HISTORICAL FOUNDATIONS OF BOTANICAL MEDICINE

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Contents

Summary

This chapter reviews the history, biology, and epistemology of medicinal plants as used by human beings and their primate, other mammalian, and other vertebrate ancestors. Focusing on prehistoric, classical, and ethnographic examples, it delineates the careful selective process by which people selected plants for use, it considers why plants are useful at all, and it describes some of the varying human logic of plant use. It concludes with some recommendations on how (but not whether) scientists should examine nature for additional botanical medicines.

1. Introduction

Plants have probably been used as medicines since well back into the Middle Paleolithic. Since there is a substantial overlap of use of the same plants as both foods and medicines, the simple appearance of a plant in a prehistoric archaeological site does not guarantee its use as a medicine. Indeed, the difference between "food" and "medicine" is a vexed issue.

2. Primates, Birds, and Butterflies

It is possible that medicinal plant use extends back much further than the Paleolithic, and may be an essential part of all mammalian, or even vertebrate, life. As seen elsewhere in EOLSS, there is evidence for a number of primate species using plants in a medicinal fashion, i.e. for purposes not simply nutritive. Chimpanzees have been observed eating (in unusual ways) certain otherwise neglected leaves when they look sick; such leaves have been shown to contain various anthelminthic substances which

might alleviate intestinal parasites. Likewise, various birds have been shown to include in their nests certain insecticidal leaves; fledglings in such nests have been shown to have fewer lice and fleas than those raised without the leaves. These uses parallel the human use of medicinal plants. In a more complex adaptation, the monarch butterfly larva (*Danaus plexippus*) feeds substantially on the leaves of the milkweed (*Asclepias* spp.), a very nasty tasting food generally ignored by other insects. In the process, the larva secrete various cardiac glycosides in different parts of their bodies, in the process making themselves noxious to their predators, usually blue jays and other predatory birds; should a juvenile bird catch and eat a monarch, it will become sick and vomit. Usually, birds only need one try to learn this lesson. Subsequently, they avoid monarchs (and Viceroys, a different species of butterfly which does not feed on milkweeds, and is not toxic, but which has evolved to look very much like the monarch). Again, these butterflies have co-opted the evolutionary defenses of the milkweed to suit their own purposes. The emetic milkweed was used for the same purpose by various native American peoples when they wanted to cleanse themselves by vomiting.

3. Shanidar

The Middle Paleolithic cave site at Shanidar about 100 km north east of Mosul in the Zagros Mountains of northern Iraq was excavated in the 1960s by Ralph Solecki and his colleagues. A series of Neanderthal burials approximately 60,000 years old was discovered at the site. One in particular, Shanidar IV, has proven to be especially significant. Soil samples taken from around the burial have been shown to be particularly rich in pollen. Interestingly, the pollen was not distributed randomly throughout the matrix, but grains were clustered together as if they had come from a number of discrete, complete, flowers. Six different genera were identified: *Achillea* (Asteraceae, yarrow), *Centaurea* (Asteraceaea, cornflower, knapweed, etc), *Muscari* (Liliaceae, grape hyacynth), *Senecio* (Asteraceae, ragwort, groundsel), *Alcea rosea* Folk (Malvaceae) (hollyhock, originally labeled Althaea), and *Ephedra* (Ephedraceae, joint fir). All of these occur today in the Zagros mountains, blooming in May and June. The first five all have showy bright flowers (alternately white or pink, blue, blue, yellow, and white to purple), while the last, *Ephedra*, has a very inconspicuous flower. But all six are used today in Iraq by country people as medicines, and several are used that way everywhere they grow around the world. These discoveries have been taken by many as evidence that in the middle Paleolithic, there was an active knowledge of medicinal plants among Neanderthal peoples. Not everyone accepts this position. Arguments have been made suggesting that these pollens were introduced into the cave site by the investigators; only very few, however, have accepted these propositions. Controversy persists, but most scholars accept this quite remarkable and interesting discovery which indicates that human medical knowledge is ancient indeed.

4. Ötzi

In 1991, hikers in the Tyrolean Alps, just 100 meters south of the Austrian-Italian border found the corpse of a man melting out of the Alpine ice at an elevation of 3210 meters above sea level. Subsequent investigations showed that the Iceman, or Ötzi, named after the Ötzal Alps where he was found, had lived some 5300 years ago; his clothing, kit, equipment, and body contents have been carefully examined, and among

the most informative aspects of the study have been the many plants—seeds, leaves, wood, mosses—discovered in and amongst his clothes and body. He was dressed in three layers of clothing. His leggings and loincloth were covered with a cape made of grasses and bast, the inner bark fibers from linden trees (*Tilia* sp., Tiliaceae). His hat was sewn of bear skin, and his shoes, with bearskin soles and goatskin uppers were insulated with grass. His yew (*Taxus baccata*, Taxaceae, Coniferae) bow and his arrows made of wayfaring-tree branches (*Viburnum lantana* L, Caprifoliaceae) were not sufficient, apparently, to protect him against attack; he seems to have died from an arrow wound in the upper back which, at the time of this writing, has yet to be removed.

