy participants, elderly people, and patients with AD.

Conclusion

Although the clinical studies are heterogeneous, it appears that BME improves some aspects of cognition in healthy participants and is a promising candidate to help some symptoms of AD. However, well-designed DBPC trials are lacking. In addition, because some of the experimental evidence suggests the cognitive effects of BME are dose-dependent, studies also are needed to determine the optimum dose for AD patients.

Limitations of this narrative literature review include the lack of a comprehensive literature search and missing information in several of the clinical studies. In addition, the methodological quality of the clinical studies was not assessed, safety was not reported, and the sample sizes were relatively small.

Bacopa *Bacopa monnieri*
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* Quirós-Fernández R et al. Nutrients 2019 ;11, 3; Stockton A et al. EC Nutrition 2015 2.4: 396-411; Torregrosa-Garcia A et al. Nutrients 2019 11, 721; Atkinson FS et al. Nutrients. 2019 11, 8

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Systematic Review and Meta-analyses of Lavender for Anxiety

Reviewed: Donelli D, Antonelli M, Bellinazzi C, Gensini GF, Firenzuoli F. Effects of lavender on anxiety: A systematic review and meta-analysis. *Phytomedicine*. 2019;65:153099. doi: 10.1016/j.phymed.2019.153099.

By Heather S. Oliff, PhD

Study Details: At a Glance	
Study Design	Systematic review and meta-analyses
Included Studies	65 randomized controlled trials and 25 non-randomized studies
Interventions	Various lavender preparations
Controls	Various
Disclosures	None declared

Worldwide, up to 15% of the general population is affected by anxiety disorders. Lavender (*Lavandula* spp., Lamiaceae) flower essential oil is a traditional remedy for anxiety and has demonstrated anxiolytic and sedative properties. The purpose of this systematic review and meta-analyses was to evaluate the effects of lavender on anxiety and anxiety-related disorders.

The study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. PubMed, Scopus, Web of Science, Cochrane Library, Embase, and Google Scholar were searched from inception up to November 2018 using the terms "lavender," "lavandula," "Silexan," "anxiety," "anxious," and "anxiolytic."

Lavender *Lavandula angustifolia*
Photo ©2020 Steven Foster

Systematic Review

Included in the systematic review were randomized controlled trials (RCTs) and non-randomized studies (NRSs) that evaluated lavender (any species, any preparation form, any route of administration) for anxiety using any type of comparator and a validated instrument to assess anxiety. The authors excluded animal and in vitro studies and trials with unclear/unspecified sample sizes or missing data. Also excluded were studies that used lavender blends of unknown composition, with unspecified proportions, or in which lavender did not account for the majority of the blend.

A total of 90 articles met the systematic review criteria, including 65 RCTs (N = 7,993) and 25 NRSs (N = 1,200). The RCTs had a range of 13 to 597 participants with a mean sample size of 90. A single, acute dose of lavender was evaluated in 38 RCTs, and chronic lavender treatment was evalu-

ated in 27 RCTs. The most commonly evaluated lavender species was *L. angustifolia*, and the most common route of administration was inhalation/aromatherapy (49 RCTs), followed by topical (10 RCTs) and oral (6 RCTs). Controls included placebo, usual care, no intervention, and positive control. The most commonly used outcome measures were the State-Trait Anxiety Inventory (STAI), Zung Self-Rating Anxiety Scale (Zung SAS), and Hamilton Anxiety Rating Scale (HAM-A).

Of the 65 RCTs included in the systematic review, 54 RCTs (83%) found that lavender significantly improved anxiety compared with baseline or control ($P < 0.05$), and 11 RCTs concluded that lavender had no significant benefit. Of the 25 NRSs, 17 (68%) reported that lavender had a significant beneficial effect on anxiety. Seven studies (six RCTs and one NRS) reported adverse events (AEs), which included headaches, palpitations, infections, and gastrointestinal disorders. No serious AEs were reported.

Risk of bias (RoB) was assessed with the Cochrane Collaboration RoB tool. Considering performance bias as a key domain, the overall quality of the evidence was rated as low, with approximately 89% of the RCTs characterized by a high RoB. When performance bias was not considered a key domain (e.g., topical application and inhalation studies in which blinding is difficult), 71% of the RCTs had a high overall RoB.

Meta-analyses

In addition to the systematic review, the authors conducted several separate meta-analyses. Included RCTs evaluated patients with anxiety, in an anxiety-inducing setting, or performing an anxiety-inducing activity, and used validated scales to quantify anxiety levels. Interventions were oral administration of the proprietary, standardized lavender essential oil (LEO) product Silexan® (Dr. Willmar Schwabe GmbH & Co. KG; Karlsruhe, Germany), LEO inhalation, or massage with LEO; and comparators were usual care, no intervention, sham intervention, placebo, or massage without LEO.

A total of 37 of the 65 RCTs met these criteria and were included in seven separate meta-analyses.

1. Meta-analysis of five RCTs (N = 1,173) evaluating the effect of 80 mg/day of Silexan on anxiety measured with the HAM-A indicated that Silexan significantly reduced anxiety compared to placebo ($P = 0.004$).
2. Meta-analysis of three RCTs (N = 451) assessing the effect of 80 mg/day of Silexan on anxiety measured with the Zung SAS indicated that Silexan significantly reduced anxiety compared to placebo ($P = 0.02$).
3. Meta-analysis of 12 RCTs (N = 901) evaluating the effect of LEO inhalation on state anxiety measured with the STAI-State indicated LEO significantly reduced anxiety compared to the controls ($P = 0.0006$). Subgroup analyses of situations inducing high-anxiety and mild-anxiety revealed that in both cases LEO significantly reduced anxiety compared to the controls ($P = 0.04$ and $P = 0.06$, respectively).
4. Meta-analysis of four RCTs (N = 196) assessing the effect of LEO inhalation on trait anxiety measured with the STAI-Trait indicated that LEO significantly reduced anxiety compared to the controls ($P = 0.01$).
5. Meta-analysis of six RCTs (N = 398) evaluating the effect of LEO inhalation on systolic blood pressure (a proxy for anxiety levels) compared to no intervention or to sham intervention indicated that LEO had no significant effect.
6. Meta-analysis of 24 RCTs (N = 1,682) assessing the effect of LEO inhalation on anxiety measured with any validated scale indicated that LEO significantly reduced anxiety compared to the controls ($P < 0.0001$). Subgroup analyses showed that LEO significantly reduced anxiety compared to the controls in high-anxiety situations ($P < 0.0001$) but not in mild-anxiety situations.
7. Meta-analysis of six RCTs (N = 448) evaluating the effect of LEO massage on anxiety measured with any validated scale compared to other physical therapies or usual care indicated that LEO significantly reduced anxiety compared to the controls ($P < 0.001$), and this effect was maintained in the subgroup analysis of high-anxiety situations.

Conclusion

In summary, the meta-analyses indicate that oral Silexan and LEO inhalation can significantly reduce anxiety compared to controls. Massage with LEO also appears to reduce anxiety, but more research is needed to demonstrate that the benefit is due to a specific effect of lavender.

The limited safety data indicate that lavender is well-tolerated with no serious AEs. Acknowledged limitations include the low quality of evidence and high RoB of the included RCTs and the heterogeneity of the study designs.

"Further high quality RCTs with more homogeneous study designs are needed to confirm these findings," the authors wrote. "[S]ince treatments with lavender essential oil generally seem safe, and, in the case of inhalation, also simple and inexpensive, they are a therapeutic option which may be considered in some clinical contexts." HG

Saffron Comparable to Methylphenidate (Ritalin®) in Treatment of ADHD

Reviewed: Baziar S, Aqamolaei A, Khadem E, et al. *Crocus sativus* L. versus methylphenidate in treatment of children with attention-deficit/hyperactivity disorder: A randomized, double-blind pilot study. *J Child Adolesc Psychopharmacol*. 2019;29(3):205-212. doi: 10.1089/cap.2018.0146.

By Heather S. Oliff, PhD

Study Details: At a Glance	
Study Design	Randomized, double-blind, controlled trial
Participants	54 children (6-17 years old) with diagnosed ADHD
Intervention	20-30 mg/day saffron
Control	Escalating doses of methylphenidate
Disclosures	None declared

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common mental disorders in children and adolescents. Although the pathophysiology has not been fully determined, evidence suggests it involves malfunction of monoaminergic and glutamatergic neurotransmitter systems. The first line of treatment for ADHD is pharmacotherapy with stimulants such as methylphenidate (MPH; Ritalin®; Novartis Pharmaceuticals; Basel, Switzerland). However, approximately 30% of patients do not respond to treatment or cannot tolerate the adverse effects (AEs). Among the nonstimulant therapies that have been assessed, antidepressant drugs have been reported to improve ADHD symptoms, but these therapeutics also are associated with significant AEs. Dried stigmas of saffron (*Crocus sativus*, Iridaceae) may be a safe and effective treatment option for ADHD. Saffron has clinically demonstrated antidepressant and anxiolytic effects, and in experimental studies, it has shown neuroprotective properties, learning and memory enhancement, and modulation of monoaminergic and glutamatergic systems. The purpose of this randomized, double-blind, controlled pilot study was to compare the efficacy and safety of saffron and MPH in children and adolescents with ADHD.

Boys and girls (N = 54; 6-17 years old) with ADHD according to the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) were recruited from the outpatient child and adolescent psychiatry clinics at Roozbeh Psychiatric Hospital (affiliated with

Saffron *Crocus sativus*
Photo ©2020 Steven Foster

Tehran University of Medical Sciences) in Tehran, Iran. Included patients had total and/or subscale scores on the Attention-Deficit/Hyperactivity Disorder Rating Scale-IV (ADHD-RS-IV) of at least 1.5 standard deviations above norms for patient age and gender. Excluded patients had psychiatric comorbidities (except for oppositional defiant disorder); intellectual development disorder (defined as having an IQ < 70); a clinically significant chronic medical condition (such as epilepsy, organic brain disorders, or cardiac abnormalities); systolic blood pressure greater than 125 mmHg and/or resting pulse rate below 60 beats/min or above 110 beats/min; a history of allergy to saffron; psychotropic medication use in the previous two weeks; any anti-coagulant drug or herbal supplement use that might adversely react with saffron; were pregnant or lactating; or were scheduled to undergo surgery within 14 days.

Patients were randomly assigned to receive either 20-30 mg/day saffron depending on body weight (20 mg/day for < 30 kg and 30 mg/day for > 30 kg) or escalating doses of MPH for six weeks. The manufacturer of the 10-mg saffron capsules and the chemical characteristics of the saffron were not reported. MPH was initiated at a dose of 0.3-1 mg/kg/day and titrated up to 10 mg/day in week one, 20 mg/day in week two, and in weeks three through six, 20 mg/day for children < 30 kg and 30 mg/day for children > 30 kg. Parents and teachers completed ADHD-RS-IV ratings at baseline, three weeks, and six weeks. The primary outcome measure was the change in scores on the parent version of the ADHD-RS-IV. Secondary outcome measures were the change in scores on the teacher version of the ADHD-RS-IV and response rates (defined as ≥ 40% decrease from baseline to six weeks) on the parent and teacher ADHD-RS-IV ratings.

Baseline characteristics did not significantly differ between groups. Twenty-five patients in each group completed the study; two patients in each group were discontinued because consent was withdrawn. Changes in parent and teacher ADHD-RS-IV scores indicated both the saffron and MPH groups experienced significant improvements in hyperactivity and inattention at three weeks ($P < 0.001$ for both groups), and these benefits were maintained through to six weeks. At six weeks, changes in parent and teacher ADHD-RS-IV scores did not significantly differ between groups.

Based on the parent ratings, there were no significant between-group differences in response rates (100% in the saffron group and 96% in the MPH group) or the percentage of patients exhibiting marked improvement (96% of the saffron group and 84% of the MPH group), which was defined as a decrease in ADHD-RS-IV scores of at least 50%.

Saffron *Crocus sativus*
Photo ©2020 Steven Foster

The teacher ratings indicated a much lower response rate (52% in the saffron group and 56% in the MPH group) and a much lower percentage of patients showing marked improvement (40% of the saffron group and 48% of the MPH group). However, the differences between groups were not significant. No serious AEs were reported, and the incidence of AEs did not significantly differ between groups.

The authors concluded that 20-30 mg/day saffron for six weeks was comparable to MPH for the treatment of ADHD. Acknowledged limitations of the study include the lack of a placebo control, relatively small sample size, lack of neurocognitive tests, and short treatment duration. In addition, no information was provided about concentrations of important constituents (e.g., crocins, safranal, and picrocrocin), which are known to differ depending on the saffron variety. Larger and longer placebo-controlled studies are warranted to confirm these findings. HG

Iboga *Tabernanthe iboga*
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CONTROVERSY IN THE CONSERVATORY:

Iboga Confiscation and Professor Suspensions at Ohio's Miami University

By Karen Raterman

Editor's note: A previous version of this article was published in the December 2019 issue of ABC's HerbalEGram newsletter. This version has been revised to reflect developments that occurred in January 2020.

Plants have a history of both bringing great value and creating conflict, but the debate surrounding the decade-long presence of an iboga plant (*Tabernanthe iboga*, Apocynaceae) in the Hamilton Conservatory on Miami University's Hamilton, Ohio, campus (MUH) came as a surprise to many. The controversy began in November 2018, when, because of the presence and potential illicit use of the plant, two of the university's professors and a student were suspended and a staff member at the conservatory was asked to resign.

Iboga is a short shrub-like plant that is native to western Africa. Its roots contain ibogaine, an active alkaloid that shows medicinal potential to treat substance-use disorders, among other conditions.[1] But ibogaine also is known for its psychoactive effects, and it is listed by the US Drug Enforcement Administration (DEA) as a Schedule I substance,[1] defined as a substance that currently has no accepted medical use and a high potential for abuse.[2]

Some details about the original acquisition of the iboga seeds and intent for the plant are unclear, but the Miami University Police Department (MUPD) provided a comprehensive account of the initial incident, which was reported in *The Cincinnati Enquirer*. According to the article, botany student Kelsey Lovelace told Ryan Young, a university alumni office employee, of the iboga plant's presence and hallucinogenic properties. Lovelace also noted that she was growing her own iboga tree at home and that she and her friends planned to consume the root when it became mature enough to produce ibogaine. Lovelace denies that she ever said this. She was not interviewed by the MUPD or MUH officials. The MUPD report was based on Young's report to Catherine Bishop-Clark, the dean of the university's regional campus. Young's claims were not questioned or independently verified. After his reported discussion with Lovelace, he emailed Bishop-Clark, and

told her about the presence of the plant and Lovelace's intentions. Without having a conversation with either faculty member or the manager of the conservatory beforehand, the dean then forwarded the email to both the MUPD and the DEA.[3]

Both agencies investigated, and while neither filed criminal charges, the MUPD confiscated the plant. The university, however, suspended Lovelace for the fall 2018 semester; suspended Professor Daniel Gladish, PhD, and Associate Professor John Cinnamon, PhD, who were both tenured; and asked the conservatory manager, Brian Grubb, to resign.

More than a year later, Cinnamon remains suspended and faces potential termination, pending review of his appeal. In late January 2020, the university announced that Gladish had been exonerated (W.H. Eshbaugh email to M. Blumenthal, January 30, 2020). Although this bodes well for Cinnamon's appeal, MUH has been criticized for its handling of the incident, which has been called everything from "bewildering" and "inept" to "heavy-handed." The school insists that it treats faculty with fairness, however. The case raises many questions about the status of plants that contain illegal compounds. Perhaps even more importantly, the primary question may be whether professors at institutes of higher learning should have the academic freedom to pursue knowledge of obscure botanicals and their uses by indigenous peoples, despite their regulatory status.

The situation also has caused concern at other universities and academic institutions across the United States because of its potential "chilling" impact on the study of botanicals and ethnobotany, and other research in general.[4]

A Matter of Principle

Both professors appealed the ruling, but Cinnamon's appeal is on hold pending a medical leave. While Gladish did not respond to requests for comment during his appeal, one source close to him said he appealed the university's ruling as a "matter of principle." In a September 30, 2019, conversation with his colleague W. Hardy Eshbaugh, Miami University (MU) professor emeritus of botany, Gladish stated that he did not believe he had done anything wrong and that, at age 70, he wanted to fight the ruling, clear his name, and return to the university to continue teaching (W.H. Eshbaugh oral communication to K. Raterman, October 1, 2019). In particular, Eshbaugh said Gladish wanted to finish working with several graduate students who had to come to him during his suspension because the university banned him from campus. A January 30, 2020, announcement from the MU chapter of the American Association of University Professors (AAUP) noted that Gladish was not only exonerated but also reinstated with tenure and at his former rank (Cathy Wagner [MU AAUP president] email to W.H. Eshbaugh).

Gladish began working at the university in 1994. In addition to teaching students, Gladish studies plants to understand how they respond developmentally and physiologically to conditions in an environment to predict the consequences of environmental change on both wild and cultivated plants.[5] He played an important role in establishing the Hamilton Conservatory at MUH, working with local donors as well as faculty, administrators, and architects. The conservatory opened in 2005 and serves all of the MU campuses as well as the local community.[6] Daniel Hall, EdD, a professor who specializes in

The case raises many questions about the status of plants that contain illegal compounds.

Hamilton Conservatory, Miami University
Photo ©2020 Woolert

constitutional and criminal law and the campus's former dean who helped raise the money to open the conservatory and appointed Gladish as its director, confirmed that Gladish's duties primarily were to build the conservatory's plant collection, engage the community, and develop academic programming, not to put his hands in the dirt.

Cinnamon, an anthropologist who specializes in religion, politics, and ethnicity, declined to answer any specific questions, on recommendation from his lawyer, but he noted: "I have never grown [iboga], but I am accused by the university of having provided seeds to the Miami Hamilton Conservatory 15 years ago.... My case is on hold while I am on extended medical leave but will start again in early 2020" (email, October 6, 2019).

The situation also has caused concern at other universities and academic institutions across the United States because of its potential "chilling" impact on the study of botanicals and ethnobotany, and other research in general.

