BOTANICAL MEDICINE: EFFICACY, QUALITY ASSURANCE, AND REGULATION

Good Botanical Practices

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The most significant contribution that a botanist can make to a discussion about furthering the incorporation of botanicals into the U.S. health care system concerns the importance of documenting the materials that are being studied or used in the clinical setting. As Norman R. Farnsworth, Ph.D., Research Professor of Pharmacognosy, College of Pharmacy, University of Illinois at Chicago,[1] has pointed out, at a minimum, 25 percent of the prescription drugs utilized in North America were derived from plant natural products. Globally, some three billion people receive their primary health care through traditional medical practices, heavily based on the use of plant products.[2] It is the botanist's responsibility to ensure that plants are identified with accurate and up-to-date nomenclature. This includes properly vouchering the material through the preparation of herbarium specimens. The foundation of this work is what I would refer to as "good botanical practices," the appropriate use of botanical skills in collecting, identifying, and documenting the plant species that are either part of a research program or directly used in clinical practices. Good botanical practices include the making of herbarium specimens that voucher each bulk collection, whatever its ultimate use.

PREPARATION OF HERBARIUM SPECIMENS

The proper collection of an herbarium specimen begins with the selection of a plant that is representative of its population. The collecting process involves making a complete collection, including leaf, fruit, flower, and other plant parts necessary for a proper determination. It is most often the case that plants that are in flower are not necessarily in fruit and vice versa. For a good portion of the year, many plants are found in a sterile condition, especially those in tropical locations where the growing season is year round, or those in dormancy in the temperate region. However, without flowers or fruits, the so-called "fertile" portion of the plant, it is difficult for a plant taxonomist to make a proper determination. Of course, there are taxonomists who work on specific groups of plants and are able to identify their plants even in a sterile condition. However, because there are so few taxonomists today, those who are practicing are overburdened with requests for determinations, and many taxonomists often decline to carry out work on incomplete specimens.

If the plant is small, such as an herb, then the entire organism can be collected and pressed for preservation. However, many of the botanicals come from trees and, thus, there must be selectivity in the collection. Sections of the stem that contain leaves, flowers and/or fruits are clipped off for pressing. Such specimens can also contain bark or root, especially if that part of the plant is used as a botanical medicine. Figure 1 is an example of a poor herbarium collection.

This particular taxon is described as coming from a two-meter-tall plant in the primary forest with a yellow flower. Unfortunately, the flower has not been collected, and only leaf fragments are present on the specimen. One specialist who examined it noted that it was definitely not a palm, while another one could not place it in the proper family. This particular species is used by local people in Ecuador to thatch roofs and tie bundles. As far as the botanist is concerned, it is an unidentifiable entity. Figure 2 is said to be a tree in the secondary forest, 25 feet tall with a white flower. Note that only a piece of this twig and a few leaves have been

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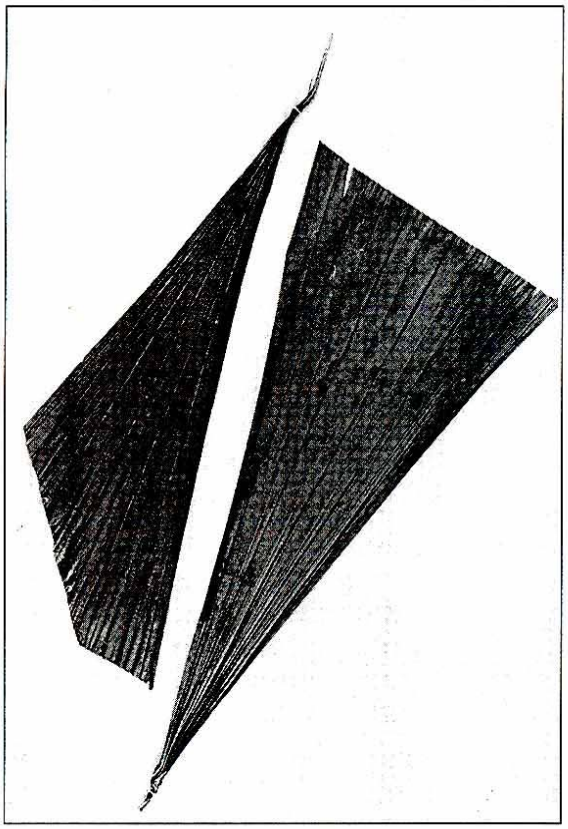

FIG. 1. Herbarium specimen comprised of leaf fragments only, without flowering or fruiting material provided to assist in the identification. Reproduced, courtesy of The New York Botanical Garden Herbarium.

