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CHAPTER 5

Informant Consensus: A New Approach for Identifying Potentially Effective Medicinal Plants

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Introduction

The anthropological study of medicinal botany has numerous objectives (cf. Messer 1978:137), one of which is to identify ethnomedically important species that warrant chemical analysis and testing for biological activity. Such research not only clarifies the empirical basis of herbalism in diverse cultural settings, it also provides data of potential significance for modern pharmacology and health care delivery (cf. Krieg 1964; Lozoya 1976; Swain 1972).

Anthropologists have employed several methods of analysis in their attempts to suggest, for a given society or group of societies, which species should enjoy a higher probability than others of being biologically active, particularly in a manner consistent with local ethnomedical use. Aside from briefly illustrating these methods, our purpose here is to advance a new approach useful for identifying which plants within a folk pharmacopoeia deserve the increased research attention of phytochemists and pharmacologists. In so doing we hope to improve the ethnographer's ability to contribute direction for future biochemical research on ethnomedically important plants.

Identifying Potentially Active Species

A review of the anthropological literature on medicinal botany reveals several approaches to a common research problem, that of suggesting which plants employed ethnomedically are likely to be effective. Since there are so many studies that could be cited to illustrate these approaches, the examples presented here will be limited to research that is current or ongoing, as well as confined to the Americas.

Perhaps the most frequently used approach is that of "historic depth." By focusing on those plants that have enjoyed considerable currency over time in a given culture area, researchers have identified a large and growing number of species that are biologically active in a manner consistent with ethnomedical predictions, or ones that are active in a manner consistent with both ethnomedical and Western medical practice (cf. Ortiz de Montellano 1975a). Basic to this approach is the assumption that if a given species was employed in the past for a specific disorder, and people today employ the same species for the same purpose, then the plant is likely to be effective.

Ongoing research by Davidson and Ortiz de Montellano (n.d.) concerning Maguey (*Agave atrovirens*) provides an informative example of the "historic depth" approach. Maguey sap, applied as a poultice, was a common wound remedy among the Aztecs (Hernandez 1959:348; Sahagun 1950-1969 [Book X]:145). It continues to be used in the same manner today, as well as for numerous other medicinal purposes (cf. Luis Díaz 1976b:4). Davidson and Ortiz de Montellano demonstrated that Maguey sap is an effective antimicrobial agent which inhibits the growth of five species of bacteria: *Sarcina lutea, Shigella sonnei, Salmonella paratyphi, Escherichia coli,* and *Pseudomonas aeroginosa.* When combined with salt, a practice frequently employed by the Aztecs, Maguey also proved effective against *Staphylococcus aureus.* As this research illustrates, there is typically an empirical reason why certain species are used in a consistent manner over time. This is surely the case with Maguey, a species now known to be antimicrobial and anti-inflammatory, thus an effective treatment for wounds and many generalized skin infections.

Another commonly used approach is that of cross-cultural comparison. By collecting inventories of herbal remedies in two or more culture areas and identifying which species are employed in similar fashion by peoples of different locations and cultural backgrounds, anthropologists frequently can suggest which plants are most likely to be efficacious. The argument here is that if culturally and geographically distinct populations have access to some of the same species, many of the parallels in herbal practice recorded among these peoples should involve species that are biologically active.

The utility of this approach is clearly seen in data provided by Moerman (1977) for Native North America and those supplied by Mexico's National Institute for the Study of Medicinal Plants (cf. Luis Diaz 1976a, 1976b). One example from each of these extensive surveys should prove more than adequate to illustrate how productive comparative data can be.

On the basis of his 1977 survey, Moerman recently concluded (1979:527) that due to the common and culturally widespread use of wild geranium (*Geranium maculatum*) as a specific treatment for sores or lesions of the mouth, several North American populations had discovered (perhaps independently) a truly effective astringent. The presence in wild geranium of substantial amounts of tannin and gallic acid confirms, in this case, the predictive value of cross-cultural analysis. In a similar manner, Mexican researchers have added importantly to knowledge of the medicinal uses of the Nopal or prickly pear cactus (*Opuntia* spp.) which is frequently prescribed to treat diabetes mellitus throughout Indian and Hispanic Mexico. Recent tests (Ibañez-Camacho 1978; Ibañez-Camacho and Roman-Ramos 1979) demonstrated that Nopal acts as a hypoglycemic agent capable of temporarily but significantly lowering blood sugar levels in pancreatectomized animals. In this and the previous case, comparative research provided a guideline along which biochemical research has been directed.