Cinnamon also has two decades of service at the university, where he supported the Hamilton campus mission by producing local ethnographies[7] and engaging with community groups. He specializes in historical anthropology, environmental anthropology, and intersections of religion, politics, ethnicity, and nationalism in Africa. He has worked primarily in Gabon and Cameroon, where iboga is native.[8]

According to some reports, Cinnamon originally acquired the iboga seeds and gave them to the first manager of the conservatory when it opened in 2005. The seeds were planted as part of an effort to build a biologically diverse and academically relevant collection.[6]

After the DEA and MUPD investigations, University Provost Phyllis Callahan charged Gladish and Cinnamon with professional incompetence and for violating the university's policies on a drug-free workplace and on reporting and addressing illegal activity and misconduct.[4] Grubb, the conservatory manager, was an at-will employee and was given the option to either resign or not have his contract renewed. All three men deny knowing that the iboga plant contains a controlled substance.[6]

In a July 2019 commentary in *The Cincinnati Enquirer*, Hall expressed concern about the treatment of all four people involved. "I am shocked from a legal perspective…, as a faculty member, and as a citizen," he wrote in the July 5, 2019, opinion piece. "I consulted five attorneys and three senior law enforcement officers. Seven of these people concluded that the university's decisions [were] patently unreasonable. The eighth believes [those involved] were negligent, warranting only minor discipline."[6]

Although it is illegal to possess ibogaine, it is not clear whether that restriction also applies to possession of the iboga plant. Both legal and botanical experts have noted that some plants contain controlled substances that are illegal to possess and distribute, while the plants themselves are not, citing examples like the opium poppy (*Papaver somniferum*, Papaveraceae), which contains opium, and even nutmeg (*Myristica fragrans*, Myristicaceae), which contains myristicin, a natural compound that in large doses can produce psychoactive effects.[9]

Hall wrote that the status of iboga is unclear and also noted that many plants do have dangerous and/or mind-altering properties but are not necessarily classified as controlled substances. He cited plants, all of which grow in Ohio, including jimson weed (*Datura stramonium*, Solanaceae) and the seeds of morning glory (*Ipomoea* spp., Convolvulaceae), both of which have hallucinogenic properties, and hemlock (*Conium maculatum*, Apiaceae), which is poisonous.[6]

In addition, it is disputed whether the seeds of the MUH iboga shrub were brought into the United States legally. One of the university's suspension letters reportedly suggests that Cinnamon illegally imported the iboga seeds from Gabon in 2004 before giving them to Gladish for the conservatory.[3]

If this is true, that would be significant, according to ethnobotanist Michael J. Balick, PhD, vice president for botanical science, director and philecology curator at the Institute of Economic Botany of the New York Botanical Garden (NYBG). "Not clearing [the seeds] through customs, if that is [the case in this situation], would be a serious mistake by the person who brought in the seeds," Balick explained (oral communication, October 2, 2019). "Any plant collector or, for that matter, any traveler who comes into the US via air, land, or sea must declare any plant materials and clear these through the US Department of Agriculture, including having import permits stating the genus and species. It is a complicated but necessary process."

According to a report in *The Miami Student*, Cinnamon's lawyer, Erin Heidrich, said that the professor does not remember receiving the seeds, but, if he had, he would have given them to the conservatory for research.[10]

One might say that Gladish should have known that iboga contains a controlled substance that might be of questionable legality. Hall counters, however, that iboga shrubs have been found at various other university conservatories and greenhouses, including at Gladish's alma mater, the University of California, Davis (UC Davis).[6]

The study of obscure plants, including iboga, in university programs is relatively common, according to Ernesto Sandoval, director of the UC Davis Botanical Conservatory (oral communication, October 29, 2019). But it is complicated, he said, and getting more so. Sandoval noted, for example, that the San Pedro cactus (*Echinopsis pachanoi*, Cactaceae) is abundant in public

and private gardens throughout the West and is not listed as a Schedule I substance even though it contains some of the same compounds as peyote (*Lophophora williamsii*, Cactaceae), which *is* a Schedule I substance (oral communication, December 5, 2019).

Nevertheless, the presence of such plants may be getting less common as universities weigh the pros and cons. "I have talked to several colleagues at other universities, before and during this incident," Sandoval said, "and they have been speaking to their administrations and deciding that it is best to get these plants out of the institution due to the potential for legal issues." While he would not name the universities with which he spoke, Sandoval said that at UC Davis, after internal discussions with people on campus who deal with controlled substances, a mutual decision was made to remove or destroy any plants that may cause legal problems for the university. UC Davis did have an iboga plant for a couple of years, he added, "but they are difficult to grow, and we didn't figure out its climatic needs."

The University of Colorado (CU) in Boulder, Colorado, also was reported to have an iboga plant in its conservatory. When asked to confirm whether the plant was still present, Tim Hogan, collection manager of the CU Museum of Natural History's herbarium, said: "I have looked into this, and it appears the CU greenhouses no longer have the iboga tree to which you refer. It is unfortunate there are sentiments at an institute of higher learning that [caused] such a unique specimen in the living plant collection [to be] deaccessioned" (email, October 30, 2019).

If this becomes the norm, it may indeed be unfortunate. While ibogaine currently is not used in medical practice in the United States, studies suggest that it may be useful for drug detoxification and treating substance abuse. For example, the compound has been found to reduce symptoms associated with opioid withdrawal, post-acute withdrawal syndrome, and cravings for opioids, alcohol, and cocaine, to name a few.[1] The plant also has significance from a cultural and ethnobotanical perspective. The name "iboga" translates to "to care for" or "to heal" in various tribal dialects of the Congo Basin, where the plant has been used for centuries as a medicine and sacrament in the traditional spiritual discipline of Bwiti.[1]

'Ibogagate'

Back at MU, the case of the professors and the iboga plant prompted backlash and came to be known as "Ibogagate." Many individuals and organizations in the academic community have favored reversing the decision, including the university's chapter of the AAUP, a group whose mission is to support faculty welfare and encourage their involvement in governance. In addition to articles in *The Cincinnati Enquirer* and other local and national media, the AAUP published an article expressing concern over the possibility of the professors' terminations and also circulated a petition in their support.[11] The petition was submitted to MU leadership on September 15, 2019, with 2,300 signatures from MU faculty, students, and community members, as well as botanists and anthropologists in the United States and beyond.[12]

The AAUP also published letters of support written to MU President Gregory Crawford from organizations and individuals including the Botanical Society of America,[13] Professor Gretchen Walters of the University of Lausanne in Switzerland,[14] Eshbaugh,[15] and the American Anthropological Association.[16]

Iboga *Tabernanthe iboga*. Photo ©2020 Scamperdale

> "Sometimes for students it is much better to see the plant than to look at a PowerPoint presentation or read a PDF. It brings the plant and its cultural importance to life. This was just a plant in a collection. We don't know that any nefarious use was intended or made."

Adding further fuel to the controversy, MU has since attempted to implement a policy for reporting arrests and illegal activity, which AAUP notes is part of a recent pattern by the university, including the iboga case. AAUP says this goes far beyond Ohio law and appears to place liability and risk reduction above other university values and at the expense of faculty members.[17] The policy would require faculty to "report any formal police report, arrest, charge or indictment for alleged criminal conduct ... to the Office of General Counsel, within three working days." In a faculty assembly meeting in September 2019, 350 faculty members voted unanimously to put the policy on hold and send it back to the university Senate.[18]

Eshbaugh said he believes that the incident is a wakeup call for the university, noting that the presence of 350 faculty at the meeting sends a strong message that they want to be involved in governance. "I have no idea what will happen in the iboga case," he said before Gladish's exoneration, "but I suspect if [the appeal] goes against the professors, it would not surprise me if the faculty ends up censuring the university." He added that such a move might damage the university's reputation and impact enrollment and funding for years.

Dissecting a Decision

The question that remains is why MU chose to take such a hardline position. Although the university did not respond to specific questions, its communications director, Claire Wagner, contradicted concerns that the university does not value its faculty or freedom of academic research. "Teaching and research are at the heart of Miami University's academic mission," she wrote (email, November 18, 2019). "Miami fully supports faculty and staff in these endeavors with the expectation that all university policies and local, state and federal laws are followed. Possession of an iboga plant is illegal in the United States absent a federally approved research permit."

Wagner added that "Miami also is committed to treating all employees fairly. This includes giving accused faculty the opportunity to present their case in an impartial hearing before a decision and/or potential discipline are determined. This matter is being handled following this university process."

Those close to the situation have offered some speculation about the university's harsh reaction. Eshbaugh, for example, believes that it is reflective of how the US government thinks about drug plants. He noted that there was such paranoia, particularly about plants with hallucinogenic properties, that a 1976 book, *Hallucinogenic Plants (A Golden Guide)* (Golden Press) by Richard E. Schultes, PhD, a Harvard University ethnobotanist who was considered a preeminent authority on hallucinogenic and medicinal plants, was limited to a first edition printing, the only guide so limited in a series of more than forty publications.[19]

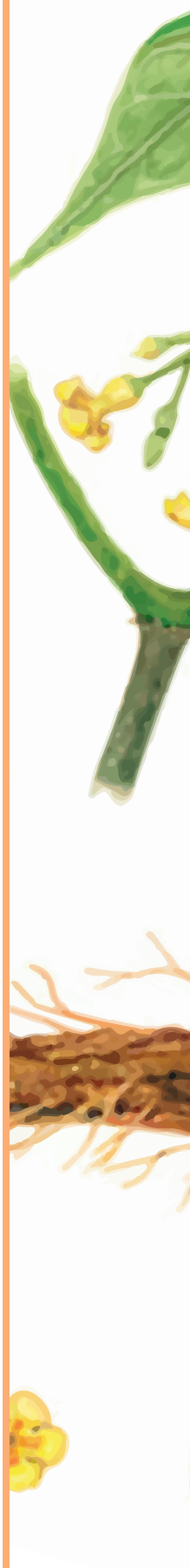
The way people study plants has been hampered for many years, Eshbaugh said. He cited cannabis (*Cannabis* spp., Cannabaceae) as another example. Because of its legal status, it was, for many years, legally grown and studied at only one place in the United States: the University of Mississippi. Meanwhile, Eshbaugh added, researchers in other countries like Israel, Germany, Italy, and Thailand have studied these plants in a meaningful way and advanced the use of compounds from cannabis for children with epilepsy, for example. "I don't know where we would be today if we had allowed that. The Europeans and Asians have pioneered much of the science on drug plants we rely on today."

Sandoval thinks "it is a shame that they made this decision that affected four people and careers when no DEA or local sheriff charges were filed." He noted that the issue hits close to home for him because Gladish is a UC Davis alumnus and a 30-year friend. "If you read between the lines, I think there were non-academic issues involved, and it's a disappointment that this would happen, especially considering it would take years and a lot of processing to make any drugs from this plant."

The university "completely overreacted," according to NYBG's Balick. "If they did this for everything a university administration faces, there wouldn't be a university left," he said. "They need a botany lesson about how plants work and the importance of teaching students by touching, feeling, and smelling plants. Sometimes for students it is much better to see the plant than to look at a PowerPoint presentation or read a PDF. It brings the plant and its cultural importance to life. This was just a plant in a collection. We don't know that any nefarious use was intended or made."

Balick also attributed the decision to a "moral panic" at the university. "Perhaps someone is bending over backward to ensure that they have no culpability."

Hall sees the hardline approach as a form of risk and reputation management. "Some people believe that can't be the case because it is hurting the university," he said. "But that is only because the story has gone public. I don't think they thought it would generate so much interest."



Sandoval is thankful that other institutions are taking a different approach. "They are looking at the problem and taking plants out of the collection, but faculty and staff are not being ejected."

No matter how Cinnamon's appeal turns out, there are implications for both this university and beyond. Eshbaugh said that the situation already has caused a loss of years of institutional knowledge and will likely have a financial impact on the conservatory and the university.

For some, it may be impractical to keep controversial plants. "The legal lines have been drawn, and they will create a barrier of access to these things," said Sandoval. "In my situation, I won't grow certain plants, and students won't see them, if I have to go through serious legal hoops to grow them, keep them under lock and key, and spend an inordinate amount of time because of the legal requirements. It makes more sense not to have them."

Hall said he is not surprised that universities are getting rid of the plants. "This is reflective of a larger problem at universities — excessive corporatization," he said. "They fear and react to any news that they perceive as diminishing their brands or putting them at odds with accrediting or legal authorities, even when there isn't evidence that the feared outcome will occur. In this environment, brand and risk management too often trump academic freedom, academic quality, and humanity" (email, November 20, 2019).

It is difficult to estimate the long-term impacts of these kinds of decisions. The study of ethnobotany, and in particular plants with psychoactive effects, is of interest to students. "Over the years, our society, including students, has developed what is referred to as plant blindness," said Balick. "They don't recognize the importance of the green world or choose to learn about plants, and only a few degrees in botany are awarded at US universities. So, our job as professors and teachers of botany is to change that. Ethnobotany, I think, is a 'gateway subject' to bring in students and get them excited about the plant world and to stand at the vanguard of people who defend the earth from what is happening today.

"Students get excited about the relationships between plants and people and culture," Balick continued. And ultimately, he added, the study of psychoactive plants is a legitimate area of inquiry, and it is time to think about it differently. "Every culture has psychoactive plants or substances. It is ubiquitous through human culture and history. In Western culture, these include alcohol, cigarettes, chocolate, and coffee — all of which are derived from plants and have an impact on the mind. So, understanding how these are processed and used traditionally gives us a cultural perspective that is an essential theme of ethnobotany."

We need academic disciplines, he added, "to bring people out of the Middle Ages and treat plant blindness to help make them more aware of nature. Without students working on conservation and on the front lines of environmental issues, we are in trouble." HG

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Feliciano Sevillano, an expert on the sustainable production of dragon's blood, inspecting the flow of latex from a tree that may be selected as a "mother tree" to produce seedlings for reforestation in the lower Napo River region. Photo ©2020 Steven King

Sustainable Harvesting of Dragon's Blood (*Croton lechleri*) in Peru

By Steven King, PhD, Manuel Lazaro Martin, Ricardo Pariona Fonseca, Mario Pariona Fonseca, Cesar Gregorio Lozano Diaz, and Kodix Garcia Valles

This article describes the sustainable management practices and use of sangre de drago (Croton lechleri, Euphorbiaceae), meaning "dragon's blood," a medicinal plant native to tropical forests, which has been used in traditional medicine by many Amazonian indigenous peoples and cultures for centuries. This plant is also used as a phytomedicine in Latin America, North America, and Europe. The authors, who are experts in the sustainable management of dragon's blood, describe how they are working to create strategic alliances with families, communities, and regional nonprofit agencies to promote an ecologically sound production network focusing on triple bottom line benefits for a diverse array of stakeholders, including local forest-dwelling people, patients, communities, and tropical forest biocultural diversity. The authors have been working with plants, people, and communities in the Peruvian Amazon for more than 30 years.

The increased global focus on managing human health with plant-based medicines is enhancing the wellbeing of many people but continuing to put pressure on wild medicinal plant populations. Cultivation of medicinal plants, along with sustainable wild harvesting, can ensure the long-term survival of medicinal plant species around the world for the benefit of local producers, patients, ecosystems, and developers of plant-based products. A number of initiatives, nonprofits, companies, communities, and individuals are working to implement and document sustainable harvesting and management practices worldwide.

This article is a follow-up to the article "Blood of the Dragon: The Sustainable Harvest and Replanting of the *Croton lechleri* Tree," which was published in *HerbalGram* issue 84 in 2009.[1] In this report, we provide an update on the sustainable harvesting and management of *C. lechleri* in the Peruvian Amazon with multiple partners over the past decade.

In 2012, the US Food and Drug Administration (FDA) approved Fulyzaq® (now called Mytesi®; Napo Pharmaceuticals; San Francisco, CA) as the first oral botanical drug which is a chemically complex new molecular entity (NME) for the symptomatic relief of non-infectious diarrhea in patients with HIV/AIDS on antiretroviral therapy.[2] The active ingredient in Mytesi is crofelemer, which is isolated and purified from the latex of *C. lechleri*. Crofelemer is a complex proanthocyanidin that currently cannot be produced by a synthetic method. Because of this, the producers of Mytesi (including the authors of this article) have been focusing on the long-term sustainable management and harvesting of *C. lechleri* during the development

and commercialization of Mytesi. The development and regulatory approval of Mytesi has been a long-term process that allowed for investments in studies on basic biology and ecology and the implementation of reforestation programs over many years. (See Table 1 on page 48 for a list of products currently sold or under development that are extracted and purified from the latex of *C. lechleri*.)

Croton lechleri: Botany, Benefits, and Regeneration

Croton lechleri is a fast-growing tropical tree in the spurge family of plants, many of which produce milky, usually white, sap. Sangre de drago is the common name of both the tree and the characteristic deep red latex produced by this species. *Croton lechleri* is the most well-known and widespread of the red latex-bearing *Croton* species in the northwest Amazon basin, and it is found throughout parts of Colombia, Ecuador, Peru, Bolivia, and Brazil.

The small-to-emergent canopy tree has white or gray bark that exudes clear red latex when lacerated. This tree is monecious (it contains female and male reproductive organs in the same individual) and is a pioneer species that often is found in disturbed sites and in riparian habitats (adjacent to rivers). It tolerates both sun and light shade, and its seedlings typically grow 1-2 m per year. *Croton lechleri* is not listed as endangered or threatened under the US Endangered Species Act or the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and is not entitled to special protection under other US federal laws or via any international treaty to which the United States is a party.

Croton lechleri has been shown to help optimize soil conditions in secondary forests, which facilitates ecological succession and restores soils that have been degraded as a result of clear-cutting. In secondary forests, *C. lechleri* provides shade for understory growth and improves soil biology through aeration and the addition of organic matter to the soil, which not only returns important nutrients to the

Florencia Cuno Pishagua, from the Asháninka indigenous community of Puerto Porvenir, in a field with *Croton* trees planted as part of her agroforestry food production system. She has received plants, technical support, and financial assistance as part of the reforestation activities in the Pichis River valley.
Photo ©2020 Steven King

Enemias Jumanga Villar, from the Asháninka indigenous community of El Milagro near the town of Lorencillo, with seedlings of *Croton* delivered to him for his food and medicinal plant agroforestry garden near his home. Photo ©2020 Ricardo Pariona Fonseca

Ricardo Pariona Fonseca, general manager of CORFA SAC, preparing *Croton* seedlings for transport to a local family for planting in an agroforestry system in Lorencillo in the central rainforest area of Peru.
Photo ©2020 Steven King

soil (e.g., nitrogen, phosphorus, calcium, potassium, and magnesium), but also balances soil pH and catalyzes microbial activity.