He was found to have an infestation of whipworms (*Trichuris trichiura*) which can cause serious periodic diarrhea and, at its worst, dysentery. This probably accounts for the fact that he was carrying two plum-sized pieces of bracket fungus (*Piptoporus betulinus*) which contains a number of toxic resins, plus an active compound, agaric acid, as well as several oils which are toxic to worms and bacteria. The pieces of bracket fungus were pierced with a leather thong, probably used to fasten them to his belt or in a bag so he wouldn't lose them. He probably had these with him to take as a treatment for his intestinal parasite infection; eating some of the fungus would weaken or kill the worms and their eggs, and then act as a strong laxative to expel them from his body. There are many more fascinating plant elements associated with the Iceman, including several mosses which he used to wrap the food he was carrying with him. It seems reasonable to conclude, however, that he was carrying a plant-based medicine with him to treat a potentially very serious medical condition which could have weakened him on his journey through the mountains.

5. Herbals

Another indication of the significance of historical knowledge of plants used for medicinal purposes is the herbal, or compendium of written information on these uses. In China, tradition holds that Shen Nung, the "Divine Husbandman," discovered the uses of many plants thousands of years ago. Shen Nung is said to have learned to talk at the age of 3 days, to walk at a week, and to plow his first field when he was 3 years old after inventing the plow and domesticating an ox to pull it. His learning about plants was, it is said, passed down orally until it was put in written form by an unknown author over 2000 years ago; the *Shen-nung pen ts'ao ching* (Divine Husbandman's Materia Medica) included 365 medicines made from a wide variety of minerals, plants and animals. The ancient Greek and Roman worlds, too, were very interested in medicinal plants. One of the most important medical books of the western world was written by Pedanius Dioscorides, a Roman citizen of Greek origins from Cilicia (in modern Turkey) who lived from roughly 40. to 90 A.D.. Dioscorides, a surgeon in the army of the emperor Nero, traveled widely learning the medicinal plants of various regions around the Mediterranean. His book, *De Materia Medica*, was translated into Arabic at the time of the fall of Rome, and into English in 1655. It was in many ways the standard medical textbook of the western world for 1700 years.

With the European invention of the printing press and movable type in about 1450, one of the first sorts of books (after the bible) to be printed and widely distributed was herbals. Among the most famous is one by John Gerard, *The Herbal or General History*

of Plants, first printed in 1596. Based largely on the work of others who preceded him, Gerard's became extremely popular. A later edition, revised and enlarged by Thomas Johnson in 1633, seems not to have been out of print since that time. The book was, in its day, quite up to date, including a significant number of plants from the Americas, previously introduced into Europe, including sassafras (*Sassafras albidum* Nees, Lauraceae) and tobacco (*Nicotiana* spp., Solanaceae).

6. Native American Medicinal Plants

In what follows, we will examine the use of plants in one part of the world, North America north of the Rio Grande. This very large area was populated by roughly 300 different groups of native peoples before European contact. Although the native population was largely decimated after contact, mostly by introduced diseases to which people had no immunities, the population reached a low point in the 1930s, and has been increasing since then. Various observers have been interested in American plants, and native American plant use, for 500 years; recall that Columbus traveled from Spain seeking "spices." As a result, the flora, and the medicinal and food floras of North America are probably better known than any other continental flora; moreover, there is a remarkable unity to what is called the Holarctic flora, i.e. the flora of the northern hemisphere north of the tropics (which comprises much the largest portion of the land mass of the planet). Throughout this vast region, many cosmopolitan species can be found, and many of them are medicinal, used wherever they grow. North America is, then, a good proxy for the medicinal plants of the world north of the tropics (preliminary research indicates that tropical floras and tropical medicinal floras are dramatically more variable, even among neighboring peoples, than are temperate floras and medicinal floras).

The North American flora, as far south as the Rio Grande, comprises some 18 100 species and some 26 000 taxa at species and subspecific rank, i.e. subspecies, varieties, quads, and crosses. Of these, about 1750 were used for food, 2700 were used as medicines, and 1000 were used as both food and medicine. We will focus here on the medicinal species. Roughly 10% of the flora was used medicinally. But which 10%; what characteristics differentiate the medicinal flora from the rest of the flora?

