

Kelly Kindscher *Editor*

Echinacea

Herbal Medicine with a Wild History

 Springer

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*To the Native Americans who learned
about the benefits of Echinacea as a
medicine long ago and have shared their
traditional ecological and medical
knowledge with us.*

Foreword

This drug, which has slowly wedged its way into attention is persistently forcing itself into conspicuity. The probabilities are that in a time to come, it will be ardently sought and widely used for it is not one of the multitude that have flashed into sight, been artfully pushed, then investigated, found wanting, and next dropped out of sight and out of mind. (Lloyd 1904)

I knew that the prophetic words of John Uri Lloyd, penned more than a hundred years ago, rang true when I first heard the word *Echinacea* mentioned on a television sitcom in the late 1990s. Lloyd is cofounder of Lloyd Brothers, Specific Medicines, Inc., of Cincinnati, and a respected and still influential figure in the development of an American *materia medica*. He and his brothers, Nelson Ashley Lloyd and Curtis Gates Lloyd, also founded the Lloyd Library and Museum in Cincinnati, the world's largest library devoted to medicinal plant-related topics. The Lloyds made the first pharmaceutical *Echinacea* preparation in 1895 sold only to physicians. One might also argue that *Echinacea* made the Lloyd Library. By the early 1920s that product became the most widely prescribed native plant preparation by physicians in the United States.

In America, medicinal plant preparations gave way to single chemical entity drugs in the 1920s. However, many American medicinal plants widely used today such as *Echinacea*, black cohosh (*Actaea racemosa*), and saw palmetto (*Serenoa repens*) were adopted by German phytomedicine firms and have a continuous use as ethical drugs—phytomedicines—which represent the totality of chemical constituents within a plant part, rather than a single isolated chemical entity. Throughout much of the twentieth century, we turned to German science for answers to questions about the chemistry, pharmacology, and clinical application of American medicinal plants.

In the 1930s *Echinacea* was adopted in Germany as an ethical drug, prescribed by physicians and dispensed by pharmacists, with over 60 years of market experience, and until the last decade, prescriptions were reimbursed through the German federal health-care insurance system. Products included ointments, salves, injectable product forms, tinctures, and other preparations from the fresh expressed juice of flowering *Echinacea purpurea*, grown in Germany in 1939, the serendipitous result of *E. purpurea* seeds mislabeled as *Echinacea angustifolia*.

Melvin Randolph Gilmore founded the first Ethnobotanical Laboratory at the University of Michigan in 1938. Gilmore was the first scholar to tease the relatively new discipline of ethnobotany away from the broader pursuits of ethnology and anthropology. In his classic 1919 work, *Uses of Plants by Indians of the Missouri River Region (Thirty-third Annual Report of the Bureau of American Ethnology)*, he penned the famous quote, “*Echinacea* seems to have been used as a remedy for more ailments than any other plant” (p. 131). That quote, too, proves to be a prophetic leap from indigenous society to modern culture.

In 1976, herbalist Ed Smith introduced me to *Echinacea* preparations. In the late 1970s he was the first to import modern *Echinacea* products from Europe and later the first to manufacture his own widely distributed *Echinacea* tincture under the Herb Pharm label which he cofounded with Sara Katz. At the time, *Echinacea* was but another arcane herb relegated to obscure academic pursuits.

In the summer of 1980 I had recently arrived in the Arkansas Ozarks and couldn’t help but notice *Echinacea simulata* blooming along the roadsides. Its beauty was mesmerizing. That summer the late Richard Davis, an Arkansas Natural Heritage Commission botanist, and I rediscovered the yellow-flowered *E. paradoxa* var. *paradoxa* in Stone County, Arkansas.

When plant ecologist Kelly Kindscher and I met in 1982, he was an undergraduate in his sophomore year at the University of Kansas. He was keenly interested in and curious about native medicinal plants, and we enjoyed botanizing during his all-too-infrequent visits to the Ozarks and my even more rare excursions to Kansas. *Echinacea* was a mutual interest. It had been brought to my attention, but now *Echinacea* captured my undivided interest.