Dragon's blood is used in traditional medicine by local and indigenous people for a number of purposes, including diarrhea, ulcers, wound healing, skin infections, and respiratory problems.[3-8] Because of its effectiveness at healing cuts and treating various gastrointestinal issues, and the wide distribution of *C. lechleri* trees, dragon's blood is one of the most common traditional medicines in all of Latin America. Commercial products based on *C. lechleri* extract are found widely in the Peruvian Amazon, in the capital city of Lima, as well as in many places in North America and Europe. Throughout its natural range, *C. lechleri* trees are considered part of the standard natural pharmacopeia and frequently are observed growing in local gardens where the latex can be extracted as needed, typically by cutting a small incision in the trunk with a machete, a process known as tapping.

Preliminary studies have found that the tapping method of latex extraction (wherein crude plant latex is extracted without initially harming the tree) is less successful for large-scale production than the traditionally used felling method (cutting the tree down to extract latex from the felled tree).[5] The average volume of latex obtained differed significantly between the two methods of harvesting (50 mL using the tapping method versus 3,000-3,800 mL using the felling method), and within 10-12 months following tapping, the tapped trees suffered a high mortality rate.[1]

A boat transporting latex on the Huallaga River near the city of Yurimaguas, Peru. In this region of tropical forest in the department of Loreto, the primary mode of transportation is via rivers and streams. Photo ©2020 Steven King

Natural Regeneration and Seedling Reproduction

Experts assert that successful natural regeneration is key to the sustainable management of tropical forests. Assuring the replacement of harvested specimens is a constant concern for forest ecologists and specialists to maintain the forest structure and composition.[9] The critical period of the regeneration process is the seedling stage. There may be higher seed production and a higher germination capacity, but if the species does not have the capacity to overcome the external factors that reduce its abundance, such as lack of adequate sunlight, the regeneration of a species will fail.[10,11]

Croton lechleri reproduces early and profusely. It does not require a specific pollinator, and at about four years of age it can produce approximately 600,000 seeds per tree per season. On average, one kilogram of seeds (dry weight) corresponds to roughly 70,000 seeds. Seed germination is quite successful, especially under the disturbed conditions of a forest clearing. As a result, natural regeneration is widespread, and dozens of seedlings compete for light and nutrients at the base of mother trees.

Croton lechleri has large clusters of terminal inflorescences, which grow up to 30 cm in length. Flowering occurs every year between June and October, during the dry season. Fruits are capsular, trilocular, grouped in spikes, have one seed per monocle, and mature in two to three months. Seed dispersion occurs by the violent explosion of fruits between October and November, at the beginning of the rainy season.[12] This dispersion method creates a viable seed bank in the understory soil, associated with leaf litter. These seeds can remain dormant for long periods at the base of the mother tree, waiting for environmental conditions that are conducive to germination.

Due to these characteristics, the natural regeneration of this species can be seen in areas altered by forest exploitation (e.g., for roads, yards, trails), areas used for agriculture and grazing, and places where the competing vegetation largely is eliminated. This allows the development and unrestricted growth of *C. lechleri* seedlings. By thinning forests and exposing soil to additional sunlight, fire can lead to increased germination and a greater number of seedlings. The fires that destroyed large areas of the Brazilian and Bolivian Amazon in late 2019 likely did not affect this species, because *C. lechleri* does not generally occur in the affected regions.

Studies of the dragon's blood tree's natural regeneration have been undertaken by multiple authors. Ravelo (1994) reported six to 72 specimens per hectare in Ecuadorian rainforest, with an average diameter at breast height (DBH) of 26.3 cm per plot.[13] Gaviria (1995) reported densities of natural populations of five trees per hectare in Palcazu and 88.6 trees per hectare in Oxapampa. In Madre de Dios, Gaviria reported 149 trees per hectare in areas without human intervention, 42 trees per hectare in areas

Production areas for sustainable harvest and reforestation of *Croton lechleri* latex in Peru.
Map image courtesy of Geology.com

with light intervention, and 57 trees per hectare in areas with substantial intervention.[14] On the other hand, Ríos (2006) reported 10-33 trees per hectare in the Alexander von Humboldt National Forest.[15,16] Densities have been recorded at 8.4 trees per hectare on the Napo River in Pona and 6.4 trees per hectare in Cuyana near Iquitos, with stem growth rates of between seven and 12 inches per month for the first two to three years.[17]

Central Rainforest Region of Peru: Pichis River Valley

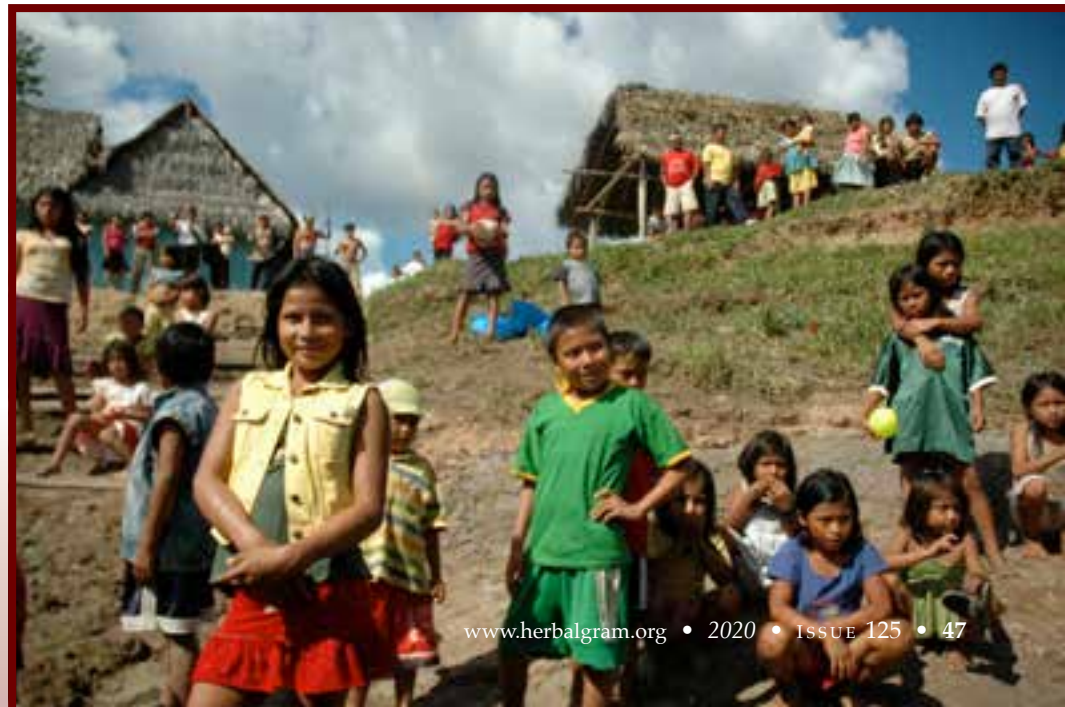
The Puerto Bermúdez and Constitución districts of the Oxapampa province in central Peru are covered by tropical rainforest. With altitudes ranging from 210 to 290 meters above sea level, this area is considered a transition zone between the Andes and low Amazon. It has a humid and warm tropical climate with an annual average temperature of 22.5°C (72.5°F), a minimum temperature of 15°C (59°F), and a maximum temperature of 32°C (89.6°F).

The Pichis River valley is the ancestral territory of the Asháninka, Yánesha, and Cacataibo indigenous peoples. Since 1980, the cultural environment has changed due to migration by people from other regions. The recent immigrants have introduced new knowledge and land use practices that are different from the traditional methods used by indigenous peoples. These immigrants also have implemented trade mechanisms and created dependence on commercial goods. One of the negative agricultural practices introduced that continues to generate social conflicts and environmental damage is the production of coca (*Erythroxylum coca*, Erythroxylaceae) leaves to make illicit drugs. Government institutions and non-governmental organizations (NGOs) such as the National Commission for Development and Life without Drugs (DEVIDA) are working to improve the agricultural and social conditions in the valley.

From a conservation perspective, the Oxapampa-Asháninka-Yánesha Biosphere Reserve, recognized by UNESCO, protects the Yanachaga-Chemillén National Park, the Yánesha and El Sira Communal Reserves, and the San Matías-San Carlos Protection Forest. The objective of the biosphere reserve is to create a biological corridor of protected natural areas to ensure biodiversity in perpetuity, guarantee the permanence of indigenous peoples' cultures through the sustainable use of wild resources, reduce external pressure on titled land territories, and empower the active participation of civil society to strengthen the sustainable management of forest resources and improve their quality of life.

Relationships with Indigenous Peoples and Local Institutions

The development of initiatives with indigenous communities and rural settlers cannot be separated from their identity and culture. The experiences of the last few decades have shown us that successful projects arise from locally identified needs. We have ensured this through the involvement of the indigenous and local communities from the early design stages of these projects through the later stages



Families of the Awajún community of Yamakay, where reforestation and latex collection work is taking place, saying goodbye after a series of meetings, field observations, and discussions on current and future reforestation work. Photo ©2020 Steven King

of implementation. The inclusion of the population in decision-making not only guarantees the protection of their rights, but also contributes to community-based sustainable management of plant resources. Therefore, this approach is not only morally correct but economically wise.

In the territories where we interact with indigenous and rural communities, our philosophy is to maintain a relationship of collaboration and coexistence. This consists of establishing effective communication mechanisms, holding working meetings with leaders and executives, and actively participating in communal meetings. Our participation in these events allows us to collaborate in a climate of trust with the indigenous peoples. This collaboration also helps to prevent or resolve social and environmental conflicts that may arise when working with forest resources and with reforestation and the collection of *C. lechleri* latex.

In the Pichis valley, there are two indigenous organizations: the Asociación de Nacionalidades Asháninka del Valle Pichis (Association of Asháninka Nationalities of the Pichis Valley; ANAP) and Unión de Nacionalidades Asháninkas y Yáneshas (Union of Asháninkas and Yáneshas Nationalities; UNAY). We have built alliances and strategic collaborations with these nonprofit federations to promote the ecological production of latex and carry out the reforestation of *C. lechleri,* mainly in native communities in the Pichis valley. We also have beneficial collaborative relationships with DEVIDA, Instituto del Bien Común (Institute for the Common Good; IBC), Fondo Verde (Green Fund), Servicio Forestal y de Fauna Silvestre (Forest and Wildlife Service; SERFOR), and Programa de Bosques del Ministerio del Ambiente y Servicio Nacional de Sanidad Agraria (Forest Program of the Ministry of the Environment and National Service of Agrarian Health; SENASA). The objective with these institutions is to promote the reforestation of *C. lechleri* in the Pichis valley.

Sustainable Management of Croton lechleri *Latex*

Historically, the Pichis valley has served as a source of high-quality *C. lechleri* latex. In the 1970s, the Asháninka marketed latex through intermediaries in the markets of Lima and other major cities in Peru, as well as internationally. We started the first latex collections and reforestation work in this region in 1998 on behalf of the now-defunct Shaman Pharmaceuticals, and later, Jaguar Health Inc. Since that time, we have developed positive and mutually beneficial working relationships. Admittedly, there have been challenges, but the goal always has been to ensure the sustainable production and fair trade of latex in the Pichis valley.

This production activity has become an important economic resource for many families in indigenous communities. In this area, approximately 95% of latex collectors are from indigenous communities. We have trained 32 two-person teams on the most effective methods for latex collection to ensure quality. Each group is provided a complete set of materials and tools to collect latex. They also receive basic medicines, and training occurs at frequent intervals.

Table 1. Napo Pharmaceuticals Product Portfolio

PRODUCT	INDICATION	DEVELOPMENT STAGE: PRE-CLINICAL / PHASE 1 / PHASE 2 / PHASE 3 / MARKET
Mytesi	Non-infectious diarrhea in adults with HIV/AIDS on antiretroviral therapy	
Mytesi	Cancer therapy-related diarrhea (CTD)	Study report expected late 2020
Mytesi	Supportive care for inflammatory bowel disease (IBD)	
Formulation of crofelemer	Short bowel syndrome (SBS) and congenital diarrheal disease (CDD)	Orphan-drug status previously received for SBS; applying for orphan-drug status for CDD
Mytesi	Irritable bowel syndrome - diarrhea predominant (IBS-D)	Paper published December 2019
Mytesi	Idiopathic/functional diarrhea	Study initiated and sponsored by the University of Texas Health Science Center at Houston
Lechlemer	Cholera and other gastrointestinal indications (second generation anti-secretory agent)	Received pre-clinical services funded by the National Institute of Allergy and Infectious Diseases for pre-clinical toxicity studies

We estimate that approximately 75% of the latex from the Pichis valley is collected in secondary forests, 15% from reforestation sites, and 10% from primary forests where timber species have been harvested. As indicated above, the natural regeneration of this species is rapid and widespread, but the goal is to shift the harvesting ratio to 25%-30% from secondary forests and 65%-70% from reforested areas.

Our collectors in this region indicate that they obtain an average of one gallon of latex from one to five trees with an average DBH of 28-35 cm. Larger trees (DBH > 60 cm) can yield up to two gallons of latex. When harvesting trees from reforested areas, we recommend harvesting trees that are 9-10 years of age. In most locations, it is ideal to collect latex from trees with DBHs of 35 cm or larger.

Recently, in the Pichis valley, *Croton lechleri* wood has entered the market. The main customers are the manufacturers of containers for the transport of fruits, most often for the packaging of papaya (*Carica papaya*, Caricaceae) to ship to Lima. Therefore, the latex producer gains additional income from the sale of the wood.

Reforestation on Indigenous and Local Communities' Lands

The success of reforestation depends on the quality of seedlings. Once we locate the mother trees, we remove weeds from the base of the tree in a roughly 15-meter radius. Then, about 20 to 30 days later, we select the seedlings or saplings that have sprouted. We dig them up, place them in plastic bags with organic material, and transport them with great care to the forest nursery. The seedlings remain in the forest nursery for a maximum of three months until they have acquired sufficient size and resistance for transplanting into the final ground.[1]

Reforestation ideally is carried out in places where latex is collected and where families grow subsistence crops. We reforest using an agroforestry system and plant each seedling in a 5 x 5-meter space (a total of 400 trees per hectare). We learned from our 30 years of experience that reforestation in secondary forests and open-field agroforestry systems works well. We recommend reforesting in relatively humid soils with good organic matter content. In degraded soils, it is necessary to use at least 25 grams of natural fertilizer (e.g., phosphoric rock or island guano). It is important to prune other trees and remove other fast-growing plants at least twice during the first two years of growth of the *C. lechleri* trees, as this species requires adequate sunlight and is susceptible to competition from the surrounding vegetation. We also replace seedlings that have not survived in the first six months after planting. Finally, a general thinning of the reforestation site is undertaken at the end of the first two years to remove trees that are not growing well, which allows for the healthiest trees to flourish.

In the Pichis valley, we have been conducting reforestation since 2009 with the financial support of Jaguar Health and Napo Pharmaceuticals Inc., and the critical contributions of 140 families from Yánesha and Asháninka indigenous communities and local communities. The collaborating families are 85% indigenous and 15% local non-indigenous. To date, we have planted approximately 118,230 *C. lechleri* trees on about 230 hectares. The reforestation work has been undertaken on secondary forest lands, as well as on soils that were used to cultivate cassava (*Manihot esculenta*, Euphorbiaceae), bananas (*Musa* spp., Musaceae), cacao (*Theobroma cacao*, Malvaceae), maize (*Zea mays*, Poaceae), rice (*Oryza sativa*, Poaceae), and other daily food products. Currently, 90% of the reforestation is well-developed; the trees planted in 2011 have a maximum diameter of 30 cm and an average height of 15 meters. In this area, we have set a goal of replanting up to five trees for each gallon of latex collected.

In 2019, we replanted approximately 5,600 *C. lechleri* trees. We currently have a list of local families who will receive seedlings produced by our nursery. During the reforestation process, it was important to coordinate actions

Enrique Perez, a member of the Asháninka indigenous people, examining the growth of a portion of the 1,600 *Croton* trees that he planted in 2011 on four hectares of his land near the community of Nuevo Progreso-Kirishari using seedlings provided by CORFA SAC. The latex from these reforested trees will be sold in the next 12 months for income for his family. Photo ©2020 Steven King

with the indigenous organizations UNAY and ANAP and the local communities, and to select families who were serious and committed to taking on the reforestation work. In some cases, we established collaboration efforts with the Association of Cocoa Producers promoted by DEVIDA. We have found that women are and continue to be key in the management of plants, weed control, and silviculture as the trees grow.

Reforestation in Collaboration with Cocoa Producers

In September 2017, we established agreements with DEVIDA and the Association of Cocoa Producers to supply cocoa producers with *C. lechleri* seedlings to create windbreak curtains and enable the producers to sell the latex and wood of *C. lechleri* trees. Tree windbreak curtains can help reduce damage caused by strong winds, reduce wind erosion, minimize sudden changes in soil temperature, protect cacao pods when ripening, and establish a microclimate conducive to development and production of better-quality cacao fruits. The *C. lechleri* trees are being reforested in association with tornillo (*Cedrelinga cateniformis*, Fabaceae), bolaina (*Guazuma crinita*, Malvaceae), mahogany (*Swietenia macrophylla*, Meliaceae), capirona (*Calycophyllum spruceanum*, Rubiaceae), and other commercial timber species.

According to DEVIDA, in the Constitución district in central Peru, more than 970 families have cacao plantations distributed in 39 communities, and they are members of the Association of Agricultural Producers of the Pichis Valley. These producers receive support and technical assistance from DEVIDA. The aim is to incorporate a minimum of 100 seedlings of *C. lechleri* per hectare of cacao cultivation in a windbreak curtain formation, with a distance of 5 x 5 meters between each plant; in the case of reforestation in "open-field" agroforestry systems, we suggest a distance of 5 x 5 meters, or 400 trees per hectare. However, we leave this to the discretion of each farmer and work only with cocoa producers committed to diversifying their crops through the implementation of windbreak curtains and agroforestry systems.