Empiricism and selection are processes largely responsible for both temporal and geographic continuity in medicinal plant use. These processes lie at the base of other methods of analysis employed by anthropologists when attempting to isolate efficacious species. For example, research that focuses on the diffusion and selective borrowing of herbal remedies frequently can be a productive approach, as can studies pertaining to the marketing of medicinal species. Similarly, by selecting for biochemical analysis those species identified by anthropologists as the ones most frequently cultivated in household gardens ("huertas"), phytochemists and pharmacologists gain information useful for directing their research. Of these approaches, market based studies are surely the easiest to conduct, and they also may be the most productive.

Species which (1) invariably appear in market settings, (2) have a consistent and limited number of uses, and (3) enjoy a high volume trade, are the ones that deserve special research consideration. For this approach, as for those of historic depth and cross-cultural analysis, consumer use and evaluation of remedies provide a natural form of empiricism, one that can be explored profitably through biochemical research.

Literally dozens of species sold throughout Mesoamerican and U.S. Latino herbal markets could be cited to illustrate the utility of this approach. The example presented here—although less well known etically than such commonly encountered remedies as Ajo (*Allium sativum* L.), Epazote (*Chenopodium ambrosioides* L.), Manzanilla (*Matricaria chamomilla* L.), Pericón (*Tagetes lucida* Cav.), and Ruda (*Ruta graveolens* L.)—nonetheless merits increased research attention.

The example is Haba de San Ignacio (*Hura polyandra* L. and *H. crepitans* L.), a relatively large, circular bean which is frequently prescribed and sold by "hierberos" as a remedy for alcohol abuse (cf. Trotter 1979). When the beans are dried, pulverized, and added to food, they reportedly induce nausea and even vomiting when one consumes alcholic beverages, particularly when alcohol is ingested shortly after eating. Although the chemical properties of Haba de San Ignacio are not fully known, the presence of a toxalbumin and perhaps a phytotoxin suggests that this therapy is most likely effective as an aversion agent (cf. Pammel 1911; Standley 1961:645-646; Tampion 1977:42). Our point is that *Hura* deserves closer inspection than it has received to date, particularly because it is commonly sold in markets, exhibits a fairly consistent use pattern, and enjoys considerable public demand. Obviously Haba de San Ignacio is only one of a large number of plants that meet these characteristics, thereby "qualifying" for an improved research status among phytochemists and pharmacologists.

Another approach viewed to be productive, yet unfortunately little used, involves the collection of case history and folk-symptomatology data. These detail not only the biographic traits of those employing herbal remedies but also the reports of informants on both the appearance and remission of specific symptoms; thus, they provide useful direction for biochemical research. For example, Flor de Manita (*Chiranthodendron pentadactylon* Lar.) has long been used in Mexico to treat inflammation of the eyes and genitalia and to improve the quality and strength of one's blood (cf. Logan 1982). Collection of case histories and folk symptomatologies for individuals who had used or were currently using this species proved to be instructive. When asked, for example, what bodily complaints spelled the need to begin ingesting a tea of Flor de Manita, informants invariably mentioned general weakness, shortness of breath after minor exercise, and a bluing of the lips, fingers, and toes. A few cited upper chest pain as an additional sign to begin taking this remedy. Clearly, these symptoms suggest cardiopulmonary insufficiency as the underlying medical problem, one which is frequently treated or controlled through the use of diuretics. *C. pentadactylon* is already known to be anti-inflammatory and anti-atherogenic (Jiu 1966:257). Moreover, analyses by Harborne and Smith (1972) and Rodriguez and Arellano (n.d.) have confirmed the presence in this plant of two well known diuretics, luteolin and quercetin. This finding adds considerable validity to informants' claims that Flor de Manita is indeed effective. As this example demonstrates, biochemical research can be significantly guided by ethnographic inquiry regarding who uses which plants, what problems convince an individual to adopt a specific herbal therapy, and what results follow the selection and consumption of these medicines.