FIG. 2. Herbarium specimen comprised of complete leaves and stem, but no flowering or fruiting material that could be used for identification. Reproduced, courtesy of The New York Botanical Garden Herbarium.

collected. It was felt to be in the family Euphorbiaceae, but the specialist who examined it pointed out that it was not in this family. The use of this particular plant is for firewood, and unfortunately because it is such a poor collection, it remains unidentified. Figure 3 is a medicinal plant used for skin burns. It is said to be a vine growing to two meters with purple tubular flowers and green fruits that turn red at maturity. Note that both fruits and flowers are present on the specimen, as well as a good section of the vine and numerous, representative leaves of various life stages. This one easily can be identified in the family Solanaceae, as *Lycianthes lenta*. Each of these specimens was made to document an ethnobotanical use by indigenous people. Unfortunately, only the plant in Figure 3 can be properly identified, and specimens shown in Figures 1 and 2 represent a waste of time involved in the collection, expenditure of research funds, and botanical expertise.

Unfortunately, botanists are the frequent recipients of such poor specimens. It is especially tragic when a great deal of funds have been invested in the collection and research of a species and care has been taken to make bulk samples, medicinal extracts, herbal tinctures, and the like. It is important to involve a botanist in the research and collection program from the very beginning, to avoid the possibility that the research project will be compromised by the lack of identification at a later date.

In addition to well-made specimens, it is important to take careful notes to accompany the specimens. These notes contain information on the collecting location, including the latitude and longitude, village, state or county, and country. The notes should also contain as complete a botanical description as possible, especially if the plants are large and cannot be completely preserved in the herbarium specimen. The latter case is common, for example, with palms, that might be 30 meters tall with 8-meter-long leaves. In this case, representative pieces of flower, fruit, leaves (pinnae), inflorescence, axis, and stem sections can be taken. In addition, copious photographs and notes are used to document the collection. As mentioned above, with herbaceous plants the situation is easier. But still, information is required on the size of the plant; general description; colors of flowers and fruits that might fade; any fragrance that might be present in flowers, fruits, leaves,

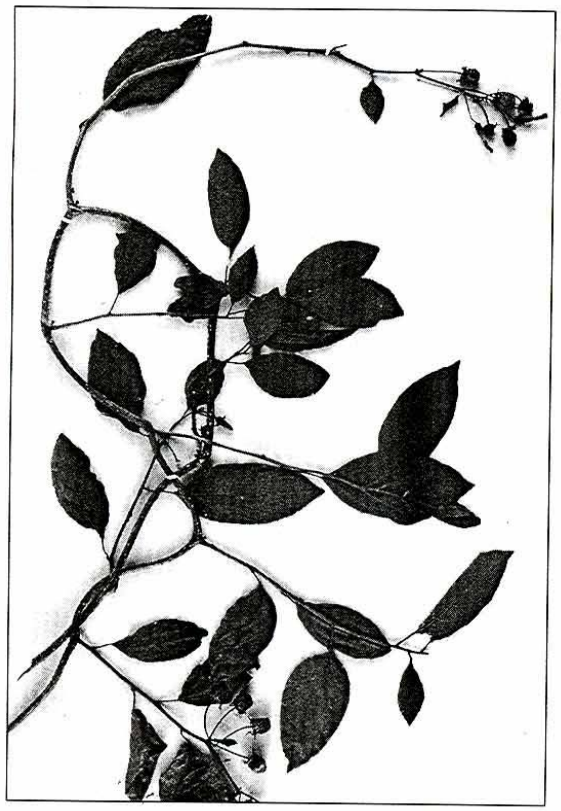

FIG. 3. Complete herbarium specimen containing leaves, stem, and fruiting material, making absolute identification possible. Good botanical practices should include making specimens of this quality to voucher any plant material, whether used for producing herbal products or conducting clinical studies. Only in this way can the studies be reproducible and of the highest quality. Reproduced, courtesy of The New York Botanical Garden Herbarium.

or stems; and information on the shape of fruits or stems that might be lost as part of the process of pressing the specimen. In addition, the date of collection, along with the names of all members of the collection team, should be provided in the lower portion of the label. Finally, credit given to collaborating institutions and foundations that have supported the research must appear on the label.