Over a period of two years, our goal was to distribute 10,000 *C. lechleri* plants to more than 100 families (100 plants per family) of cocoa producers in the Constitución district. In this program, we managed to meet only about 30% of our goal and distributed 3,000 plants to approximately 30 families. The remaining 7,000 plants were distributed and reforested in alliance with indigenous communities (4,500 plants), Fondo Verde (1,000 plants), and owners of individual plots (1,500 plants), benefitting another 15 families in the valleys of Pichis and Palcazú,

Organic Certification of *Croton lechleri* with the Yánesha and Asháninka

Organic certification for *C. lechleri* latex in indigenous communities of the Pichis valley was facilitated by the company Corporación Forestal Amazónico (CORFA SAC), with the economic support of Jaguar Health. The certification was audited by IMOcert, an accredited entity for a variety of certification programs and with expertise in the socio-environmental context of the central rainforest region of Peru. The collectors and people who reforest *C. lechleri* do not use pesticides, insecticides, or chemical fertilizers. There is no need or advantage in doing so, and these external inputs cost money. The latex of *C. lechleri* also is quite bitter and acts as a natural deterrent to insects and pests. The latex periodically is tested after leaving Peru for the presence of synthetic chemicals, and, to date, none have been detected using standard analytical methods. This certification process was a useful exercise for both local families and CORFA SAC.

At the beginning of this new certification process, we had to make sure that certain fundamental principles of ecological production and conservation were being followed. We also had to be sure that producers were able to adopt sustainable management standards, which include compliance with environmental and social laws, a commitment to follow a detailed management plan, limited use of organic agrochemicals, prevention of commercial hunting and sale of bushmeat, respecting the proper use of soils, and implementation of safety practices.

Once these basic principles were reviewed with the producers, we informed IMOcert that we were ready to start the formal process. We then completed an organic certification class. The first task was to identify potential producers, locate them on a map, and contact them to provide information and training related to the certification process. After the training, we scheduled a technical visit to assess production centers and areas where *C. lechleri* was both regenerating naturally and planted manually. Once the field supervision work was completed, we carried out an evaluation and established a follow-up plan with the producers or latex collectors. We intensified this fieldwork process during the peak latex collection months in this area (i.e., from October to May). At the latex collection center, we prepared for the inspections, and adapted and organized the product reception documents (e.g., producer identification, origin, volume, quality control mechanism, latex packaging, and registration information) in accordance with the requirements of IMOcert

The First Organic Certification of *Croton lechleri*

The certified organic production of *C. lechleri* latex required a sustainable production system with optimal management of natural resources without contamination of chemical synthesis products. This helps maintain soil fertility and biological diversity. It also indicates a respect for traditional forms of land use and enhances the use of traditional agricultural crops, which generally do not require synthetic pesticides or fertilizers.

In the Peruvian Amazon, very few non-timber forest products (NTFPs) have organic certification. We are aware of two other NTFPs in Peru that have achieved this: aguaje (*Mauritia flexuosa*, Arecaceae) oil and camu camu (*Myrciaria dubia*, Myrtaceae) pulp. We are proud to be the first certified organic producers of *C. lechleri* latex, which was accomplished with Yánesha and Asháninka indigenous peoples. We started this process in January 2016, and by 2018 we had 52 latex-producing families who were providing certified organic latex. During this two-year period, we learned that to ensure that indigenous communities comply with organic requirements, the participation of a permanent local facilitating institution is required because certification is relatively complex. The collection center is required to assure careful handling of technical documents, reception of latex, quality control, and appropriate packaging and labeling of the product.

Selva. We learned that alliances and good institutional relationships can help create synergistic collaborations to recover degraded areas, reduce damage to biodiversity, and minimize illegal coca crops.

Reforestation with EDMAR

In 2000, the NGO Eco-Development, Environment and Reforestation (EDMAR) initiated a large reforestation project based on the market we have been creating in this region, planting 110,000 *C. lechleri* trees. These trees were planted in agroforestry systems and in seven native communities of the Pichis valley (El Milagro, Puerto Davis, Sargento Lores, Belén, Divisoria, Dinamarca, and La Paz de Getarina). This project was approved and funded by the International Tropical Timber Organization (ITTO). Technical support for this project was provided in part by Elza Meza, an expert on the sustainable management of *C. lechleri* who has worked with Napo Pharmaceuticals in several regions of Peru.

The Napo River Region in the Department of Loreto

In this section, we present information on the reforestation and sustainable management of *C. lechleri* in the areas of the Napo River, Mazán and Alto Nanay, which are near the large city of Iquitos, Peru. The most frequently used modes of transport are by river with some limited roads out of Iquitos. Large areas close to rivers and streams have been cultivated, and timber species have been harvested from primary and secondary forests for more than 100 years. There are areas of primary forest in reserves and protected areas, especially between the Napo River and Putumayo River. The population of these areas, excluding the city of Iquitos, is approximately 57,750 people. The indigenous communities in this area are Kichwa, Orejone, Arabela, Huitoto, and Yagua, as well as a large number of non-indigenous mixed-descent Spanish-speaking communities.

Maintenance of Open-field Reforestation and Enrichment Planting

Between 2009 and 2011, reforestation was carried out on 232 hectares near the village of Llachapa using the open-field reforestation system. Seedlings were planted in lines 100 meters wide, with a variable length from 600 to 1,000 meters depending on the physiography of the land. *Croton lechleri* plots were situated next to equal-sized areas of untouched forest in a checker-board pattern to maximize the conservation of biological diversity. The distribution of seedlings was mostly random, with an approximate planting distance of 4.5 meters, and about 450 trees per hectare. Approximately 104,000 trees were reforested in this process.

The most recent silvicultural treatment was performed in May 2019 and consisted of removing the fast-growing trees, especially cetico (*Cecropia* spp., Urticaceae)

Dragon's blood *Croton lechleri*
Photo ©2020 Steven King

Feliciano Sevillano in one of the multiple reforestation sites near the village of Llachapa on the Napo River in Peru, where Sevillano has supervised and planted approximately 104,000 *Croton* trees since 1997, developing innovative low-impact methods for collecting seedlings, planting, and maintaining plants for maximum growth. Photo ©2020 Steven King

and palo balsa (*Ochroma* spp., Malvaceae), followed by thinning and cutting of lianas. This reforestation maintenance was effective as the *C. lechleri* trees are now growing successfully, occupying the upper canopy, and have good ramification branches. On average, the elite trees have DBHs of 32 centimeters and stem heights of 15 meters. It is evident that silvicultural treatments can significantly enhance *C. lechleri* tree growth.

We also have implemented natural-regeneration forest management on the 30 hectares where we collected latex in May 2018. Ten months after collecting latex from the trees, we carried out a general evaluation of the entire harvested area. We found the area mainly covered by secondary forest plant species. When exploring the interior of this thick vegetation, we found small stands with a large number of *C. lechleri* seedlings, with heights ranging from 10 cm to 1.5 meters, trying to compete with shrubs, lianas, and other fast-growing species.

In places with *C. lechleri* seedlings, we observed the spatial distribution, development, and phytosanitary condition of the seedlings. Then, in circular plots with a radius of about three meters, we carried out the silvicultural work to promote the seedlings' growth. We cleared other fast-growing vegetation to create spaces with appropriate sunlight and then selected *C. lechleri* seedlings by pruning the branches and removing the small, weak, or unhealthy trees.

In areas where *C. lechleri* trees were harvested and not regenerating naturally, we replicated the natural clearings that occur in tropical forests by creating artificial clearings in nearby places or around the stumps of harvested *C. lechleri* trees. The area of these clearings varied from approximately 10 to 12 square meters. The aim of creating these open spaces is to increase sunlight and soil temperature, to offer favorable conditions for germination of *C. lechleri* seeds that are still dormant in the soil.

We will continue with silvicultural treatment in the 30-hectare area every six months. The goal is to achieve a harvestable population of 270 to 330 quality trees per hectare.

Natural regeneration of a *Croton* seedling in a secondary forest near the village of Llachapa on the Napo River in Peru. Hundreds of seedlings grow in and around gardens, reforestation sites, and natural clearings or gaps in secondary forests. Photo ©2020 Steven King

A portion of 10,000 *Croton* seedlings in a CORFA SAC nursery that were collected from wild "mother trees" being prepared for distribution to families, communities, and nonprofits who are part of the sustainable harvesting of this species in the area of Lorencillo, Peru. Photo ©2020 Steven King

Relationships with Neighboring Communities in the Napo River Area

The policy of Jaguar Health and Napo Pharmaceuticals Inc. is to conduct operations in a harmonious manner, build a relationship of healthy coexistence with indigenous peoples and local residents, respect the laws of indigenous communities and civil society in general, and provide up-front benefits to the communities with which we work. As examples, we describe two cases:

- In August 2017, the Llachapa Village requested that Jaguar Health donate a plot of land to expand the infrastructure of the high school educational center and areas for agricultural research. After evaluating the proposal, Jaguar Health accepted the request. The company donated 27 hectares of forest land that will be used solely by students and teachers according to the plan developed by the principals of the integrated alternative high school: the Yarina Isla-Llachapa Rural Center for Alternative Training No. 60303 (Centro Rural de Formación en Alternancia Yarina Isla-Llachapa).
- A donation was made to the Orejones Native Community, who requested equipment to improve the community's water supply and economic resources to improve administrative activities in the city of Iquitos. To provide support to this neighboring community, Jaguar Health donated a Honda motor pump to complete a project that the community had already invested in, which will supply clean well water for more than 40 families.

Reforestation and Sustainable Management in the Departments of Amazonas and Loreto

In this section, we present a summary on the reforestation and sustainable management of *C. lechleri* in the departments of Amazonas and Loreto as well as the provinces of Datem del Marañón, San Martín, and Condorcanqui by the organization PROBOS-L&CH. The climate in this area is also tropical and humid, with temperatures ranging from 23°C to 36°C (73°F to 97°F). The approximate population of the area described is 450,000 people and the land area is 88,000 square kilometers. The indigenous communities that have collaborated with us are Kichwa, Awajún, and Kandozi peoples, though a number of other indigenous groups live in this large region. The primary mode of transportation is by river, and this area has a large amount of primary tropical forest that also has been used to extract hardwood timber species, and it is a region that produces oil in various locations. The region has a high level of poverty with limited opportunities for families to generate income for basic necessities that cannot be grown or produced in the communities.

In this region, we have replanted 236,000 *C. lechleri* trees since 2006 in collaboration with indigenous and local communities. The primary method we have used in these reforestation sites is opening gaps in lines in secondary forests where *C. lechleri* commonly is found. With this approach, we clear enough vegetation so that the trees have enough light to grow and reach the lower canopy within the secondary forest. After three to four years, it is difficult to notice that trees have been planted if the secondary forest is viewed from above the canopy. In this system, as in the majority of reforested areas with *C. lechleri*, the secondary forest rapidly reabsorbs the trunks of felled trees, returning all of the nutrients contained in the trees to the forest floor through the rapid action of fungi and other organisms.

We have undertaken this process in five distinct locations where we have been collecting latex of *C. lechleri.* We have spread this work out over eight years and will continue to work with communities that are interested in the sale of latex as well as reforestation. The process by which we collaborate in this region is similar to the process undertaken in the central rainforest area of the Pichis valley. We also are making monthly visits to communities, providing technical information on the most efficient process for reforestation and collection of *C. lechleri.* Most recently, we have entered into a collaboration agreement with a regional government agency to enhance our outreach and effectiveness in this region.

PROBOS-L&CH Collaboration with Regional Government Agency PEDAMAALC

Datem del Marañón – Alto Amazonas – Loreto and Condorcanqui (PEDAMAALC) is a special project attached to the Ministry of Agriculture and Irrigation (MINAGRI) of Peru. Its purpose is to identify, promote, formulate, and execute projects that include forestry and reforestation. PEDAMAALC is especially focused on families with reduced access to national assistance or support. Its objective is to increase the agricultural capacities of local communities with an emphasis on women and families. It promotes the exchange of knowledge on adding value and diversifying sources of income through the enhanced production and commercialization of a diverse set of agricultural and forest resources, including *C. lechleri.* PEDAMAALC recently signed an agree-

Ricardo Pariona Fonseca, Steven King, and Manuel Lazaro Martin, who have been working on the sustainable harvest and management of *Croton* in the Pichis River valley with reforested *Croton* trees.
Photo ©2020 Steven King

ment with PROBOS-L&CH to collaborate on the long-term sustainable management of *C. lechleri*. In this collaboration, PROBOS-L&CH will provide expertise on how to produce, plant, prune, maintain, and effectively harvest *C. lechleri* in diverse locations where PEDAMAALC is active.

Conclusion

Over the past 30 years, we have been learning about the most effective methods of reforestation of *C. lechleri*, as part of our commitment to the long-term sustainable management of this species in the tropical rainforest of several western Amazon basin countries. Our approach combines wild harvesting and reforestation/cultivation in numerous locations using a low-density agroforestry approach. We also have focused on using distinct regional approaches to reforestation and natural regeneration management, as learned from and practiced by local peoples and our collaborating expert colleagues, many of whom have devoted more than 25 years to learning how to manage this species in a way that is both ecologically sustainable and of economic and social benefit to local forest-dwelling communities. HG

Natural regeneration of a *Croton* seedling near a harvest site in a secondary forest near Lorencillo, Peru. Photo ©2020 Steven King

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Ricardo Pariona Fonseca *is general manager of the family business CORFA SAC and manages all aspects of the collection and export of Croton lechleri latex. He is an agronomist, with extensive knowledge of agricultural crops and tropical forest management. He has been working with medicinal plants since 1998.*

Mario Pariona Fonseca *is a consultant for CORFA SAC and Jaguar Health. He has been working with Croton lechleri for 25 years, as well as other medicinal plants in Peruvian tropical forests. He has forestry training from the Universidad Nacional del Centro del Peru and Faculté Universitaire des Sciences Agronomiques de Gembloux, Belgium. He worked with OXFAM Peru on community development for eight years, with the Netherlands Development Organization (SNV) implementing forest management plans in Amazonian communities of Peru for five years, and with the Field Museum of Natural History in Chicago as part of the rapid ecological survey teams that conducted ecological and community inventories in 10 locations in Peru over an 11-year period.*

Cesar Gregorio Lozano Diaz *is the founder and executive director of PROBOS-L&CH Naturaleza y Negocios SAC. He has been working with Croton lechleri for 27 years. He has train-*

Mature eight-year-old reforested *Croton* trees in a secondary forest in the village of Llachapa on the Napo River in Peru. Photo ©2020 Steven King

ing from Universidad Nacional del Callao in Peru with a focus on environmental management. For 30 years, he has worked on numerous alternative development projects with a focus on forestry, agroforestry, and agriculture in multiple tropical forest regions of Peru, with extensive experience working directly with indigenous and non-indigenous local communities and families.

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Dragon's blood *Croton lechleri*
Photo ©2020 Steven Foster

Fire cider ingredients in a mason jar ready to infuse for three to four weeks. Photo ©2020 Gayle Engels

Fire cider preparation. Photo ©2020 Gayle Engels

FREE FIRE CIDER

Traditional Remedy Remains Generic after Landmark Case

By Hannah Bauman

The Story of Fire Cider

In winter 1979-1980, herbalist and teacher Rosemary Gladstar sought a non-alcoholic tonic to support the immune system during the long, damp winters in northern California. With the input of her students at the California School of Herbal Studies in Forestville, California, and inspired by similar vinegar-based products from folk medicine practitioners D.C. Jarvis, MD, and John R. Christopher, ND, Gladstar went to the grocery store and purchased hot, fiery herbs, including garlic (*Allium sativum*, Amaryllidaceae), horseradish (*Armoracia rusticana*, Brassicaceae), onion (*Allium cepa*), and ginger (*Zingiber officinale*, Zingiberaceae).

"It was a very creative process," Gladstar recalled (oral communication, December 6, 2019). With her students, she added the ingredients to apple (*Malus* spp., Rosaceae) cider vinegar and let it sit for four or five weeks. "It wasn't quite perfect. We added honey to mellow the hot flavors and we knew then that we had something here." She dubbed the tonic "fire cider."

In 1981, Gladstar included a recipe for fire cider in the first edition of her home study course, *The Science and Art of Herbalism*. Her students shared it widely and began making their own, with variations according to preference. "It developed a life of its own, as herb formulas should," she said. The reasons? "It worked, it was inexpensive, the ingredients were easy to find, and anyone could adjust the flavors

Rosemary Gladstar's Original Fire Cider Recipe

Ingredients

- 1/2 cup grated horseradish root
- 1/2 cup or more chopped onion
- 1/4 cup or more chopped garlic
- 1/4 cup or more grated ginger
- Cayenne pepper, either dried and powdered or fresh and chopped, to taste
- Unpasteurized apple cider vinegar
- Raw honey

Directions

1. Place herbs in a half-gallon canning jar and add enough apple cider vinegar to cover the herbs by at least three to four inches. Cover with a tight-fitting lid.
2. Place jar in a warm location and let it infuse for three to four weeks. It is best to shake every day to help with the maceration process.
3. After three to four weeks, strain out the herbs and reserve the liquid.
4. Add honey to taste. The fire cider should taste hot, spicy, and sweet.
5. Rebottle and enjoy. Fire cider will keep for several months unrefrigerated if stored in a cool pantry, but refrigeration is recommended.

Source: Rosemary Gladstar's *The Science and Art of Herbalism*

Honeycomb
Photo ©2020 Steven Foster

Ginger *Zingiber officinale*
Photo ©2020 Steven Foster

Horseradish *Armoracia rusticana*
Photo ©2020 Anna Reg

Cayenne *Capsicum annuum*
Photo ©2020 Steven Foster

Onion *Allium cepa*
Photo ©2020 Steven Foster

easily." Fire cider continued to be a mainstay of Gladstar's winter health classes. She included the recipe for fire cider in several of her books, including *Rosemary Gladstar's Herbs for the Home Medicine Chest* (Storey Books, 1999) and a variation that added ginseng (*Panax* spp., Araliaceae), which she called "fire cider zest," in *Rosemary Gladstar's Herbs for Longevity and Well-Being* (Storey Books, 1999).