Herbs were just beginning to interest the public. Medicinal plant research had all but disappeared in North American academia, except for a handful of pharmacognosy programs in schools of pharmacy. USDA’s one-man medicinal plant research laboratory, with James A. Duke as chief, ceased to exist in 1980. At the time, the late Norman R. Farnsworth (1930–2011), then considered the leading medicinal plant researcher in the United States, used a red rubber stamp on his correspondence which read “Save the Endangered Species Pharmacognosy.” Dr. Farnsworth’s European counterpart, Hildebert Wagner, at the University of Munich had published several papers in the late 1970s which suggested a modern chemical and pharmacological basis which helped to explain the potential of *Echinacea*’s revival as a medicinal plant.

Still, as Kelly and I began to compare notes on the history, ethnobotany, biology, and ecology of *Echinacea*, far more questions than answers emerged. The extant contemporary scientific literature in many respects only added to the confusion. By 1983, as *Echinacea* products gained a modicum of popularity, we began to see serious declines in roadside *Echinacea* populations in the Midwest.

Just what is in those *Echinacea* products(?) became an important question arising from field observations. In a few short years, it became clear that products labeled *Echinacea angustifolia* in the commercial wholesale trade included other species all traded under the name “Kansas snakeroot.” We documented that at least five species of *Echinacea* were included in the Kansas snakeroot trade.

Another wholesale herbal ingredient “Missouri Snakeroot” ended up in products labeled as containing *Echinacea purpurea* root. Yet, that species was not abundant in the wild, certainly not in the quantities necessary to develop a commercial supply source. Missouri Snakeroot was identified as *Parthenium integrifolium* based on herbarium specimens that I had sent to Prof. Wagner’s research group in Munich, but not before they had presented and published two papers describing four new sesquiterpenes from the roots of *Echinacea purpurea*. The studies which relied on commercial samples were actually conducted on *P. integrifolium*, requiring a correction to the published research. Further research revealed that much of what had been published on *E. angustifolia* had actually been studies conducted on *E. pallida*. Those in academic disciplines relative to plant biology and photochemistry need to compare notes before heading to the lab bench.

Important lessons were learned and two Ph.D. candidates, Rudolf Bauer and Ikhlas Khan, produced dissertations which helped to answer questions about *Echinacea* species and their chemistry and biological activity leading to a new era of modern *Echinacea* research. It was to become in many respects Rudolf Bauer’s life work.

About a year later, 26 April 1986, the Chernobyl nuclear disaster in the Soviet Union’s breadbasket, Ukraine, consumed world attention. In late 1986 researchers at the University of Poltava, Ukraine, contacted me for seeds of *Echinacea* species that I had wild-collected in the Ozarks. Studying the potential of *Echinacea* preparations for use as immunomodulators to prevent or treat disease from exposure from Chernobyl radiation, they rapidly developed commercial supplies of *Echinacea purpurea* from wild native Ozark germplasm. A medicinal *Echinacea* vodka product soon followed. One question became: What are the chemical or biological activity differences between landrace wild *E. purpurea* plants and horticultural cultivars, the progeny of which had been in the nursery trade for nearly 300 years? That question awaits an answer.

Each turn of the evolving *Echinacea* story brings into focus new unanswered questions. Kelly and I continued to compare notes. Once he had attained his doctorate, he posed some of the growing list of questions to his graduate students, challenging them to design innovative research. Empirical observations of wildcrafters engaged in commercial trade of the roots suggested that if tap-rooted *Echinacea* species were lopped-off about eight inches below ground, the root left in the ground would sprout new vegetative growth. A road grader cut into an *Echinacea* population produced more plants the following year, when one might expect the population would have been destroyed. Do the roots regrow? Short of commercial cultivation, could a rational plan for sustainable wild harvest be feasible? Kelly’s graduate student, Dana Hurlburt Price, Ph.D., studied this problem for five years, with intriguing results.