For the most part, plants are pressed in sheets of folded newspaper, and either preserved in an alcohol bath until they can be dried or plants are directly dried in the field. When preserved in an alcohol bath (usually less than 50 percent) the chemical integrity of the herbarium specimen is compromised, which can inhibit future research opportunities. Such preservation should be noted on the label. Drying plants in the field is difficult and involves taking, for example, a heater, plant press, cardboards, corrugates, ventilators, wooden presses, and straps into the area under study. If the area is remote, then this can be quite difficult, and short-term preservation (e.g., with alcohol) of the plant is the preferred method of collection.

Once the material returns to the institution where it is being studied and curated, the plants are sewn or glued to high-quality rag bond paper.

ETHNOBOTANICAL INQUIRY

The actual sourcing of ethnobotanical data, while appearing to be quite simple, is a complex series of activities that are successful only when the investigator is experienced and patient. The ethnobotanist must approach traditional healers with a great deal of sensitivity, respecting the cultural heritage and limitations of age, health, and time. It is very common for researchers to arrive unannounced at the home or clinic of the healer, bearing collection equipment, cameras, and notebooks poised for action, only to close the door they came to open. A better methodology is to seek an introduction, make several visits to sit and chat, and, within that exchange, explain the purpose of the research work and what role the traditional healer would play. Issues of intellectual property rights and compensation must be acknowledged and discussed. It must be made clear as to how the healer would receive fair recognition for his or her contribution. Some traditional healers do not wish to share their information and their decision should be respected and accepted gracefully, because there are usually valid reasons behind it.[3]

A frequent observation made by ethnobotanists is that people being interviewed often get the sense of what the interviewer wishes to hear and sometimes are happy to oblige that person, especially if he or she seems dissatisfied with the progress of the interview. Thus, herbaria as well as the scientific literature are filled with ethnobotanical collections and citations of questionable value.

To help address this, one recent development being implemented at The New York Botanical Garden (NYBG) Institute of Economic Botany is the establishment of a "credibility rating" for information that is collected on plant utilization, based on the idea of Elliott[4] as cited in Alexiades.[5] In the past, there has been little opportunity to evaluate the quality of data based on the way it has been collected during ethnobotanical studies. In reading through

TABLE 1. CREDIBILITY RATING FOR INFORMATION COLLECTED ON USE OF BOTANICALS

Category/example	*Rating*	*Comment*
Collector uses or directly observed use	1	Dr. Smith saw these *Orbignya cohune* leaves being used as thatch in Belize
Informant uses or directly observed use	2	Maya healer, D. Elijio, told Dr. Smith he uses these *Piper amalago* roots for snakebite
Informant heard/knew from a further source	3	Ethnographer on the Sioux reservation heard that the Sioux used the *Aster* for menstruation problems
Use reported from the literature	4	As for the Institute of Economic Botany's teaching collection, where uses will be gathered from the literature and summarized on the use label
Common knowledge	5	As, for example, a collection of a cultivar of coffee from a coffee plantation with a reported use as a stimulant beverage
Credibility of use information unknown	6	New field botanist neglected to write down any information about his informant

the ethnobotanical literature, it is rarely clear whether the investigator has actually observed or participated in the uses discussed or whether the plants have been collected during a casual walk through the forest pointing out plants or interviewing a younger person who remembers specific use by one of his forebearers. To address this, the credibility rating presented in Table 1 will be incorporated into the database utilized at the NYBG. Data with a rating of 1 have a reasonable certainty of being accurate, while those with a rating of 5 or 6 may be less authoritative. Although this rating is an experiment, and will certainly be revised over time, it is an attempt to begin to standardize the quality of data collected and evaluate its relative credibility.

THE CONCEPT OF THE MULTIPLE-USE CURVE

A key issue that needs to be addressed in ethnobotany involves sample size. When carrying out an ethnobotanical study of a particular group of plants, it is important to determine the number of collections that must be made and number of people contacted before one has a reasonable certainty