Fire Cider Trademark Granted

On April 20, 2012, the Pittsfield, Massachusetts-based company Shire City Herbals (SCH) filed for a registered trademark for "Fire Cider" from the US Patent and Trademark Office (USPTO) as they sought to market their own spicy and sweet apple cider vinegar formulation made with garlic, ginger, onion, horseradish, habanero pepper (*Capsicum chinense*, Solanaceae), turmeric (*Curcuma longa*, Zingiberaceae), black pepper (*Piper nigrum*, Piperaceae), lemon (*Citrus* × *limon*, Rutaceae), and orange (*Citrus* × *sinensis*).[1,2] Though SCH's application could have been opposed after the trademark's publication on October 2 of the same year, Gladstar claims that no one in the herbalist community was aware of the action, and no opposition petitions were filed. The trademark officially was registered by USPTO on December 18, 2012.

SCH was founded in 2010 by Dana St. Pierre, his wife Amy Huebner, and Amy's brother Brian Huebner. None of the co-founders have a background in herbalism, though Amy Huebner has an education and background in nutrition and integrative health.[3] The story of St. Pierre's introduction to fire cider has varied: On SCH's website, his biography states that the initial recipe came from his German grandmother and he experimented to create his own blend; later, he was informed that the mixture was called fire cider by a man ("a hippie," in St. Pierre's words) at a potluck in 1997.[4,5] A representative for SCH did not respond to repeated requests for comment for this article.

Sticker created by Mountain Rose Herbs
in support of the Free Fire Cider movement.
Photo by Amanda Mura, courtesy of Mountain Rose Herbs

After the opposition period had passed, SCH began contacting other purveyors of fire cider and asking them to rename their products, but refrained from formal legal action. According to Gladstar, these letters were civil and non-threatening (although some of the recipients thought otherwise) and did not constitute a legal cease-and-desist notice. Many herbalists became aware of the trademark for the first time after SCH notified Etsy, an online marketplace, of the trademark and the website took down all the non-SCH product listings in violation (i.e., those that appeared to infringe on SCH's trademark).

Katheryn Langelier of Herbal Revolution Farm and Apothecary in Union, Maine, received a takedown notice from Etsy and described seeing a notification that SCH sent to businesses directly: "It wasn't a legal document…, but [SCH was] nonetheless letting people know, without coming out and saying it, 'If you continue to use this, there will be issues,'" said Langelier (oral communication, December 13, 2019). "Most herbalists I know who received that notice stopped using the term 'fire cider.'" Initially, Langelier did as well, changing the name of her product from "fire cider" to "fire tonic." "I did [change it] because I did not have the money for a lawsuit," she said.

The Battle for Tradition

Mary Blue, owner and founder of Farmacy Herbs shop and school in Providence, Rhode Island, learned of the trademark in January 2014 and launched a change.org petition to raise awareness and gain support for cancelling SCH's trademark (oral communication, December 17, 2019). The petition gained more than 11,000 signatures and, as of the time of writing (January 2020), has grown to almost 16,000, despite the outcome of the case being decided in September 2019.[5,6] After the petition was launched, Nicole Telkes, founder and director of the Wildflower School of Botanical Medicine in Austin, Texas, contacted St. Pierre by email and asked him to give up the trademark; a company representative responded that they would seek legal advice before proceeding.

Blue commented: "[SCH] never communicated with my business directly, but I did receive a notice from Etsy. I was really surprised that the trademark office approved it. Then I thought, perhaps there was a mistake. Maybe the company didn't realize? Those were my first thoughts. Then I was upset."

After the petition and unsatisfied with the response from SCH, a group of herbalists including Blue, Telkes, Langelier, and Gladstar formed "Tradition Not Trademark," a group whose goal was to remove trademark restrictions from fire cider. Tradition Not Trademark launched a boycott against SCH and founded the "Free Fire Cider" website to expand the effort. Free Fire Cider urged people and businesses to boycott SCH and file cancelation petitions with the US Trademark Trial and Appeal Board (TTAB), and encouraged herbalists to continue selling fire cider preparations under the name "Fire Cider." Eventually, these actions would inform five of the 10 counts SCH

(Left to right) The "Fire Cider Three" — Nicole Telkes, Katheryn Langelier, and Mary Blue — and Rosemary Gladstar. Photo ©2020 Nicole Telkes

initially brought against the defendants. When pressed for comment by Tradition Not Trademark, SCH indicated that it would accept a ruling from the TTAB if the body decided to cancel the trademark.

"[SCH] said, 'if we don't trademark it, some big company will,'" Gladstar recalled. "What they didn't seem to understand was that to the herbalist selling in a farmers' market, they are the big company.... Shire City didn't know that they were riding on the shoulders of others and a 40-year tradition. They were very surprised by the backlash and didn't anticipate it."

In June 2014, Blue, representing Tradition Not Trademark, filed a cancelation petition with the TTAB. During this time, the Free Fire Cider movement continued to encourage consumers and retailers to boycott SCH, offering sample scripts on how to request that SCH products be removed from shelves and replaced with a different brand. On April 16, 2015, SCH filed a lawsuit against Blue, Telkes, and Langelier in the US District Court of Massachusetts on 10 counts:

- Claim I: Declaratory judgment that the mark is distinctive and valid;
- Claim II: Trademark infringement;
- Claim III: False designation of origin;
- Claim IV: Trade disparagement;
- Claim V: Common law trademark infringement;
- Claim VI: Common law unfair competition;
- Claim VII: Unfair trade practices;
- Claim VIII: Tortious interference with contractual relations;
- Claim IX: Tortious interference with prospective business relations; and
- Claim X: Trade libel.

SCH sought more than $100,000 in damages plus any profits that the defendants made from selling fire cider. In response to the lawsuit, TTAB suspended cancelation actions pending the outcome of the case. After being named in the lawsuit, Blue, Telkes, and Langelier became known as "the Fire Cider Three" and began a fundraising campaign to offset legal costs.

Blue was the first defendant to receive the initial filing. "I was helping a customer and a constable walked into my herb shop and served me papers," she said. "I was surprised, and scared, because the lawsuit was alleging $100,000 worth of damages related to the boycott.... I've known Nicole since the early 2000s and I've known Kathi a long time, too. They didn't know each other, but I immediately took some pictures of the front page [of the filing] and texted it [to them] and called them. They hadn't received it yet."

"What they didn't seem to understand was that to the herbalist selling in a farmers' market, they are the big company.... Shire City didn't know that they were riding on the shoulders of others and a 40-year tradition. They were very surprised by the backlash and didn't anticipate it."

The three defendants then filed two counterclaims:

- Counterclaim I: Declaratory judgment that the mark is generic or descriptive without secondary meaning; and
- Counterclaim II: Unfair and deceptive acts or practices in violation of Massachusetts' consumer protection statute.

Telkes commented: "We were encouraged to file a cancelation petition if we didn't like the trademark and spent several months looking for legal help. The lawsuit was filed against us just before Shire City's evidence was due to the TTAB" (email, January 31, 2020).

Shire City's Plaintiff Argument

In its initial filing, SCH alleged that the defendants had violated a valid trademark and undercut the company's profits by selling their own versions of fire cider, and additionally had damaged the company's reputation and sales

Photo of a framed poster by Storey Publishing that includes the names of all who contributed recipes to the book *Fire Cider*. Photo ©2020 Susan Belsinger

"It was intense, arduous, outside of my normal comfort zone. It was tough and long. But you know, having all this vocal support was really the best thing about it: people bringing us food to the trial, having time to spend with my codefendants and Rosemary, through all the conference calls and meetings.... The herbal community standing up for us was great."

through the organization and promotion of a boycott. SCH, represented in court by Sonya del Peral and Paul C. Rapp, noted that in many of the defendants' promotional postings and materials, they offered alternative suggestions for fire cider products, including their own, and encouraged vendors who sold SCH products to discontinue them. These actions in particular, according to the suit, caused economic harm to SCH. The legal term used in the suit, "tortious interference," typically refers to wrongful attempts to interfere with the business relationships of a third party.

However, the counts that did not relate to the trademark (i.e., counts IV, VII, VIII, IX, and X) were dismissed on May 12, 2016, after the defendants filed a special motion to dismiss. According to United States District Judge Mark G. Mastroianni, who oversaw the proceedings, the defendants' activities targeted by counts IV, VII, VIII, IX, and X were protected "petitioning" activity (i.e., protected under the First Amendment of the United States Constitution). Specifically, Mastroianni found that the defendants' publishing statements, gathering signatures, speaking with retail establishments, and organizing a boycott was all for the purpose of canceling SCH's trademark registration for "Fire Cider." Mastroianni also noted that the counts were dismissed under a Massachusetts general law that prohibits "generally meritless" suits brought by private interests to intimidate private citizens from exercising their right to petition a governmental body. This "strategic litigation against public participation" (SLAPP) suit was, indeed, what the defendants feared would come to pass, and the dismissal was a huge relief. The case would proceed on the trademark claims and defenses alone.

Even though SCH did not originate the term "fire cider," and never argued that it did, it contended that, despite the term's previous use in the herbalist community, this subsection of the population was too narrow, and the term was not well known to the public at large.

Trademark law protects terms in commerce that serve as a source-identifier of goods. To gain trademark protection, a term must be distinctive; otherwise, it is considered generic. Classifications include: generic, descriptive, suggestive, arbitrary, and fanciful. As the plaintiff's expert witness Robert Wallace stated, a generic term answers the question, "What are you?," while a trademarked term answers the question, "Where did you come from?"[7]

A brand identity expert, Wallace conducted two consumer surveys to submit as evidence for the plaintiffs: one in 2015 and one in 2017. The purpose of the surveys was to determine consumer perception and the level of public awareness of the term "fire cider." SCH argued that because their products were available in more than 5,000 stores around the United States, including large retail chains, that the relevant consumer base consisted of the general adult population of the United States, and Wallace conducted his surveys accordingly.

In both the 2015 and 2017 surveys, Wallace concluded that awareness of fire cider was "exceptionally low" among the general population, and still low among a subset of people

who answered affirmatively to the question, "Have you ever used homeopathic or herbal remedies?" Therefore, he wrote, "'Fire Cider' is not associated with a consistent perception of what it is, further confirming that it is not a generic term."[7]

The Defensive Strategy

The defendants worked with lawyers James Goggin and Seth Coburn of the Verrill Law Firm who offered their representation pro bono, and used two expert witnesses of their own: Ronald R. Butters, PhD, professor emeritus of English at Duke University, and Mark Blumenthal, founder and executive director of the nonprofit American Botanical Council (ABC). Butters, in addition to specializing in linguistic and legal issues related to trademarks, is also an expert in lexicography, or the creation of dictionaries. Blumenthal offered his perspective pro bono. He had previous experience in creating and marketing herbal remedies and, via the publication of more than 20 reports on the herb market in the United States in ABC's peer-reviewed journal *HerbalGram*, has followed and reported on the herbal supplement market for decades.

Blumenthal's decision to serve as an expert witness came after careful thought and recognition of the importance of the trial for the herbal community. "When I was contacted by the defendants' attorney Seth Coburn, and he asked if I would act as an expert witness in this case to provide rebuttal to Mr. Wallace's market surveys, initially, I was uncertain," Blumenthal wrote (email, January 22, 2020). "Having been an expert witness in several previous court cases, I realized that it requires a huge time commitment. However, on further examination, I also realized that the defendants were taking an important stand for traditional herbalism and its nomenclature, and I concluded that it was in the best interests of the herbal community at large for ABC to use its resources to support the defendants and their laudable position."

In examining the history of use of the term "fire cider" in American English, Butters found a total of 35 uses of the term, with the earliest from 1997.[5] He described these materials as "being written by and for people who are particularly interested in herbal remedies and who have a highly specialized vocabulary." In addition, a large number of the results referred to the term using all lowercase letters, which, according to Butters, indicated generic usage. These results came from newspapers, magazines, books, and websites selling the product; none of them indicated a particular provenance or claimed ownership of the name.

Blumenthal responded to Wallace's surveys regarding consumer perception of fire cider.[8] According to Blumenthal, Wallace's results were misguided because the population surveyed was too broad and did not consider the actual market for multi-ingredient liquid herbal supplements like fire cider. (Shire City's "Fire Cider" had been labeled and marketed initially as a dietary supplement.) In his testimony, Blumenthal referenced the current size of the herbal supplement market and critiqued Wallace's survey for failing to address

Ingredients for making fire cider: garlic, ginger, turmeric, citrus, and other herbs.
Photo ©2020 Susan Belsinger

Two versions of fire cider: the left jar has elderberries added for their immunostimulant properties.
Photo ©2020 Susan Belsinger

Straining the marc (macerated botanicals) from the menstruum (fire cider) and bottling and adding honey to taste.
Photo ©2020 Susan Belsinger

An elderberry fire elixir (left) and traditional fire cider (right) with grated turmeric root. Practicing herbalists recommend drinking one shot per day. Photo ©2020 Susan Belsinger

"Trademark law is primarily focused on commercial use. This case presented the question of how the law should consider traditional use of a term outside of a purely commercial context. The Court's decision reaffirms that such traditional use is not only relevant but can establish how a term is understood to the relevant public. This decision is an important precedent for future disputes involving other herbal terms with similar traditional uses."

the most likely fire cider purchasers: core shoppers with a commitment to natural health and wellness, not the entire adult population of the United States. The size of the relevant purchasing public would become the linchpin on which Mastroianni's decision turned.

The Trial for Fire Cider

After five years of negotiation, pre-trial documentation, and depositions, the jury-waived trial took place in Springfield, Massachusetts, over nine days, starting on March 25, 2019, and ending July 2.

"The trial was an interesting process," said Gladstar, who attended most of the court dates and also testified for the defense. "The courthouse was built around enormous trees, the largest linden [*Tilia americana*, Malvaceace] tree I've ever seen as well as an herb garden. The support from the community was tremendous and felt amazing." Local herbalists and others who were sympathetic to the defendants' cause were present every day of the trial and provided food to the defendants and fire cider samples to visitors during the process. Gladstar continued: "To see the community standing up for traditions — fire cider was a poster child for it. They offered financial support and moral support. The defendant side at court was always full. There were picnics at the courthouse and children playing. The plaintiff side was always empty."

Blue said: "It was intense, arduous, outside of my normal comfort zone. It was tough and long. But you know, having all this vocal support was really the best thing about it: people bringing us food to the trial, having time to spend with my codefendants and Rosemary, through all the conference calls and meetings…. The herbal community standing up for us was great."

Telkes described the difficulty of traveling to Springfield from Austin for trial dates while maintaining her teaching schedule. "At one point I had to fly back on a Friday to teach on a Saturday and Sunday, cut Sunday's class a little short, and fly back to federal court for Monday morning," she wrote (email, December 26, 2019). "The judge seemed fair and though the trial itself was excruciating, I was hopeful."

Blumenthal commented: "I was there for only one day of the trial: the day Professor Butters and I were scheduled to give our expert testimony and face questions from the plaintiff's attorneys. Aside from various legal issues that were discussed during that day, I found it somewhat curious that the owners of Shire City did not show up in court to hear our testimony."

The five-year process came to an end on September 30, 2019, when Mastroianni ruled that fire cider was, indeed, a generic term. In his final decision, he noted that SCH registered fire cider as a dietary supplement drink and noted, based in part on Blumenthal's expert testimony, that "considering that genus, the relevant purchasing public is smaller than the entire adult population but larger than only herbalists and purchasers of liquid, multi-herb supplements" and that the "plaintiff's subsequent success marketing its product … does not alter the scope of the relevant purchasing public at the time."[4] He concluded that the defendants "presented evidence of generic uses of the term in the media and by competitors, consumers, and Shire City itself." Fire cider was generic when SCH first sold it and applied for the trademark, and would remain so.

According to Coburn: "Trademark law is primarily focused on commercial use. This case presented the question of how the law should consider traditional use of a term outside of a purely commercial context. The Court's decision reaffirms that such traditional use is not only relevant but can establish how a term is understood by the relevant public. This decision is an important precedent for future disputes involving other herbal terms with similar traditional uses" (email, January 31, 2020).

Judgment was found in favor of the defendants for counts I, II, III, V, VI, and Counterclaim I.[5] In regard to Counterclaim II, for unfair and deceptive acts, Mastroianni found in favor of the plaintiffs. He pointed out that bringing the lawsuit was not unfair or deceptive, and that SCH was entitled to test the validity of its registered mark.

The Future of Tradition

The outcome was everything that the defendants, Gladstar, and the herbal community that supported the defendants had hoped for. Gladstar sees the value in trademarks but wanted fire cider to remain available to everybody. "No one ever told Shire City that they couldn't sell it — we just didn't want them to trademark something that didn't belong to them. While it sometimes seemed like a total waste of time, energy, and money, it was also incredibly important for us to stand up for our herbal traditions."

Telkes commented: "The trial was one part of our adventure, but there was so much more. We were sued for $100,000 and up until the end, we were potentially liable for trademark infringement. It was extremely taxing but well worth it, in the end. We had to work in our free time to raise $50,000 to cover trial costs outside of representation. We spent countless hours organizing and raising funds. We did this with the herbal community behind us" (email, January 31, 2020).

To Blue's relief, her life can continue, and she no longer feels like everything is on hold. "Going through it, you're thinking, 'What am I doing? Am I doing the right thing?' And yes, we did the right thing."

The precedent set by this case holds immense meaning for any population subset with a specialized language. According to Mastroianni's decision, the deciding factor was the prevalence of the term "fire cider" in herbalist circles prior to SCH's trademark filing; therefore, the community of herbalists was considered relevant enough to have genericized the term. The implication going forward is that any "legacy product" within a group can be considered generic and unavailable to trademark, and Telkes called the case of fire cider the "canary in the coal mine" for traditional herbal remedies. This can impact any subset of the population: a religious group, Native American tribe, or even a crafting group can potentially use this case to argue for a term's generic standing.