Admittedly, other methods have been utilized by ethnographers in their efforts to suggest which species should enjoy a high probability of proving efficacious. Phytogeographic distribution, random screening, and incidental discovery are but three examples. The ones discussed above, however, seem to be either the most frequently employed or the most productive to date. Underlying each of these approaches is a natural form of empiricism, one that has developed from the repeated human use and evaluation of herbal remedies over time and space. Such empiricism is seen clearly in the approach we present here—that of informant consensus regarding herbal remedies.

The Research Hypothesis

As with other cultural domains—for example color terminology, kin networks, and religion—medicinal plant use exhibits considerable group patterning with respect to beliefs and behaviors. Such patterning in the context of herbalism results from many factors including: cultural tradition; the unifying force of socialization; health needs; and—most frequently—empiricism, where intragroup similarities in medicinal plant use arise and persist because particular remedies produce effects that are anticipated and frequently therapeutic. On the other hand, variation can be viewed as a product of several variables including differential socialization and acculturation, innovation, experimentation, and differences in the preferences or life experiences of individuals.

Both conditions, consensus and variation, must be adequately addressed in any model pertaining to the use of ethnopharmacologic resources. While consensus may support the assumption of empiricism in an ethnomedical system, variation may obscure that empiricism; or, alternately, it may suggest a localized failure in discovering suitable treatments for particular illnesses within an otherwise effective therapeutic system. Certainly the latter case is true of scientific biomedicine in relation to the common cold. Thus far, Western medicine can provide only treatments for symptoms and not a cure of the viral infections that underlie colds. Giving undue emphasis to this failure, and to the failure of biomedicine to cure certain chronic illnesses (e.g., arthritis, diabetes, etc.), might lead one to conclude that the overall process of empiricism in biomedical science is weak, just as overemphasizing variation within an ethnomedical system might lead to the same unwarranted conclusion. Thus, any model concerning the effectiveness of a therapy or a treatment system must take into account both consensus and variation; and it must discover a method for evaluating the former, while simultaneously minimizing the "clouding" effect of the latter.

We suggest that intra- and intergroup similarities in the use of medicinal plants have arisen and persist because particular remedies produce reactions that are both predictable and considered to be desirable. We also recognize that ethnomedical systems contain an anticipated, and perhaps even predictable, level of variation in the use of available remedies. It is in reference to these two points that we advance the following hypothesis, which serves as the major focus for the research discussed here:

> The greater the degree of group consensus regarding the use of a plant based therapy, the greater the likelihood that the remedy in question is physiologically active or effective.

What we are testing, then, is whether variance in group knowledge concerning herbal remedies is sensitive to, or an indicator of, variance in the effectiveness of medicinal plant species. The null hypothesis, therefore, would predict that remedies known pharmacologically to be effective would not enjoy greater group consensus regarding their use than would species which are inactive or ineffective.

Several research requirements had to be met in order to test this hypothesis: (1) A sufficiently large number of interviews must be collected to comfortably establish both consensus and variation within the ethnomedical system. (2) Such interviews should cover a broad range of health problems and their associated herbal therapies. (3) The species involved must be identified taxonomically. (4) A measure to assess informant consensus regarding medicinal plant use must be devised. (5) A procedure for evaluating the effectiveness of the research species should be developed.

The discussion that follows details how these requirements were met.

Requirement 1: Sufficiently Large Data Base

This study is based on data housed in the Ethnopharmacological Archives at Pan American University. To date, more than 3,000 cases of home based remedies have been collected in the lower Rio Grande Valley, Texas (cf. Trotter 1981a, 1981b, 1982; Trotter and Chavira 1980). Each case in the archives contains data on the remedy employed (including its English translation and taxonomic nomenclature, if known), the specific illness treated, the remedy's method of preparation and administration, examples of other ailments and home based treatments identified by the informant, and a set of biographic data for that informant (i.e., age, sex, ethnicity, occupation, residence, etc.). Only cases collected from persons who identified themselves as Mexican-Americans are reported here. Yet the data base is sufficiently large to document both consensus and variation in the use of home based remedies ("remedies caseros").

Requirement 2: Scope of Interview Data

A total of 1,223 cases, involving 378 informants, were selected for analysis. (These were chosen on the basis of completeness and comparability of data.) The informants ranged in age from 16 to 82 years of age, but they are clustered most heavily in the 30-55 year range. Of the selected cases, 41.5 percent were collected from individuals who were born in Mexico and who now reside in Texas. All other interviews were taken from individuals born in the United

States. Most of the interview data were secured from female informants (84.5 percent of the cases selected).