Other questions included how one could enhance commercial production of *E. angustifolia* by developing a pre-germination treatment for the hard-to-sprout seeds. What types of morphological variations correspond to chemical variations? Kelly not only asked these questions to his own students but invited graduate students from other institutions to informal colloquia to discuss research challenges and share results.

This book is the result of 35 years of asking broad-ranging questions about an intriguing plant group and how humans interact with it. The human experience of *Echinacea* encompasses all aspects of medicinal plant research, touching and drawing upon dozens of academic disciplines. Absorbing Kelly Kindscher's many-faceted *Echinacea* sojourn is like being on a hike without end. One pauses for a moment on a windswept prairie to admire how the distant horizon melds with the sky. The next step forward reveals more questions, and the journey continues.

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Steven Foster

Preface

Echinacea has been a central theme of my work, a long-term interest that is part of my Great Plains love affair. That love affair has led, step by step, by foot and by car, across a landscape of plants, to this book. I learned and appreciated pasture plants growing up on the 1871 Kindscher homestead farm near Guide Rock, Nebraska. In college, I read prairie ecology and Melvin Gilmore's 1919 book on Great Plains uses of plants by the Pawnee, Omaha, Lakota, and others (Gilmore 1977). I also learned about wild plants from friends (including Daniel Bentley, to whom I dedicated my first book, *Edible Wild Plants of the Prairie: An Ethnobotanical Guide*, published in 1989) and other colleagues. One of these was Steven Foster, and I have fond memories of trips to see him in the Ozarks when he was working on his own book, *Echinacea Exalted!* (Foster 1985). He would tell stories, and we would sample tinctures of all sorts of wild plants late into the night. And I am delighted that he has willing to write the Foreword to this book and provided beautiful photographs.

In the early 1980s, as a skilled gardener, I was growing food for the Lawrence, Kansas, farmers market and soon after directing a community garden program in Columbia, Missouri. I also experimented with many plants in my garden and found that my *E. pallida* and *E. purpurea* plants did fine, while my *E. angustifolia* plants did not survive long in the wet, humid environment of eastern Kansas. This got my attention.

My fascination with *Echinacea* grew as I saw it in wonderful places during my High Plains treks and encampments with Kansas Area Watershed (KAW) Council and friends at wonderful places that also had *Echinacea angustifolia* growing such as Horsethief Canyon, Castle Rock, Jacob's Well, and Cedar Bluff in Kansas; Pawnee Buttes in Colorado; and the Pine Ridge and Badlands in Nebraska and South Dakota. As I started doing research in the mid-1980s on *Edible Wild Plants of the Prairie* (Kindscher 1987), I also starting compiling information on medicinal plant uses. As that book was being published, and I did not have other good options for interesting work, I decided to go to graduate school at the University of Kansas in Systematics and Ecology and write a master's thesis and book that was titled *Medicinal Wild Plants of the Prairie: An Ethnobotanical Guide* (Kindscher 1992). And the most important chapter of this book was on *Echinacea* species. During this period, I started spending time during the summers with elder

Alex Lunderman in the Ring Thunder community on the Rosebud Sioux Reservation in South Dakota to learn about their medicine, and I also read extensively about *Echinacea* and other medicinal plants. I also wrote my first academic paper, on *E. angustifolia* and its ethnobotany (Kindscher 1989), and published it in *Economic Botany*.

For my dissertation, I originally proposed an autecological study of *Echinacea* species to my major advisor Phil Wells and my committee, but was persuaded to look at a broader ecological theme and so focused on the identification of guilds of prairie plant species based on morphological and ecological traits (Kindscher and Wells 1995). After completing my Ph.D., I started my research career at the Kansas Biological Survey at the University of Kansas. *Echinacea* continued as a subject of research for me. I explored herbal products that were adapted to production in Kansas, and I took part in an *Echinacea* safety review (Kindscher and Mitscher 1993) with Les Mitscher, a KU medicinal chemist, who also kindly reviewed the medicinal chemistry chapter of this book. Conducting population work on *E. angustifolia* became the central focus of Dana M. Price dissertation work (Hurlburt 1999) with me. We had previously met while she was a student at the Land Institute, and she also took the lead in writing a very fine history of *E. angustifolia* harvest (Price and Kindscher 2007) that we have updated for this book.