And, in the meantime, herbalists can sell their fire cider at farmers' markets without fear of legal action, just as Rosemary Gladstar wanted. HG

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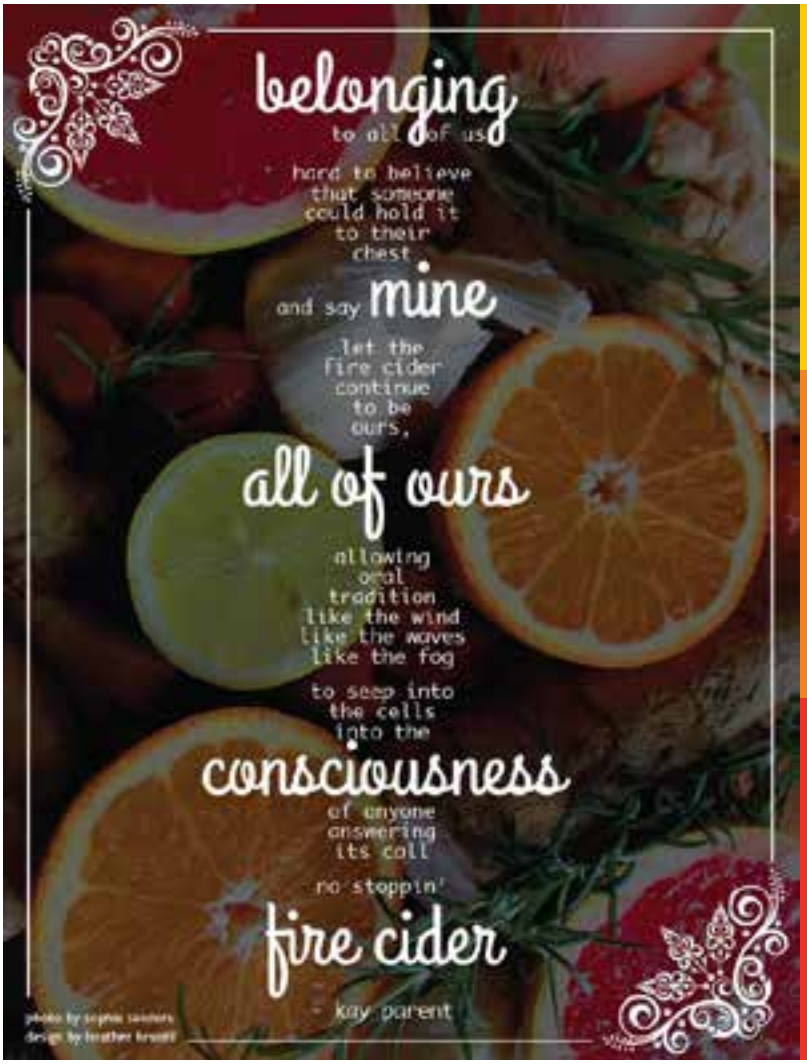


Image courtesy of Nicole Telkes

Honeybee *Apis mellifera*
Photo ©2020 Daniel Prudek

Can Fungi Ease Disease in Bees?

Fungi Bees?

Reishi *Ganoderma resinaceum*
Photo ©2020 Paul Stamets

By Connor Yearsley

Many people grew up with Winnie-the-Pooh, the good-natured bear who was often looking for "hunny" in rotting tree hollows. Renowned mycologist (fungi expert) Paul Stamets, however, may be the first person to wonder if some bees are drawn to rotting wood partly because of the health benefits that the fungal mycelia can provide as they break down the wood. Mycelia are the vegetative part of a fungus' life cycle and consist of threadlike tubes called hyphae that spread in every direction.

With researchers at Washington State University (WSU) and the United States Department of Agriculture (USDA), Stamets' hypothesis that fungi can help bees is being validated with extracts of the mycelia of two fungal species: amadou (*Fomes fomentarius*, Polyporaceae) and reishi (*Ganoderma resinaceum*, Ganodermataceae). In laboratory and field trials on the Western or European honeybee (*Apis mellifera*), these extracts significantly reduced levels of viruses that are devastating bee colonies (see sidebar). Stamets and his team hope that these and other fungal extracts can become long-term and widespread solutions to improve the health, immunity, and longevity of bees, which are critical for healthy ecosystems and human food security.[1-4]

"I believe this is a paradigm-shifting discovery that can reverse loss of biodiversity, which is a significant and immediate threat to global food biosecurity," Stamets

said (oral communication, July 3, 2019). "Many people use the analogy of the canary in the coal mine, but the canary in the coal mine probably just affects coal miners, while the loss of bees will affect not only people, but has effects that echo throughout the fabric of nature."

Stamets emphasizes that mycelia have "hidden secrets" and generally contain many more compounds and proteins than mushrooms do. "Mycelia are a lot more bioactive because they are in direct competition with microbes that are trying to consume them," he told *HerbalGram* in 2016.[5] "The fleshier mushrooms rot in a few days, so, in fact, they don't have a very good immune system, compared to the immunologically active mycelia. There are millions of microbes per gram of healthy soil, and for the mycelia to navigate through that potentially hostile environment speaks of a treasure trove of new active constituents that can help human and environmental health."

Paul Stamets with a "bee beard." The honeybees are attracted to Stamets because their queen is contained in a box around his neck.
Photo ©2020 Paul Stamets

Fungi and Bees: What's the Connection?

Because of their effectiveness in laboratory tests, the amadou and reishi mycelial extracts were validated in a field trial. In this trial, honeybee colonies treated with the amadou extract showed a significant 79.7-fold reduction in Deformed Wing Virus (DWV) levels 12 days after treatment, while colonies treated with the reishi extract showed 79.6-fold greater DWV reductions than control colonies. Amadou administration also decreased Lake Sinai Virus (LSV) levels 87.9 times more than the control colonies, while reishi decreased LSV levels 45,000 times more than control colonies. Treatment colonies were fed the mycelial extracts in a sucrose solution, while control colonies were fed the sucrose syrup only.[1*]

Amadou *Fomes fomentarius*
Photo ©2020 LianeM

* It is not clear yet how the extracts work (e.g., their mechanisms of action) or which chemical constituents are involved, but Stamets and colleagues are conducting studies to determine which of the bees' immune-regulating genes are activated by the extracts.

Over the past 50 years, the combination of *Varroa destructor* mites and Deformed Wing Virus has killed billions of bees.

This study, published in *Scientific Reports* (a *Nature* publication), remains in the 99th percentile of all tracked articles of a similar age in all *Nature* publications.[1] Stamets thinks that may be because it is one of the first reports of "a natural product giving a broader 'bioshield' of protection than a pure pharmaceutical, underscoring the complexity of animals' immune systems," he wrote (email, January 28, 2020).

Walter S. Sheppard, PhD, chair of the department of entomology at WSU who is working with Stamets, was quoted as saying: "As an entomologist with 40+ years of experience studying bees, I am unaware of any reports of materials that extend the life of worker bees more than [these extracts]."[4]

Jay Evans, PhD, a virologist and research leader of the USDA's Bee Research Laboratory who also is working with Stamets, thinks it will not be difficult to convince beekeepers to use the extracts once they see firsthand that they are safe and effective for everyday use. "Beekeepers are really interested in using natural medicines," Evans said (oral communication, November 21, 2019). "They don't like putting synthetic chemicals in their hives. Europe and South America have thousands of beekeepers, because they tend to have smaller scale beekeepers, and I think they would be eager to adopt something like this."

Why Bee Concerned?

An estimated 87.5% of all flowering plants are adapted to animal pollination.[6] Pollinators strongly impact ecological relationships, ecosystem stability, plant genetic variation, evolution, and more.[7] Bees, which include about 20,000 known species worldwide, are the main pollinators in most ecosystems and have been found in all habitats with flowering plants.[6]

Apis mellifera is the most widely managed pollinator. It is not native to North America. Colonists brought the species from Europe in the 1500s and 1600s. Many crops also were brought to North America from elsewhere and evolved in the same places with honeybees. Now, *A. mellifera* pollinates more than 100 food and other commercial crops in North America. In the United States alone, *A. mellifera* colonies add at least $15 billion in agricultural value per year. Also, pollinators, including honeybees, are responsible for an estimated one of every three bites of food that humans eat.[8,9]

Almonds (*Prunus dulcis*, Rosaceae), for example, depend almost completely on honeybee pollination, which is significant with the popularity of almond milk and almond butter.[8] Dairy aisles would be much less diverse without pollinators, including bees. Most fruit-flavored yogurts would disappear. Pollinators also are responsible for the chocolate (derived from *Theobroma cacao*, Malvaceae) in chocolate milk. Milk products could decrease up to 50% without bee-pollinated clover (*Trifolium* spp., Fabaceae) and alfalfa (*Medicago sativa*, Fabaceae), which are fodder for cattle.[10]

One honeybee can visit between 50 and 1,000 flowers per trip and can make seven to 14 trips per day. So, for example, a colony with 25,000 forager bees, each making 10 trips per day, can pollinate 250 million flowers per day![7] According to an expert peer reviewer of this article, bees prefer to stay within two miles of their hive, but can travel up to five miles, so one colony can cover an area ranging from 12 square miles to 78 square miles. This creates challenges for "organic" beekeepers, because they need to center their hives where the bees will not come in contact with insecticides, fungicides, or herbicides, all of which affect bee health.

During winter 2006-2007, beekeepers in the United States lost many bees to a set of symptoms later called Colony Collapse Disorder (CCD). Specifically, CCD occurs when most worker bees in the colony disappear and leave behind a live queen, food stores (honey and pollen), capped brood (bees usually do not abandon a hive until all capped brood hatch), and a few nurse bees to care for the remaining immature bees.[8,9]

CCD does not describe all colony losses, and no single factor is known to cause CCD. Instead, multiple factors likely are involved and possibly not always the same factors in the same order. Since 2010, CCD cases have decreased, but beekeepers continue to lose bees for other reasons.[8,9] In fact, colony losses in the United States have averaged about 30% per year in recent years.[11]

Threats to honeybees include *Nosema*, a parasitic fungus that infects bees' midguts and causes symptoms like dysentery.[8,9] Also, neonicotinoids, a class of insecticides, are absorbed by plants and can be present in pollen and nectar, making them potentially toxic to bees.[8,12] Poor nutrition from a loss of diverse foraging plants also weakens bees' immunity, making them more vulnerable in general. However, beekeepers have identified *Varroa destructor* mites as the most serious problem.[8] These parasitic arachnids, native to Asia, have spread to almost every beekeeping region in the world. They latch onto bees and suck their hemolymph (a blood-like fluid in most invertebrates), which weakens the bees and shortens their lifespan.[11]

Varroa mites and other parasites can spread among bee colonies through bee drift. That is, while bees have amazing navigational abilities, a foraging bee sometimes returns to the wrong colony. Typically, the colony accepts her because of the pollen or nectar she brings. This can infect the colony if the drifter carries *Varroa*.[13]

Two bumblebee species, *Bombus mixtus* and *B. melanopygus*, at a bee feeder containing the reishi extract in sugar water.
Photo ©2020 Paul Stamets

Still, even larger field trials are needed to confirm if and how the amadou and reishi mycelial extracts might work in the field, according to Evans. Field trials, in general, are challenging partly because it is difficult to control where the bees forage and what beekeepers do to them. An entire field trial can be compromised if the bees bring in a pesticide from outside. "We think the effects are additive, so if you treat the viruses, the bees might do better against other stresses, but there is a lot more noise at the colony level," Evans said.

Sometimes, even if a treatment is effective, uncontrollable variables in the field may prevent a measurable effect from being seen in a month, which is the length of some field trials. The treatment needs to work in this un-ideal, real-life situation, though. "A lot of treatments don't survive the field trial stage, which means you need to have more candidates or be willing to keep refining it," Evans said. "And I think Paul is doing that."

Evans and his colleagues have tested dozens of candidates for antiviral properties in bees, including thymol, which is derived from the essential oil of thyme (*Thymus vulgaris*, Lamiaceae), and some compounds from nectar. So far, Stamets' extracts are working better than all of those, Evans said. Still, he "would love to see more" fungal candidates tested. "In science, you are really lucky if you find the winner on the first attempt, so I think it is worthwhile to keep looking."

Stamets is screening other fungal species for antiviral activity in bees, including agarikon (*Laricifomes officinalis*, Fomitopsidaceae), a rare fungus from old-growth forests. "Keep in mind that these tests are complicated," he wrote

The mites transmit viruses, most notably the Deformed Wing Virus (DWV), which they inject directly into the bees' hemolymph. DWV causes shriveled wings and shortens the lifespan of bees. Colonies without *Varroa* maintain low and often asymptomatic levels of DWV. With *Varroa*, however, the percentage of infected bees in a colony can increase from 10% to 100%. Over the past 50 years, the combination of *Varroa* mites and DWV has killed billions of bees.[11]

A 2016 study found that male drone honeybees with DWV can infect queens during mating.[14] Also, flowers can be hotspots for viral transmission, a 2019 study found. Honeybees were shown to deposit both DWV and Black Queen Cell Virus on flowers, but viruses were not evenly deposited on all analyzed flowers. Floral traits, virus ecology, and/or foraging behavior may, therefore, affect virus deposition.[15] In a different 2019 study, some wild bumblebees (*Bombus* spp.) near honeybee apiaries had DWV, while bumblebees that were not near apiaries did not, and viruses were found on flowers only near apiaries. This suggests viruses are passing from managed honeybees to wild bumblebees through shared floral resources.[16]

Honeybee (*Apis mellifera*) parasitized by *Varroa* mite (center) and another honeybee with signs of Deformed Wing Virus (bottom left).
Photo ©2020 Piscisgate

Photo ©2020 Whole Foods Market

(email, July 3, 2019). "We need to have many replicates, and the controls need to work. These are, in fact, animal clinical studies. If I had the money, we would be screening 100 species of wood-decomposing fungi. [I expect we] would find many that would have specificity against different sets of viruses and extend longevity in bees."

After September 11, 2001, Stamets became involved with Project BioShield, a collaborative federal effort to discover new ways to protect Americans from chemical, biological, radiological, and nuclear threats. He submitted more than 500 fungal extracts, many of which showed significant effects against small pox, flu viruses, and herpes in vitro. Later, Stamets submitted to the US National Institutes of Health (NIH) 20 isolated compounds produced by agarikon mycelia as they rot wood. Nine of these compounds were found to have significant effects against different viruses (also in vitro).[5] This work later caused him to wonder if fungi could also have antiviral properties in bees.

Several observations led Stamets to notice a connection between fungi and bees. One July morning in the 1980s, he noticed bees from his two beehives all over the wood chips in his garden giant (*Stropharia rugosoannulata*, Strophariaceae), or king stropharia, patch. For about 40 days, from morning to dusk, he observed the bees move from their hives to the garden giant patch and ingest the mycelia. The garden giant is normally red but turned white. Stamets suspects the bees interfered with the garden giant's melanin pathways, which could suggest a possible mode of action by which fungal extracts could help bees. He wrote about this in his book *Growing Gourmet and Medicinal Mushrooms* (Ten Speed Press, 1993), and then it faded from memory until later.

Later, Stamets' observation of bears' scratching trees was also important. When bears scratch trees, it creates wounds in the tree from which bees can collect plant materials to make propolis (or bee glue, a complex, sticky, resinous, wax-like mixture that bees use as cement and disinfectant and to embalm dead hive invaders). The wounds also allow fungi, like the red-belted polypore (*Fomitopsis pinicola*, Fomitopsidaceae), to enter and break down the tree. The fungi thus create a place for bees and other cavity dwellers to move in. "Lots of cavity-dwelling organisms take advantage of myceliated wood once an entry wound is created," Stamets said. "We need cavity dwellers, and some bees are cavity dwellers."

Of the estimated 5.1 million fungal species,[17] Stamets chose to test reishi and amadou for several reasons. During his work with Project BioShield, reishi extracts were found to be highly active against bird flu viruses. And, as Stamets explained, amadou was found in a pouch carried by the Iceman, also called Ötzi, a naturally mummified 5,300-year-old Neolithic hunter who was discovered in 1991 in a glacier in the Ötztal Alps on the border of Italy and Austria. He likely used amadou, which is highly flammable and burns slowly, as a fire starter and medicine.[18,19] Also, according to Stamets, beekeepers have used amadou as a fuel to smoke beehives to calm the bees while they work. Moreover, amadou produces a compound that is highly active against the tobacco mosaic virus, which was the first virus ever discovered and causes mosaic-like mottling on the leaves of tobacco (*Nicotiana tabacum*, Solanaceae) and other species in the Solanaceae family.[20] These factors intrigued Stamets.

Some fungi may also be able to control *Varroa* mites that transmit viruses to bees. *Varroa* mites are tough, Evans said. Like many pests, they have developed resistance to single-chemical treatments over time. Plus, it is difficult to eliminate the mites without also harming the bees. However, preliminary studies by researchers at WSU suggest that

Metarhizium (Clavicipitaceae) fungi may be toxic to *Varroa* but not harmful to bees.[3] The ideal temperature of beehives is typically about 95°F, and *Metarhizium* fungi typically grow at about 90°F, Stamets said. So, through natural selection, WSU researchers are trying to develop heat-tolerant phenotypes of *Metarhizium* so they can be applied in beehives to kill *Varroa*.

Other recent research also supports that fungi can benefit bees. A 2018 study examined the symbiotic relationship between the Brazilian stingless bee *Scaptotrigona depilis* and a fungus in the genus *Zygosaccharomyces* (Saccharomycetaceae). This fungus, found in the bees' brood cells, is eaten by and provides ergosterol to the developing larvae, which allows successful pupation. Insects cannot make sterols on their own and must obtain steroids through their diet to survive.[21] According to Stamets, *Ganoderma* species are known for their steroidal compounds, so this may suggest a possible mode of action by which his extracts could help bees.

Stamets is "perplexed" that science took so long to realize the potential benefits of fungi for bees. "It shows that solutions are hiding in plain sight," he said. Evans, however, is "not as much surprised, but just glad that other options are on the table now." He thinks this discovery reflects recent interest in bee health and how multidisciplinary science has become. It combines mycology (the study of fungi), entomology (the study of insects), virology (the study of viruses), botany, and more.