Each informant had been asked to provide as many or as few examples of home based remedies as they wished, although 25 was arbitrarily set as the upper limit to be collected from a single informant (on the assumption that both the informant's good will and the interviewer's stamina would be eroded by trying to discuss more than 25 cases in a single interview). Since informants were describing home remedies on an open basis, we consider that the examples given were highly salient—that is, they were highly familiar to, and/or recently used by, a given informant.

A total of 510 separate remedies were identified in the interview data. These, in turn, were associated with 198 distinct ailment categories. Since the interviews yielded such a large and diverse inventory of remedies and associated ailment categories, we were forced to be selective with respect to which entries would be chosen for analysis. The remedies analyzed here are those that (1) involve a single plant species, (2) comprise the 25 most common remedies cited in the interview data (Table 1), and (3) represent the "remedy of choice" for the 25 ailment categories exhibiting the greatest degree of informant consensus (Table 2). Employing the three criteria above, 29 species (representing 30 different remedies) became the object of study (Tables 2 and 3).

Requirement 3: Taxonomic Identification

The research species are well known botanically. Taxonomic identification was achieved through two procedures, one based on the collection of field or market speciments which were identified by a professional botanist[1], the other by linking a plant's common name to its scientific name as discerned from several ethnobotanic sources for Mexico and the American Southwest[2] (e.g., Ford 1975; Kimber n.d.; Luis Díaz 1976a, 1976b; Martinez 1969; Morton 1981). We are confident that the 29 species have been identified correctly.[3]

Requirement 4: Assessing Informant Consensus

Two procedures were used to operationalize the dependent variable, informant consensus. The first is based on a simple frequency count of the 25 most common remedies in the total remedy base of 510. Here, consensus is measured with reference to increased frequency of occurrence: the greater the occurrence of a given remedy, the greater the assumed consensus regarding its use.

The second measure, which evaluates consensus regarding the treatment of specific ailments, is somewhat more complex. For this measure a frequency count of all cases of a particular ailment category is made, then the number of separate remedies for that ailment is subtracted from the total. The remainder is divided by the total number of cases, minus one, for the ailment in question. This procedure can be summarized by the following formula, which we designate the Informant Agreement Ratio (IAR):

$$\text{IAR} \quad \frac{\left(\begin{array}{c}\text{Total Cases of}\\ \text{Ailment in Sample}\end{array}\right) - \left(\begin{array}{c}\text{Number of Separate}\\ \text{Remedies for Ailment}\end{array}\right)}{(\text{Total Cases for Ailment})}$$

The IAR gives a product ranging from 0 to 1. the higher the number, the greater the assumed consensus on the use of a given remedy for a given ailment. Earache, for example, produced an IAR score of .571—the highest encountered in this study (36 cases recorded, minus the 16 separate remedies employed, divided by 35 cases = IAR.571). By contrast, the IAR for the common cold, .071, is relatively low (15 cases recorded, minus the 14 separate remedies employed, divided by 14 cases = IAR .071). The IAR score not only provides a measure of consensus, it also indicates the presence of a "remedy of choice," a therapeutic procedure or procedures that are most frequently utilized during the illness episodes reported here. For the examples above, the remedy of choice for earache was Ruda (*Ruta graveolens* L.), in which 19 of the 37 illness episodes involved this plant (relative frequency, 51 percent); and for the treatment of colds—a condition exhibiting low consensus—Oregano (*Oreganum vulgare* L.) was only slightly favored over 13 other species (of the 15 episodes recorded, 2 involved the use of oregano, giving a relative frequency of 13 percent). On the basis of these data—IAR scores and the relative frequency of "remedy of choice"—we would suggest that Ruda is more likely to be an effective remedy against earache than Oregano is against the common cold. This is not to suggest that remedies with low IAR's cannot be bioactive. Oregano, as a case in point, is bioactive, containing thymol, origanine, carvacrol, tannic acid, and resin. It may alleviate several symptoms associated with the common cold.

In summary, then, informant consensus is measured by variance in the frequency count of the 25 most popular remedies and by variance in IAR score for 25 ailment categories.