And two other graduate students became involved with me in *Echinacea* work and have collaborated with me on chapters in this volume. Rebecca Wittenberg, from Montana, decided to study botany with me at the University of Kansas, and one result of that work was our collaboration on the Taxonomy chapter in this book. And Rachel Craft, a graduate student in sociology at the University of Kansas, came to work with me to help with data entry for a variety of projects and then fieldwork, and our collaboration on medicinal plants grew. Medicinal plant use and health care have now also become a focus of her dissertation work, and with my encouragement, she has provided some very interesting insights into *Echinacea*'s media coverage and how that may impact markets, as a chapter in this book.

All of this *Echinacea* work resulted in significant fieldwork (which I thoroughly enjoy, in fact, live for). I was involved in the *Echinacea* Symposium that the American Herbal Products Association held in Kansas City, for which I lead a tour of local *E. pallida* stands and presented a paper. And then I led an unsuccessful effort with Dr. Jeanne Drisko of the University of Kansas Medical Center to obtain funding to establish a National Institute of Health (NIH) Botanical Center and five-year research program focused on *Echinacea* species at the University of Kansas. And that collaborative effort has led to other collaborations with Jeanne including our work together on the chapter in this book on the medical uses of *Echinacea*. And although we did not get funding for our botanical center, I was asked and agreed to serve on the outside review board of an NIH Botanical Center that was established at Iowa State University focused on *Echinacea* species and St. John's wort.

A very significant step in working on this book was funding by the US Forest Service for a conservation assessment of *Echinacea* species and especially for those populations on Forest Service lands, including the National Grasslands. This work

allowed for some of the authors of this book to begin to pull all of this information together and also allowed us to conduct fieldwork on populations and density of *E. angustifolia* stands in the Smoky Hills of Kansas and on the Little Missouri National Grassland in North Dakota. That project, in turn, led to our study that documented significant root resprouting after plants were harvested in the wild in both Kansas and Montana (Kindscher et al. 2008). And I have very much enjoyed my work in Montana over the years, including work with Crow elder and author Alma Snell. I also had the opportunity to work on a multiyear biodiversity study in the greater Yellowstone ecosystem, for which Bozeman, Montana, became one of our research trading posts and recovery centers, and it was here, through encouragement of others, that I met herbalist and botanist Robyn Klein and developed one of the most intellectually rigorous discussions on herbal products that I have had. This, of course, led me to want to include Robyn in this book, and because of her legal protection work in Montana for *Echinacea angustifolia* and other species, I was delighted that she took the lead in our legal protection chapter.

And I would be remiss to mention, in this list of fieldwork in North Dakota and Montana, and especially in Kansas, the works and collaboration with graduate students and all of these other friends and researchers that my partner, Maggie Riggs, has played. She is an entrepreneur, a freedom fighter for plants, and a really good coauthor on both the Cultivation chapter and the Marketing chapter, as she has expertise in both. She has also played the essential role of consultant for many of the research activities in this book and in my other work. Her help has been invaluable.