Down the Road and Bee-yond

Using fungal extracts to improve bee health is both "highly sustainable" and "ecologically rational," according to Stamets. *Ganoderma* species grow in tropical and temperate regions, and amadou commonly grows on birch (*Betula* spp., Betulaceae) trees in northern areas and beech (*Fagus* spp., Fagaceae) trees in southern areas.

Polypore fungi, which form large fruiting bodies with pores or tubes on the underside, such as reishi and amadou, are found in forests around the world. "So it is a vast genomic library that we can tap into," Stamets said. It is possible that fungi found in one area can be used to benefit bees in that area. Often, it is not necessary to wild-harvest entire fungal specimens. By taking small tissue samples, the mycelia can be propagated in vitro anywhere in the world. Stamets' company, Fungi Perfecti (Olympia, Washington), grows tons of mycelia per week using in vitro propagation, he said.

Stamets envisions having a widespread, decentralized network of fungal production facilities. "We should reinvent mushroom cultivation facilities as environmental training and learning centers," he said. "I have been saying that for decades. Mushroom production facilities should be reinvented as keystone components in the fabric of sustainable ecosystems, and this fits in perfectly."

Honeybees *Apis mellifera*
Photo ©2020 Kuttelvaserova Stuchelova

Watercolor of a forest landscape by Jamichael Henterly commissioned by Paul Stamets. Image courtesy of Paul Stamets

The mycelial extracts are "extremely easy to deploy," Stamets said. Many or most beekeepers already regularly feed sugar water to their bees to maintain health. Because the mycelial extracts are water-soluble, they can be added directly to the sugar water feeding system, at one drop of extract per 100 drops of solution. The extracts could also be sprinkled in the hive, Evans said, but it is probably easiest to add them to the sugar water, as has been done for some other products.

Stamets' company also developed a bee feeder, similar to a hummingbird feeder, so everyone can help bees in their own yards. The feeders can be filled with a solution containing the mycelial extracts. Stamets commits that his company will give away 10,000 of these feeders for free. (More information is available at www.fungi.com/bees.) He also is developing another feeder that will hopefully be able to track bee visits and pollen loads, with the intention that citizen scientists and others around the world will upload the data to a portal to monitor progress. He estimates that millions of these feeders will be needed to reverse loss of bee populations.[2,4]

All of Stamets' experiments so far were conducted on *A. mellifera*, specifically female worker bees, but he believes the extracts "absolutely" can benefit both managed and wild bees. Wild bees, which sometimes are outcompeted by *A. mellifera*, are also important pollinators. Photographic evidence shows two wild bumblebee species, *Bombus mixtus* and *B. melanopygus*, together at a bee feeder containing the reishi extract and sugar water (see image on page 69). "I saw them coexisting," Stamets said. "Both of them were going happily on their way, in and out of the bee feeder and not being aggressive to each other, but just sharing the resource. That was fun to see." From his experience, wild bumblebees usually find the bee feeder first, in about one to two weeks. The honeybees usually find it later and in greater numbers.

Stamets anticipates that the cost of the extracts will be low in general. At first, he and his team grew the mycelia using organic brown rice (*Oryza sativa*, Poaceae) as the substrate, or the material on or from which an organism lives, grows, and/or obtains its nourishment. After switching to birch sawdust, the extract reportedly became more than 10 times more potent, meaning the viral load decreased more than 10 times more. Stamets noted that, unlike brown rice, wood contains lignin, a complex organic polymer that lends rigidity to vascular plants and some algae. He suspects that, when the mycelia are grown on wood instead of brown rice, more bee-beneficial compounds are produced as the mycelia delignify (or remove lignin from) the wood, which increases the potency. According to him, a ten-fold increase in potency results in about a ten-fold decrease in cost. He and his colleagues are still experimenting to make the extracts more potent and thus less expensive.

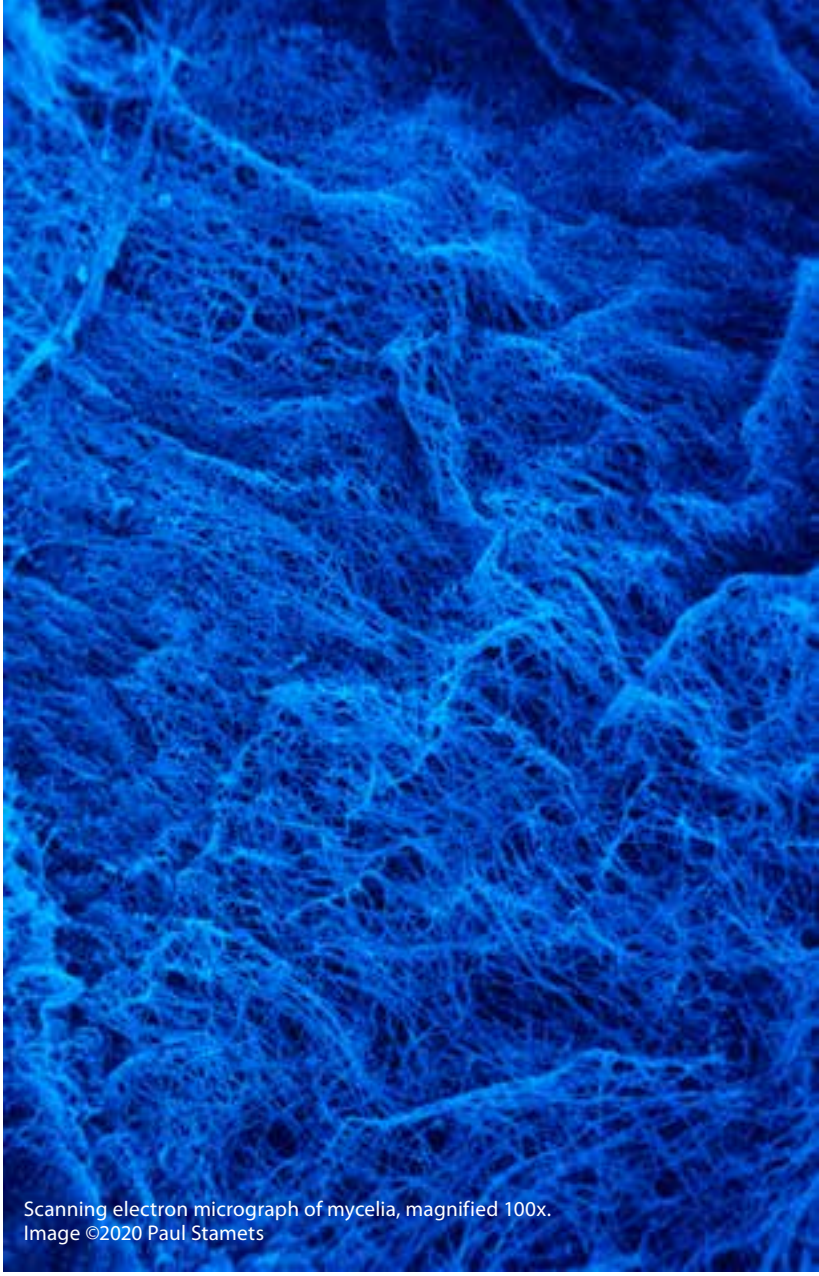
Using fungal extracts to improve bee health is both "highly sustainable" and "ecologically rational," according to Stamets.

The possibility that the viruses could become resistant to fungal extracts in general is a concern, Stamets said, but it shouldn't prevent the problem from being addressed. He thinks the proliferation of the viruses, in the first place, is partly, or largely, due to widespread deforestation, which has decreased the quantity and variety of woods on which mycelia grow, thus reducing the production of natural compounds that could otherwise help control the viruses. Because the extracts contain many compounds, instead of just one, it is less likely that the viruses will become resistant, Stamets said. Plus, it is thought that the extracts reduce viruses indirectly by improving the overall immunity of the bees, instead of directly affecting the structure of the viruses. If true, that also means resistance may be less likely, Evans noted.

"We need all hands on deck and can't let the perfect be the enemy of the good," Stamets said. "We can twiddle our thumbs and worry about resistance as this massive extinction event unfolds. Or we can begin to take action and deploy these now, because we are in a full-blown crisis."

Stamets noted that, in general, very little is being spent on saving bees, "which have such an important economic impact. It is disproportionate. If we lose bees, then people will better appreciate how important they were when the cost of food skyrockets and a large percentage of our food disappears from the marketplace or becomes so exceptionally rare that only the wealthy can afford it.

"I think I found something fundamental to the foundation of nature: that these polypore fungi and their mycelia are keystones that immunologically protect and connect animal inhabitants of forest lands, from bees to birds, bats, bears, pigs, and people," Stamets said. HG



Scanning electron micrograph of mycelia, magnified 100x.
Image ©2020 Paul Stamets

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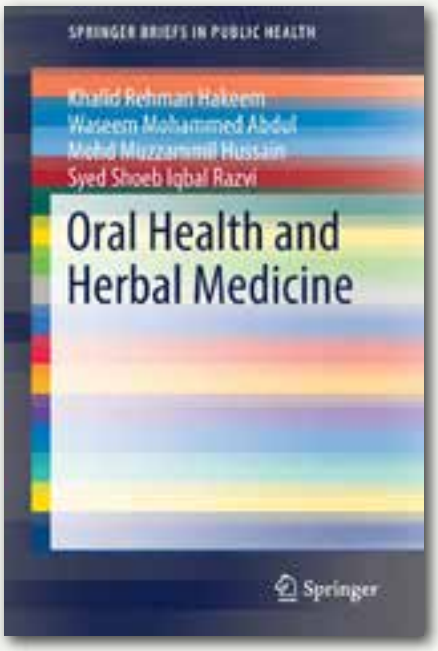


By Memory Elvin-Lewis, PhD

The purpose of this book is to provide examples of medicinal plants that have been used traditionally for, and are considered valuable against, dental disease. Not only is it difficult to understand the book's target audience, but, with four authors, the presentation is uneven and sometimes professionally questionable. A clear and succinct presentation of each topic was needed. Some critical details are missing, glossed over, or referenced rather than clarified in the text. The lack of coordination among authors was evident, since discussions about certain facets, such as dental disease, were found throughout the book rather than being concentrated in one place. Generally, I found the content disappointing, since much of the richness of Middle Eastern and Indian dental ethnobotany was not included, and other examples, seemingly picked at random, lacked a long tradition of use. Moreover, the book should have been copy-edited appropriately, since colloquial use of English by some of the authors is evident rather than the type of English expected in a scientific publication.

A significant omission was the lack of information about the acquisition of normal oral microflora and how changes in the microbiota can occur normally throughout a person's lifetime. The understanding of this concept, and how the organisms involved could be affected by using traditional plants or extracts and compounds, is pivotal to oral health maintenance. While it was stated that many of these natural products have been valuable for ameliorating dental disease, many details, including relevant clinical studies, were not emphasized or were omitted altogether.

The chapter "Oral Diseases and Their Severity" did not include discussions of a number of oral issues, such as halitosis; infections such as candidiasis (often a predictor of malignancy or AIDS), herpetic gingivostomatitis, aphthous stomatitis, and actinomycosis; other bacterial infections causing cellulitis and osteomyelitis; or systemic infections with oral manifestations. Since many of these conditions were cited in the chapter on herbal dentistry, it would have been logical to describe these topics in this chapter. In addition, descriptions of plaque-associated diseases were incomplete and did not differentiate between those that cause various types of caries or periodontal disease. Also, because the mechanisms of these bacteria can differ, so can their susceptibility to certain compounds found in the herbal remedies used to treat them.

However, the focus on how dental disease and certain odontoperiopathic (periodontal disease-causing) organisms can predispose individuals to cardiovascular disease, stroke, and respiratory disease does have merit. Similarly, it is interesting that the book links diabetes mellitus (and its ability to impair healing capacities) to an increase of periapical lesions (i.e., lesions affecting the apex of a tooth root) that require endodontic interventions. Other noteworthy topics include periodontal disease as a predictor for end-stage kidney disease and dental plaque as a possible nidus of infection for gastric ulcers.

Chapters 4 and 5 include several examples of culinary oils, herbs, and spices that are used traditionally for dental purposes. It would have been valuable to include their ethnobotanical origins and the rationale for their selections. Culinary herbs and spices in fresh or dried forms generally are considered safe when used for food or healing purposes, but their essential oils can cause adverse reactions. This is appropriately discussed for the European herbal remedies that use thyme (*Thymus vulgaris*, Lamiaceae) and sage (*Salvia officinalis*, Lamiaceae). However, the text lacks warnings about the allergenic potential of many essential oils used in dentistry, such as tea tree (*Melaleuca alternifolia*, Myrtaceae) oil, for example.

Chapter 4 ("Traditional Information About Herbal Medicine of Oral Activity") focuses on several culinary oils that are used in the practice of "oil pulling." Nowhere in the discussion is India, or perhaps other adjacent countries, mentioned as the source of this practice. In Ayurveda, the use of oils in therapy is commonplace, with the theory that compounds from these medicated oils are absorbed through the skin by massage. While it follows that certain bioactive substances may act in a similar way on the oral mucosa, the theory that these oils "pull" toxins from plaque has not been proven. Throughout the chapter, these oils are referred to only by their common names and lack appropriate binomials to identify their plant sources. Some are mentioned in a cursory way, and those mentioned in more detail, such as sesame (*Sesamum indicum*, Pedaliaceae) oil, should have been placed in Chapter 5 ("Role of Medicinal Plant Species in Oral Health Sector"). Any additional studies associated with their bioactive components or those that affect odontoperiopathic organisms should have been included. None of the clinical trials to support oil pulling were cited in Table 6.1. The last paragraph of the chapter, which describes Tanzanian plants used for dental purposes, is an outlier and not relevant to the theme of Chapter 4.

Some choices, such as ginger (*Zingiber officinale*, Zingiberaceae), seem trivial compared to others that were omitted, such as oil of cloves (*Syzygium aromaticum,* Myrtaceae). Clove oil contains a relatively significant amount of eugenol, which is present in many plants that are prized worldwide for toothache. Moreover, since Listerine® (Johnson & Johnson Inc.; New Brunswick, New Jersey) mouthwash was cited in so many studies in Chapter 6 ("Oral Health Care Products Obtained from Medicinal Plants"), it is surprising that two of its ingredients, eucalyptol from *Eucalyptus globulus* (Myrtaceae) and methyl salicylate from oil of wintergreen (*Gaultheria procumbens*, Ericaceae), were not included in Chapter 5.

Research into the mechanistic actions of plants used primarily as foods has led to some of them being used as herbal remedies for medical and dental purposes. This is not explained in the descriptions of either cranberry (*Vaccinium macrocarpon*, Ericaceae) or green tea (*Camellia sinensis*, Theaceae). For example, the discovery only a few decades ago that cranberry juice is valuable for the treatment of urinary tract infections has made it a popular Western herbal remedy for this purpose. Additional work followed to determine if cranberry could also affect the adherence and co-aggregating capacities of plaque-forming bacteria. Several studies have indicated that cranberry polyphenols have the ability to prevent the colonization, adhesion, and proteolytic activity of certain periopathic bacterial species and inhibit fibroblast inflammatory responses, but these studies were not cited. Also, the book's claims that cranberry affects squamous cell carcinoma are based only on in vitro studies.

Clinical observations regarding the regular consumption of green tea and a decrease in the incidence of periodontal disease were not given as the rationale for selection of this non-oxidized form of *C. sinensis.* A review of references in PubMed would have provided better insights into green tea's clinical efficacy. For example, studies have demonstrated its ability to sustain oral hygiene and that it is a useful adjunct to scaling and root planing. A mechanistic study, which indicated that green tea polyphenols can enhance gingival keratinocyte integrity by protecting against invasions of certain periopathic species, was not included. There was also no mention of green tea's high fluoride content, which might contribute to its clinical efficacy.

In Chapters 5 and 6, the rationale for selecting certain medicinal plants was not fully explained, and some binomial identifiers were not complete or correct. Also, information about the plant part and preparation was often lacking. In some instances, therapeutic claims were linked to known bioactive compounds or in vitro antibiotic or mechanistic studies without providing evidence from human clinical trials. The therapeutic claims for evening primrose (*Oenothera biennis*, Onagraceae) and caraway (*Carum carvi*, Apiaceae), for example, are supported by rodent studies only.

The root of black cohosh was cited by its pharmacopeial name (Rhizoma Cimicifugae racemosae) rather than its binomial (*Actaea racemosa*, Ranunculaceae). The only purported dental use of black cohosh, to "relieve cramps in the jaw or neck," was not included. The choice of this plant derived from Native American pharmacopeias is unusual, since in Western herbal medicine it is used primarily for the treatment of hot flashes and other menopausal conditions.

Some important clinical trial information was not cited in Chapter 5, such as for twig or oil extracts of neem (*Azadirachta indica*, Meliaceae), twig extracts of miswak (*Salvadora persica*, Salvadoraceae), or mouthwash containing flower extracts of chamomile (*Matricaria chamomilla*, Asteraceae). All should have been described in more detail and incorporated into Table 6.1. Turmeric (*Curcuma longa*, Zingiberaceae) root is used traditionally in Ayurveda and traditional Chinese medicine for a wide variety of dental disorders. While turmeric was referenced, clinical trials supporting its value in reducing plaque and gingival indices and as an ingredient as a dental sealant were missing from the discussion.

Other plants/products cited as having value because of their traditional uses for dental conditions in Western Asia, India, and the Middle East still lacked appropriate clinical evaluations. For example, tulsi (*Ocimum tenuiflorum*, Lamiaceae) has long been used in Ayurveda for a wide variety of conditions, including dental disorders. While found in the references, information about how its leaves are used fresh or powdered in a dentifrice (a paste or powder for cleaning the teeth), and how its antimicrobial and anti-inflammatory nature may be responsible for its capacity to treat gum disorders, is missing in the text.