Requirement 5: Assessing the Efficacy of the Test Supplies

Obviously this requirement was of signal importance, particularly since data on efficacy were required for statistical analysis. This requirement also proved to be the most challenging, for chemical and pharmacologic data on medicinal plants frequently appear in diverse and at times difficult to obtain sources. Moreover, many ethnomedically significant species simply have not been bioassayed or experimentally tested for identification of constituents. Two procedures were employed to assess whether the species involved in this study are physiologically active, particularly in a manner consistent with ethnomedical predictions, and whether they are likely to be efficacious when employed as designated.

First, the plants were tested for pharmacologic activity by means of a recently developed bioassay (cf. Meyer et al. 1982) which is based on observing the kill rate of brine shrimp (*Artemia salina* Leach) exposed to solutions extracted from medicinal plants.

A bioassay allows one to record, measure, and evaluate the effects (if any) a given substance will produce in test organisms. Some bioassays utilize whole living organisms, such as hydra, mice, and nonhuman primates. Others, such as the 9kB and 9Ps cytotoxicity protocols, use cell tissue cultures. Some are specific for a narrow class of compounds, while others (general bioassays) are methods of measuring if there is biologic activity in a wide array of compounds. The latter type of test is necessary for screening plants for bioactive constituents because of the great variety of compounds that might be present in any given test species. Most bioassays measure activity as reflected by the percent of organisms that die when exposed to known amounts of the test compound. It should be noted that the bioassay per se only determines that there is biologic activity present, not which particular compounds are responsible for the observed activity. This can be discovered only through pharmacognosy, pursued through fractionation of the compounds and further testing. Nevertheless, a general bioassay such as the one used in this study does provide an excellent preliminary measure of the bioactivity of plant based treatments.

Samples of the species tested were either purchased locally at an "yerbería" (herb store) or were, in a few cases, collected from living plants growing in the area. The choice of whether the sample was prepackaged or fresh depended on the most common selection process for the same remedy found in the ethnographic data. Thus, acquisition of the remedies approximated the ethnographic condition as closely as possible. The remedies processed in their fresh form included: Savila (Aloe vera, *Aloe vera* L.); Hojas de Naranjo (Orange leaves, *Citrus aurantium* L.); Ajo (Garlic, *Allium sativum* L.); Hojas de Mesquite (Mesquite leaves, *Prosopis glandulosa* Torr.); and Cebolla (Onion, *Allium cepa* L.).

With one exception, the remedies were prepared as decoctions (medicinal teas) by mixing 28 grams of the crude remedy in 500 ml of distilled water and boiling for five minutes. The exception is Savila (*Aloe vera* L.), which was prepared by cutting and peeling a leaf and steeping it in distilled water at room temperature (ca. 21° C) for 24 hours.

A 100 ml aliquot of each of the solutions tested was reserved and frozen to determine the weight of extract per unit volume of water for each of the remedies. Because the equipment necessary to reduce the extracts *in vacuo* is not presently available to us, we have not yet determined the LD 50's for the decoctions. This is the most significant departure that our study takes from the protocol designed by Meyers et al. (1982). However, since equal amounts of each remedy were prepared in equal amounts of solvent, the technique is still a method for relative comparison of the medicinal teas themselves. This modification is acceptable, insofar as it allows for a preliminary screening that can be carried out under even the most difficult field research conditions using equipment limited to scales, a shallow pan, rock salt, a measure for water, a vial of brine shrimp eggs, a magnifying glass, and small containers for the brine shrimp replicates.

Brine shrimp were hatched from encysted eggs (Jungle, Inc., Stamford, Florida) in shallow rectangular plastic dishes (20x26x8 cm). A plastic divider, with 30-35 3mm holes bored in it, was glued approximately 7.5 cm from one end of each tray. Trays were filled with artificial sea water made from Oceans 50 Instant Sea (Jungle, Inc.) and distilled water. Approximately 50mg of eggs were sprinkled on the water's surface in the larger compartment which was darkened by wrapping several layers of thick paper around it. The narrow end of the tray was left uncovered. After 48 hours under general room illumination, the phototropic nauplii swam into the smaller compartment, leaving their shells and the unhatched eggs behind. Ten brine shrimp were transferred to 2 dram vials using disposable Pasteur pipettes (through which the shrimp can be counted in the narrow portion when it is held against an illuminated colored background).