Finally, with a new project in 2009, the Native Medicinal Plant Research Program, funded by Heartland Plant Innovations and the Kansas Bioscience Authority, my lab, and Barbara Timmermann Medicinal Chemistry lab at the University of Kansas looked again at *Echinacea* and many other medicinal plants as worthy research subjects for finding interesting secondary compounds. And in the Timmermann lab, one of the talented medicinal chemists was Congmei Cao, who has been a collaborator on many papers and is also a coauthor of the medicinal chemistry of *Echinacea* chapter. As part of my work in the Native Medicinal Plant Research Program, I revisited this *Echinacea* manuscript as an appropriate subject to work on again. Three years later, the Native Medicinal Plant Research Program—which enjoyed great successes and strong public support—had its funding cut suddenly and dramatically because of state political issues beyond our control. I realized, with encouragement and help from Kansas Biological Survey communications coordinator and skilled editor Kirsten Bosnak, that this *Echinacea* manuscript should be completed and published as a book. I have been working on it ever since, coordinating the various sections and chapters, editing, and writing and am very glad that it is now available to all of you. I have also written and placed vignettes in many chapters that add personal notes, and dimension, to the topics covered. Overall, this book is a collaborative effort by a wonderful team of researchers and writers, who worked with me on the range of important topics on *Echinacea*. I am grateful for their help in putting this work together.

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Kelly Kindscher

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Information that was used to determine county distributions of *Echinacea* species within various states came from botanists and herbarium curators, including Wendy Applequist, Bruce Hoagland, Schuyler Kraus, Deb Lewis, Tim Lowry, Larry McGrath, Bert Pittman, Ken Richards, Tim Smith, Mark Widrlechner, Julia Yang, and George Yatshievych.

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Introduction

Kelly Kindscher

Echinacea has a rich cultural history, with widespread use by Native Americans in the Great Plains and Midwest for many ailments. Lewis and Clark recognized the plant as so important and potentially useful that they sent its roots and seeds to President Thomas Jefferson by boat from the Mandan village in North Dakota where they camped during the first winter of their epic (1804–1806) expedition. In less than 100 years, *Echinacea* did become an important patent medicine in the USA for snake bite, influenza, and other illnesses, and was popularized by the Lloyd Brothers and other early pharmacists. And by the 1990s, it became a best seller in the herbal products industry, largely because of consumer demand for a remedy for colds and flu, and with sporadic validation from scientific research.

Species in the genus *Echinacea* are highly valued as medicinal plants today. *Echinacea* sales over the last decade have regularly been in the millions of dollars per year, with wild-harvested material from the USA being a substantial part of the *Echinacea* market both here and in Europe (American Herbal Products Association 2003, 2012). The demand has brought about, at times, extensive and potentially unsustainable harvesting of wild populations of *Echinacea*. In addition, two species, *E. tennesseensis* and *E. laevigata*, are very rare and have been federally listed as threatened. More recently, *E. tennesseensis* has been delisted due to successful recovery efforts (U.S. Fish and Wildlife Service 2011).

Thus the need for such an up-to-date look at *Echinacea* as a useful medicinal plant and conservations assessment is clear, and it is fitting that this assessment should originate in Kansas, where more wild *Echinacea* is harvested—and it is a relatively sustainable harvest—than anywhere else. The foundation for work on this book is the research on *Echinacea* species conducted at the University of Kansas, the location of the most extensive *Echinacea* species herbarium collection. This collection was used to develop, in 1968, the most widely known systematic classification

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Fig. 1 *Echinacea angustifolia* sampling transect being set up by Kindscher for monitoring resprouting *Echinacea* plants near Plainville, Kansas (Source: Kelly Kindscher)



of *Echinacea* species by McGregor, a KU taxonomist and director of the herbarium, which eventually was named for him. More recent research, also at KU, has examined these species' ethnobotany, wild harvest, and plant population dynamics and safety (Hurlburt 1999; Kindscher 1989, 1992; Kindscher and Mitscher 1993; Kindscher et al. 2008). In addition, the Kansas Biological Survey at KU is a partner in the U.S. Natural Heritage Program and Canadian Conservation Data Centre (CDC) networks, which rank conservation status of *Echinacea* and other species, as well as conservation elements throughout their ranges. And conservation has been the central theme of work as we developed a tool to ascertain whether *Echinacea* and other commercial medicinal plants were indeed of being “at-risk” of overharvest (Castle et al. 2014) (Fig. 1). But this is not just a Kansas work as the plant use and interest in *Echinacea* species is international. It is even more commonly found in pharmacies in Germany than the USA. And consumers in the USA are consuming an international supply as *Echinacea* grown in India and China is now being marketed in the USA.