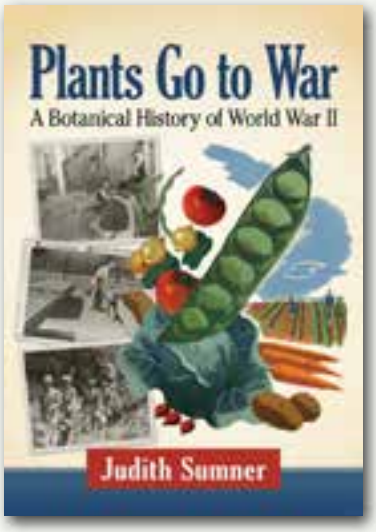
Chapter 5 cites plant uses under a variety of categories related to their reported efficacies. In some instances, I do not understand why certain plants were put into one category and not another. For example, neem was cited under "Plants Used to Maintain Oral Health" and miswak was cited under "Plants Used in the Treatment of Oral Disease." Not only are they traditionally used in similar ways, but their dental products also are considered valuable for dental hygiene as well as to ameliorate dental diseases. Their bioactive compounds have been well studied, and clinical evaluations have been made. No references were made to neem's widespread popularity as a chew stick in India and parts of Africa. I was surprised that the value of miswak was not highlighted by the authors, since, as the prophet Mohammed's favored chew stick, it is valued in Islamic traditional dental hygiene.

Generally, what often is missing when citing any of these plants is information regarding their incorporation into dental products or details of clinical trials to support their efficacy. Also, I would not have cited bloodroot (*Sanguinaria canadensis*, Papaveraceae), a native North American plant, since it was not traditionally used for dental purposes and its alkaloids can intercalate with DNA. A mouthwash containing bloodroot has been responsible for inciting leukoplakia and squamous cell carcinoma.

While I appreciate that much effort was made in preparing this book, its value as a reference is limited. HG

Memory Elvin-Lewis, PhD, *is Professor Emerita of Biology at Washington University in St. Louis, Missouri, and a world authority on the use of plants for oral health.*

Plants Go To War: A Botanical History of World War II by Judith Sumner. Jefferson, NC: McFarland and Company, Inc.; 2019. ISBN: 978-1476676128. Softcover, 366 pages. $49.95. www.mcfarlandbooks.com/.



By Mark J. Plotkin, PhD

A few years ago, while researching the ethnobotany of warfare for an *HerbalGram* article,[1] I called the National WWII Museum in my hometown of New Orleans, Louisiana, and asked if they might be interested in having me give a lecture on the topic. The initial response was concise: "No."

I replied that plants played an important role in World War II: rubber from *Hevea brasiliensis* (Euphorbiaceae) for Sherman tanks, quinine from cinchona (*Cinchona* spp., Rubiaceae) bark for treating malaria, and many others.

"Nope, not interested," they said.

I persevered, mentioning that plants as both foodstuffs and medicines played a role in many military conflicts. The final reply, in so many words: "Dude, we're the guns and ammo crowd. Why don't you call the botanical garden instead?"

Thousands of books have been written and hundreds of movies made about WWII. One might wonder what remains to be said. With the publication of Judith Sumner's, PhD, wonderful new book, many more people will have the opportunity to learn about the extraordinary role plants played in history's most widespread conflict.

Unambiguously, plants have long played an important role in warfare, possibly predating the rise of the human species: Chimpanzees are known to wield sticks as clubs in battle. The armies of imperial Rome used wood for spears, shields, and catapults while traveling in wooden ships and carts, cooking over wood fires, and employing plants as medicines. In the first century CE, Dioscorides, author of *De Materia Medica*, served as a physician in Nero's armies where he was tasked with learning which plants were employed by local tribes for therapeutic purposes.

Plants have always been found on the battlefield, whether it is wine from grapes (*Vitis vinifera*, Vitaceae) as an antibiotic, opium from the opium poppy (*Papaver somniferum*, Papaveraceae) as a painkiller during the Trojan Wars, kapok (*Ceiba pentandra*, Malvaceae) seed hairs for life vest stuffing during WWII, or cotton (*Gossypium hirsutum*, Malvaceae) for wound dressing during 21st-century conflicts.

In her preface, Sumner quotes the late Harvard ethnobotanist and my mentor Richard Evans Schultes, PhD: "Botanical knowledge is fundamental to understanding civilization and interpreting conflict." In the classroom, Schultes expressed a more sardonic view as to why the role of plants is so often underestimated: "The problem is that history is written by historians who know little or nothing about plants and their fundamental roles in the rise of civilization," he said.

Sumner's book is encyclopedic in scope, covering not only the home front in both the United States and England, but also Germany and Japan and even tropical Asia, where many key battles were fought. So broad is her reach that *Plants Go to War* could nearly be used as a textbook for economic botany courses. The book includes chapters on agriculture, fibers, forestry, medical botany, oils, resins, and rubber. Sumner also includes detailed sections on chocolate (*Theobroma cacao*, Malvaceae), coffee (*Coffea* spp., Rubiaceae), soybeans (*Glycine max*, Fabaceae), sugar beets (*Beta vulgaris*, Chenopodiaceae), quinine, latex, and penicillin. Penicillin is an antibiotic derived from the fungus *Penicillium chrysogenum* (Trichocomaceae) and was produced in adequate quantities only after the plants on which it best thrived were identified. She covers a panoply of aspects of plant use in the war, from the woods used in airplanes and boats, to the creation of children's gardens, to methods developed to combat vitamin deficiencies, to the use of plants in deception and camouflage.

One intriguing part of the book is how much globalization already had occurred by the late 1930s. The breakdown of international trade and travel threatened and sometimes curtailed the temperate world's access to tropical staples like coffee, sugar (*Saccharum officinarum*, Poaceae), and tea (*Camellia sinensis*, Theaceae). The book's most arresting image shows the before-and-after of the camouflaging of the crucial Lockheed factories in Burbank, California: Airfields and parking lots were painted to look like fields, and ersatz trees and house frames draped with burlap (manufactured, presumably, from jute [*Corchorus capsularis*, Malvaceae] or sisal [*Agave sisalana*, Asparagaceae]) were rendered to resemble a bucolic rural landscape."

Sumner is particularly strong in discussing the ethnobotany of the Axis powers (Germany, Italy, and Japan), such as the domestic efforts to feed the populations in both Germany and Japan. This became a crucial issue in the later stages of the war: As the Allies gained the upper hand, their Axis opponents faced hunger and even starvation. The book contains especially notable and well-researched sections on German herbalism and agriculture and the supplying of the front lines.

Plants Go to War — a great title, by the way — is exceptionally well researched, with more than 500 references and more than 700 chapter notes. In my eyes, Sumner has produced a classic work of ethnobotanical history. My only quibble: I found the print a bit too small for such an extended read. The wealth of information is so well presented, though, that the reader will likely visit its pages again and again. HG

Mark Plotkin, PhD, *is an ethnobotanist with the Amazon Conservation Team (www.amazonteam.org).*

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Jan Karlsen 1941–2019

By K. Hüsnü Can Başer, PhD, FLS

Researcher and essential oil specialist Jan Karlsen, PhD, died on March 21, 2019. Karlsen was born on September 2, 1941, in Norway and led a successful career as a pharmacist after his graduation from the University of Oslo in 1964. In 1970, he completed his doctoral studies in pharmacy and analytical chemistry at Rijksuniversiteit te Leiden, the Netherlands, where he specialized in the subject of gas chromatography of lower terpenes (*A Study of the Lower Terpenes in Plants by Means of Gas Liquid Chromatography*). Then, he worked as an assistant professor, first in the Department of Pharmacognosy at Rijksuniversiteit te Leiden from 1968 to 1973, and later in the Department of Pharmaceutics at the University of Oslo from 1973 to 1988.

At the University of Oslo, Karlsen was promoted to full professor and worked in the Department of Pharmaceutics from 1988 to 2012. There, he served as dean of the Faculty of Pharmacy from 1979 to 1983, 1986 to 1989, and 2002 to 2004. He also served as head of the Department of Pharmaceutics from 1986 to 1990. After his retirement in 2012, he held the title of professor emeritus until his death.

Karlsen served as a Norwegian delegate for the European Pharmacopoeia Commission in Strasbourg, Germany, from 1980 to 2010. Between 1979 and 2006, he worked as a senior technical advisor to the World Health Organization (WHO), the United Nations Industrial Development Organization (UNIDO), and the United Nations Educational, Scientific and Cultural Organization (UNESCO) on drug development, natural products, and drug quality control. He also served as a senior technical advisor to the North American Aerospace Defense Command (NORAD) on drug quality control from 1986 to 1990. He held numerous international consultancies, working in China, India, Indonesia, Malaysia, Nepal, Sri Lanka, Syria, Thailand, and Turkey on technical and scientific missions for the United Nations. Between 1975 and 2016, he served as a technical consultant for international pharmaceutical, cosmetic, and food companies. He was granted patents between 1990 and 2016 on drug formulation, and he was an author or co-author of more than 300 scientific papers and publications.

Karlsen published extensively on the subject of essential oils for cosmetic and medicinal use. His research included encapsulation techniques, carrier oils and emulsifying methods, and sustained release methods. He also researched the constituents of native Norwegian medicinal plants, such as juniper (*Juniperus communis*, Cupressaceae), and others, such as *Strychnos soubrensis* (Loganiaceae).

As a professor and head of the Department of Pharmaceutics, Karlsen built a modern laboratory for drug research and development at the University of Oslo. He was qualified as a professor in three scientific fields: pharmacognosy, pharmaceutical analysis, and pharmaceutics. He supervised many students and PhD candidates, and many have achieved important positions in academia as well as in the pharmaceutical industry. Karlsen built a worldwide scientific network and had many national and international collaborators.

Karlsen served as chairman of the board of the Norwegian Pharmacy Museum in Oslo, and he was a member of several historical organizations in Europe. One of his interests was the use of drugs through the centuries, from 800 until 1800, and the relations between European medicine and traditions in India. Until his death, he had been busy building a library of antique pharmacy books for the Norwegian Pharmacy Museum.

Information about Karlsen's work for the International Symposium on Essential Oils (ISEO) can be found in the article he wrote for the symposium's 50th anniversary, which was published in the open-access ISEO journal *Natural Volatiles and Essential Oils*.[1] Karlsen's years in Leiden from 1965 to 1973 in cooperation with Anders Baerheim Svendsen, PhD, were essential and laid the foundation for his later scientific career.

ISEO was very important to Karlsen, not only because of the science involved and the development of the different subjects, but also the people he met there: his old friends, and also the younger generation of scientists, of whom he was most impressed and proud.

Karlsen's scientific interests included pharmacognosy, pharmaceutical technology, essential oils, chromatographic methods, phytochemistry, photoactive substances, formulation of gel preparations, and history of pharmacy. He also helped to popularize research on scientific topics such as fragrances and medieval medicine.

Jan Karlsen is survived by his wife Inger, their two daughters, and grandchildren. HG

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Max Wichtl 1925–2019

By Hannah Bauman

Preeminent author and pharmacognosist Max Wichtl, PhD, died on July 30, 2019, in Salzburg, Austria, at age 93. His textbook *Teedrogen: ein Handbuch für Apotheker und Ärzte* (*Herbal Drugs: A Handbook for Pharmacists and Physicians*; Wissenschaftliche Verlagsgesellschaft; 1984) became the main text for German-speaking pharmacognosists and was known by the nickname "*der Wichtl*" ("the Wichtl") among students. "The Wichtl" remains a leading text under its current title, *Wichtl — Teedrogen und Phytopharmaka: Ein Handbuch für die Praxis* (*Wichtl — Herbal Drugs and Phytopharmaceuticals: A Handbook for the Practice*). It has been translated into English, French, Italian, Japanese, and Spanish, and Wichtl was listed as co-author on the sixth edition, published in 2016. The book has been an essential resource in the research and quality control libraries of countless herb and phytomedicine companies around the world.

American Botanical Council Chief Science Officer Stefan Gafner, PhD, commented: "In the 1980s and 1990s, 'the Wichtl' was an essential book for all pharmacy students in German-speaking countries. At a time when knowledge of macroscopic and organoleptic identification of herbal drugs was still a required class in the curriculum, we [students] would not have passed the exam without having the information contained in 'the Wichtl'" (email, January 29, 2020).

Medicinal plant expert Josef Brinckmann worked closely with Wichtl in 2001 on the English translation of the fourth edition. "Prof. Wichtl was delightful to correspond with throughout the translation project," Brinckmann wrote (email, December 7, 2019). "He insisted that the new English edition should not be a 'literal translation' and should avoid being 'Eurocentric.' Throughout the process, Prof. Wichtl received, reviewed, and commented on [translation partner Michael Lindenmaier and my] work as we completed each monograph. Nothing quite like having Prof. Wichtl check your homework every week for 18 months!"

Wichtl was born in Vienna, Austria, on October 6, 1925. He was educated at the University of Vienna and earned his doctorate in chemistry and botany in 1951 and his habilitation in pharmacognosy in 1965. He initially studied cardiac glycosides, such as those found in purple foxglove (*Digitalis purpurea*, Plantaginaceae), before expanding his interest to the study of medicinal plants in general. He published his first textbook, *Die pharmakognostisch-chemische Analyse: Untersuchung und Wertbestimmung von Drogen und galenischen Präparaten* (*The Pharmacognostic-Chemical Analysis: Investigation and Quantitative Determination of Herbal Drugs and Galenical Preparations*; Akademische Verlagsgesellschaft), in 1971.

Wichtl began his career in education in 1971 as a professor of pharmacognosy at the University of Vienna. In 1973, he became a professor of pharmaceutical biology at Philipps University in Marburg, Germany. Until his retirement in 1990, Wichtl held many positions at Philipps University, including chair of pharmacognosy and director of the Institute of Pharmaceutical Biology, and served twice as dean of the School of Pharmacy. He also mentored graduate students and supervised more than 40 doctoral theses. His research on medicinal plants continued and expanded in scope, and he became a member of the German Commission E, a scientific advisory board for the Bundesinstitut für Arzneimittel und Medizinprodukte (Federal Institute for Drugs and Medical Devices), when the commission was founded in 1978. He also served as a co-editor of commentary for the *European Pharmacopoeia* from 1981 to 1999.

With Martin Luckner, Wichtl co-authored *Digitalis: Geschichte, Biologie, Biochemie, Chemie, Physiologie, Molekularbiologie, Pharmakologie, medizinische Anwendung* (*Digitalis: History, Biology, Biochemistry, Chemistry, Physiology, Molecular Biology, Pharmacology, Medicinal Uses*; Wissenschaftliche Verlagsgesellschaft), which was published in 2000. This comprehensive text represented a lifetime of work on cardiac glycosides present in the genus *Digitalis*. Wichtl also authored dozens of journal articles during his time at Philipps University.

Later in his career, Wichtl worked closely with the Society for Medicinal Plant and Natural Product Research (GA), first as an organizer of the GA annual meeting in Marburg, Germany, in 1981; as a member of its advisory board from 1984 to 1987; two terms as vice president (1988-1989 and 1994-1997); and as president from 1990 to 1993. The GA awarded him honorary membership in 1995 in recognition of his work, and in 2008, he received the Egon-Stahl-Award in Gold, the organization's highest honor. *Planta Medica*, the journal of the GA, published two special issues dedicated to his achievements in 2017, and the Austrian Society of Phytotherapy named him an honorary member in 2012.

Brinckmann recalls that, although Wichtl was dedicated to his work, he also approached it with a sense of humor. "When we began to translate the 'Pasta Theobromae' (cacao [*Theobroma cacao*, Malvaceae] paste) monograph, and quickly realized that it was a spoof, we wrote a diplomatically worded note to the professor asking if we were to seriously translate the chapter or whether we should write a serious cacao monograph," he wrote. "Prof. Wichtl quickly responded that we were indeed to translate the humorous monograph. He said that scientists can be too serious, so he wanted to surprise them with something funny and unexpected midway through the book."

Wichtl also had a deep love and appreciation for the music of Wolfgang Amadeus Mozart. After the English-language reissue of *Mozart: A Life* by music producer Maynard Elliott Solomon (HarperCollins Publishers, 1995) in 2005, Brinckmann also helped Wichtl translate the text to German. Wichtl's translation *Mozart: Ein Leben* (Bärenreiter Metzler) was published in 2006. Wichtl also directed many Mozart operas at the Marionettentheater Schartenhof, a puppet theater, in Biedenkopf-Eckelshausen, Germany.

Wichtl is survived by his wife, Waltraud. HG

Publications

American Herb Association Quarterly Newsletter: $20/yr. AHA, P.O. Box 1673, Nevada City, CA 96969.

Australian Journal of Herbal Medicine: Quarterly publication of the National Herbalists Association of Australia (founded in 1920). Deals with all aspects of Medical Herbalism, including latest medicinal plant research findings. Regular features include Australian medicinal plants, conferences, conference reports, book reviews, rare books, case studies, and medicinal plant reviews. AUD/$96 plus AUD/$15 if required by airmail. National Herbalists Association of Australia, P.O. Box 696, Ashfield, NSW 1800, Australia.

Medical Herbalism: Subtitled "A Clinical Newsletter for the Herbal Practitioner." Edited by Paul Bergner. $36/yr, $60/2 yrs. Canada $39/yr. Overseas $45/yr. Sample/$6. Medical Herbalism, P.O. Box 20512, Boulder, CO 81308.

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Eucalyptus

Eucalyptus globulus, Myrtaceae

Photograph by David Taylor
Captured with a Nikon D800, 85mm lens
f/1.8, 1/800, ISO 200

The eucalyptus tree, sometimes known as the Tasmanian blue gum tree, is native to southeastern Australia. It has a tall growth habit and ranges from 45 meters to 100 meters in height.[1] The species has four named subspecies with different arrangements of flower buds and are distributed in New South Wales, Victoria, and Tasmania. Eucalyptus has been naturalized around the world in mild, Mediterranean climates and is considered an invasive species by the US National Park Service. *Eucalyptus globulus* is the primary species used for eucalyptus essential oil, which is distilled from the leaves. The essential oil has a history of traditional use to relieve symptoms of cold and influenza, and Aboriginal Australians have used leaf infusions to treat body pain, sinus congestion, fever, and colds.[2]

The catastrophic wildfires in Australia burned more than 26 million acres and killed an estimated one billion animals as of January 2020.[3] ABC encourages its readers to consider donating to a verified relief fund, such as the World Wildlife Fund, Australian Red Cross, or New South Wales State Emergency Service.

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