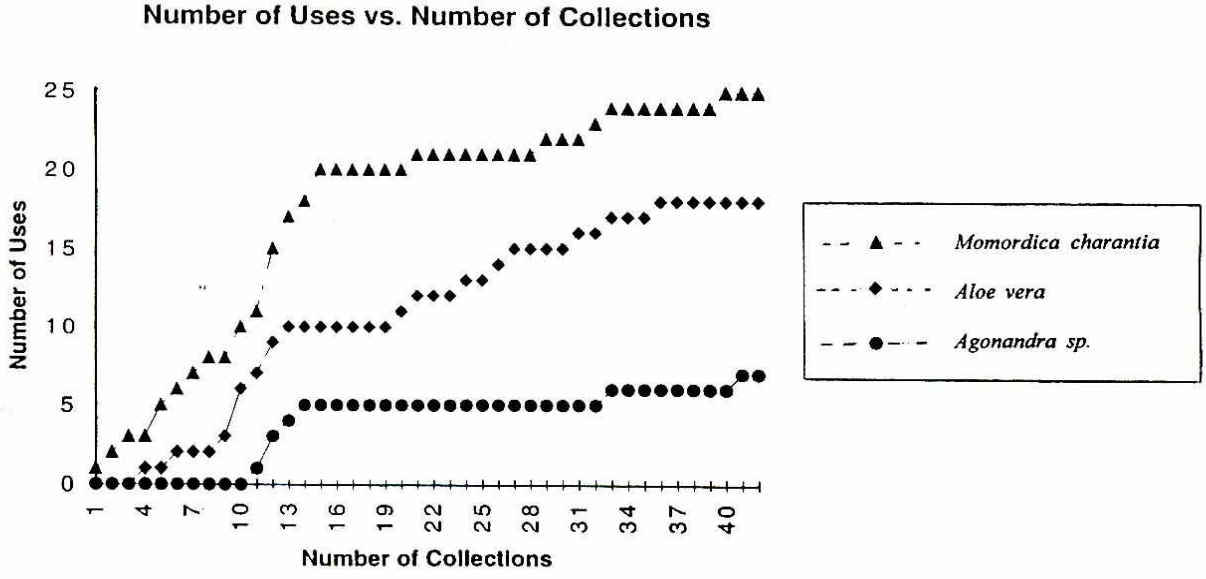

FIG. 4. Graph demonstrating the importance of multiple interviews in investigating local uses of economically important plants. The Number of Collections represents the number of people interviewed and the Number of Uses, the different ways in which each species is used. With each of the species represented in this graph, new uses are still being described after interviews with as many as 40 people.

that the compilation of information on a specific plant is relatively complete. Many ethnobotanical studies depend on one or several collections as the basis for their information and conclusions. In order to assess the adequacy of such numbers of collections or interviews, a mathematical relationship can be developed, based on the concept of the species-area curve.[6]

Figure 4 graphs the relationship between the number of different uses of three particular species (y-axis) versus the number of people interviewed (x-axis). In this example, a total of 42 interviews were undertaken in August and September 1994, in villages of Belize. Interviewees were, for the most part, not considered to be traditional healers but were primarily elderly people who were willing to discuss plant use. The group interviewed considered themselves to be Spanish, Creole, Maya, or Mestizo. Ten plants were discussed, and three were selected to illustrate the type of generalist knowledge obtained from people in these communities.

The upper curve in Figure 4 illustrates the uses of *Mormordica charantia*, a vining herb common to much of the Caribbean. The initial 13 interviews record 20 uses, but show that information on another five uses was obtained by the thirty-ninth interview. This curve illustrates a pattern for a "powerful plant,"[7] one that is widely known with multiple uses. The middle curve is for *Aloe vera*, a commonly known plant, but one that has a more focused series of uses, especially in the area of dermatology. The final species, *Agonandra* spp., is an example of a plant that is not commonly known throughout the community, and appears to have fewer uses, focused on "male" problems. It is also more limited in its habitat than the other two taxa, found primarily in the forest environment. An important point illustrated by the multiple-use curve for these three plants is the large number of interviews/collections necessary to obtain the maximum amount of data. Many ethnobotanical studies, including contemporary ones that utilize statistical methods, derive their information, and thus their conclusions, from a small number of interviews/collections per species. For some plants, such as those with specialist uses, a few collections from traditional healers may be sufficient. Others, such as the more widely used plants, may require several dozen interviews/collections before an idea of the totality of extant information can be obtained.

CONCLUSION

In a revitalization of the role of botanical medicines in the U.S. health care system, a proper understanding of the identification of the materials being collected, marketed, and utilized is essential. Some products currently on the market, which are improperly identified, pose a threat to consumers who have the feeling that all that is natural is safe. For example, an extract of *Pilocarpus* leaves, added to shampoo and hair products, could pose a danger of poisoning if it contains the alkaloid pilocarpine. To avoid potential problems such as this, the herbal industry should adopt strict "good botanical practices" that make vouchering all collections and bulk samples required, whether for research or product formulation, and have these vouchers properly identified and retained should questions arise in the future.

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