Research Focus on *Echinacea*

If I were to name one plant that has been the heart of my research, it is *Echinacea*.

When I was a graduate student here at the University of Kansas, my major professor was Phil Wells, a famous plant ecologist who did lots of work on packrat middens and post-glacial plant communities studying and carbon-dating pine needles, acorns, and other plant materials in desert caves in the US West and Southwest. He used these materials to study the climate change 15,000 years ago. He fostered in me a great interest in learning and shared a wealth of information about plants and plant communities. And one day he gave me some great advice, something to this effect: “You know, Kelly, as a grad student, you should pick your group of plants that you want to work on and have that be something you study for your career and then write something about that.”

Phil was talking in particular about figuring out the classic taxonomy or species identifications, and at the time he was finishing up a book on Manzanitas—a group of shrubs known primarily from California and the Southwest. That was his career plant group, so to speak. I heard his advice and immediately thought I ought to work on *Echinacea*. I already had published an ethnobotany of the species a year or two before.

Early in my graduate work I was going through the plants considered the most important medicinally in the Great Plains, and *Echinacea* clearly rose to the top. It is known to have been used by 16 Plains tribes; it was a cure-all—the icon of the region’s medicinal plants, as an iconic genus I have chosen to work on.

This book is unique for the following reasons:

- It is based on fieldwork experience in Kansas, North Dakota, Montana, and across the region as we know these plants in their native habitats. In addition, we visited ranches in Texas, Oklahoma, Kansas, Nebraska, and Montana where *E. angustifolia* was growing. We also visited field sites in Missouri, Oklahoma, Tennessee, and Kansas of *E. atrorubens*, *E. pallida*, *E. paradoxa*, *E. purpurea*, *E. simulata*, and *E. tennesseensis*. And we visited specific locations where overharvesting is known to have occurred in north-central Kansas, Custer National Forest, and the Fort Peck Indian Reservation in Montana. All told, we know these species, their locations, habitats, abundance, and uses.
- The maps we have put together on the range of all the species are based on verified herbarium records and are the most accurate of any produced.
- We provide detailed overviews and offer new insights into the biology, life histories, cultivation, markets, legal protection, chemistry, and medical use of *Echinacea* species.
- The information on ethnobotanical uses of *Echinacea* species, and especially *E. angustifolia*, is the most thorough and well-documented on the topic to date. We have now provided documentation of 19 different tribes that used *Echinacea* in North America.



Fig. 2 Healthy *Echinacea angustifolia* population in eastern Montana northern mixed grass prairie with *Artemisia* species and *Juniperus scopulorum* (Source: Kelly Kindscher)

- Finally, we have developed and outlined conservation recommendations for all of the species (Fig. 2).

I hope this conservation assessment will contribute to the development of a framework for successful conservation of *Echinacea* species by promoting good stewardship among managers and informed awareness among users of the National Forests, National Grasslands, and other federal lands, managers of state-owned lands, as well as among private landowners. Maintaining the viability of wild populations of the species of this wild-harvested and potentially vulnerable North American plant genus is key to its survival. As we learn more about the important medicinal uses of *Echinacea* species, we will likely one day be searching across the geographical range of its populations for germplasm that has the highest content of some secondary compound that has important health benefit, that may not even be identified yet.

I continue to support the sustainable wild harvest of *E. angustifolia*, especially in those areas with large native stands, such as the Smoky Hills of Kansas, as part of the future supply for herbal product markets. I greatly appreciate and support the work of conservation-minded harvesters who go by the names—diggers, rooters, or wildcrafters, depending on where one is, and who choose to work outside in these wild lands, in fascinating habitats and rock outcrop, and who choose to work in nature. And I greatly appreciate those who cultivate *Echinacea* species and even those who just appreciate the plant for its health-promoting properties and beauty.

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