In addressing this question, it is important to keep in mind some key facts about native populations. In North America, native peoples had no system of writing. They did not have trained botanists, ethnobotanists or agronomists; they had no computers; they didn't have as much as a spiral notebook. Therefore, everything they knew about the natural world they had to remember. Moreover, it seems clear that some things are more memorable than others.

For example, perennial plants, growing year after year in the same place, and hence more easily found than annuals which might grow here and then there, are probably easier to remember than annuals. A tree, especially a large one, rooted in one spot for hundreds of years, is probably easier to remember than is a perennial forb. Things closer to home that one sees regularly are easier to remember than things one only sees after a long hike. Since people often disturb the ground in the areas where they live, weedy plants (ones which prefer disturbed soil) are probably easier to remember than species in

distant, and undisturbed, habitats. This is counteracted by the fact that there is ample evidence to indicate that native peoples in many parts of the world have regularly and deliberately burned forests and fields, thereby disturbing the soil, and encouraging weedy species and trees to the detriment of brush and shrubs. "Undisturbed human habitats" may simply not exist.

These factors show up in native American medicinal plant choices. Over 14% of North American trees are used medicinally by native peoples while about 8% of non-tree species are so used ($\chi^2 = 103$; $p < 0.00001$). While 11% of perennials are used medicinally, only 7% of non-perennials (annuals, biennials, plants which are annuals in part of their range and perennials elsewhere) are so used ($\chi^2 = 81$; $p < 0.00001$). While 26% of weeds are used medicinally, only 9% of non weeds are ($\chi^2 = 709$; $p < 0.00001$).

There are other factors which influence choice of medicinal plants. Plants which are widespread, and hence better known than others, are likely to be chosen to be medicinal species. The average North American plant occurs in about seven US states and Canadian provinces, but the average North American medicinal plant occurs in 19 states; only 2% of plants which occur in only one state or province are medicinal while 15% of plants which occur in more than one state are medicinal ($\chi^2 = 1066$; $p < 0.00001$).

Another factor which predicts medicinal plants is that they are particularly attractive to pollinators like butterflies, hummingbirds, or honeybees. About 29% of attractor plants are used medicinally while 9% of others are so used ($\chi^2 = 503$; $p < 0.00001$). This may be so for several reasons. Plants attractive to insects and birds are often brightly colored, or have distinctive scents or other appearance, i.e. they have high levels of what botanists call apparency. As this makes them visible to pollinators, it makes them visible and memorable to people. Many such plants are common in our flower gardens precisely because of these characteristics, i.e. they are memorable. And so plants of virtue in ornamental gardens tend to be medicinal plants; 13% of garden plants are medicinal, while 9% of non-garden plants are medicinal ($\chi^2 = 104$; $p < 0.00001$)

A number of these factors work together. Most garden plants are, for example, attractors, but many are also weeds; gardens are among the most disturbed of soils. If we separate out widespread perennial weeds (in more than 7 states) which are found in gardens and are widely recognized as attractors of pollinators, we find that there are not many in our list (153) but 56% of them are medicinal plants ($\chi^2 = 350$; $p < 0.00001$); among them are *Arctostaphylos uva-ursi* (L.) Spreng (Ericaeae), *Mentha arvensis* L. (Menthaceae), *Nepeta cataria* L. (Menthaceae), *Iris versicolor* L. (Iridaceae), and *Geranium maculatum* L. (Geraniaceae). If we separate out the trees from that list we find a total of 40 species, of which 27 (or 68%) are medicinal ($\chi^2 = 141$; $p < 0.00001$). Among them are *Acer saccharum* Marsh. (Aceraceae), *Ilex vomitória* Aiton (Aquifoliaceae), *Salix discolor* Muhl. (Salicaeae), *Sassafras albidum* Ness (Lauraceae), and *Quercus alba* L. (Fagaceae).

In the following paragraphs, I will describe few cases of interesting medicinal plants.

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Biographical Sketch

Daniel E. Moerman is William E. Stirton Professor of Anthropology at The University of Michigan-Dearborn. He received his PhD in Anthropology from the University of Michigan in 1974. His first work related to health emerged during his dissertation research with a rural black population in coastal South Carolina in the early 1970s. St. Helena Islanders told him of their complex theory of health involving a subtle system of pressures and flavors of the blood which, if things went badly, could cause various illnesses which they treated with a series of plants (called "weeds") gathered from fields or planted in their gardens. Since then, he has done research primarily in two areas—medicinal plants (primarily of Native American peoples who originated the uses of most of the plants used by the Islanders), and of the impact on health of the knowledge and understanding of it that people have. His book *Native American Ethnobotany* (Timber Press, 1998) received the "Annual Literature Award" of the Council on Botanical and Horticultural Libraries for 2000. In 2002, his book *Meaning, Medicine and the "Placebo Effect"*, on the role of meaning in the healing process, was published by Cambridge University Press.