Five replicates of ten shrimp each were exposed to each of three concentrations of the aqueous solutions (i.e., herbal teas) diluted with artificial sea water: A was a 20 percent solution of medicinal tea, B a 10 percent solution, and C a 1 percent solution. The vials were maintained under general room fluorescent

illumination. Survivors were counted at the end of 24 hours by pipetting out the liquid. One or two control vials of shrimp each in 5 ml of artificial sea water were created for each set of solutions tested. Where control deaths occurred, the data for that set of solutions were corrected using Abbott's (1925) formula.

The brine shrimp bioassay provided an important means for quantitatively assessing the bioactivity of the research species. Yet an additional measure was needed. This involved searching the appropriate chemical and pharmacologic literature to determine if the "remedies of choice" are known to be active and, if so, to identify the compounds responsible for their reported activity.

All 21 species constituting favored remedies have been reported in the literature (Table 3), and we were able to compile sufficient data for all (except Cenizo) to categorize the plants into 3 nominal groups: effective, possibly effective, ineffective (or not known to be effective). Obviously, categorization is at times a truly judgmental process, in that researchers may differ regarding the assignment of any plant vis à vis the above groups. The criteria underlying our categorizations are as follows. If a species contains certain compounds capable of producing effects identical or highly similar to those predicted by informants, the species will be considered effective. If there is little or no agreement between ethnomedical prediction and the pharmacologic properties of a plant, it will be considered ineffective. Plants treated as possibly effective are those falling between the operational statements above.

Testing the Hypothesis

As stated previously, our objective is to demonstrate the utility of informant consensus data as a means for identifying potentially active medicinal plants. More specifically, we wish to test whether, and with what degree of significance, there is a correlation between the dependent variable—group consensus—and the independent variable, efficacy of certain plants in our sample.

The first test of our hypothesis involves a comparison between the rank ordering of the 25 most frequent remedies within the sample and their observed activity in the brine shrimp bioassay. The hypothesis predicts a positive correlation between the dependent and independent variables—the higher the frequency rank of a given medicinal plant, the higher its relative kill rate. The results of this test are presented in Table 1.[4]

The data in Table 1 support, and convincingly so, the suggestion that the most commonly used remedies within an ethnomedical system are the ones most likely to exhibit pronounced bioactivity. For example, the 5 most popular medicinal plants—Manzanilla (1st), Salvia (2nd), Ruda (3rd), Anis (4th), and Yerba Buena (5th)—all produced a kill rate (using solution A) of 100 percent, save for Anis at 99 percent. Their relative activity, even when testing with the more dilute solution B, proved to be considerable in that each achieved a kill rate greater than 62 percent. On the other hand, the remedies ranked 21st through 25th in frequency of occurrence in the sample demonstrate a kill rate of no greater than 1 percent, using solution A. Four out of the 5 have a 0 percent kill rate (Romero—21st, 1%; Golondrina—22nd, 0%; Comino—23rd, 0%; Hojas de Mesquite—24th, 0%; and Salvia-25th, 0%). Interestingly, Golondrina, Comino, and Hojas de Mesquite, while achieving a kill rate with solution A, did exhibit bioactivity in the more dilute solution C, where each induced a 2 percent kill rate. This raises an important point concerning the brine shrimp bioassay.

Table 1: Ranking of 25 Most Common Remedies (According to Frequency of Remedy Occurrence) and Kills Rates in Brine Shrimp Bioassay

Remedy[a]	Frequency of Remedy in Sample	Rank by Frenquency in Survey Sample	Rank by Kill Rate	% Death Solution A	% Death Solution B	% Death Solution C
Ruda	2.8	3		100	100	18
Orégano	2.0	9	2	100	100	
Yerba Buena	2.4	5	3	100	84	2
Savila	3.2	2	4	100	64	0
Manzanilla	3.4	1	5	100	62	0
Anís	2.7	4	6	99	68	4
Canela	1.5	12	7	96	8	10
Ajo	1.9	10	8	60	14	8
Albacar	2.1	8	9	46	0	2
Pelos de Elote	1.8	11	10	33	3	3
Cebolla	0.5	25	11	22	2	4
Estafiate	2.3	6	12	18	2	0
Hojas Se	0.7	19	13	16	2	2

Table 1: (Continued)

Remedy[a]	Frequency of Remedy in Sample	Rank by Frenquency in Survey Sample	Rank by Kill Rate	% Death Solution A	% Death Solution B	% Death Solution C
Borraja	1.4	14	14	6	2	2
Flor de Azajar	0.7	20	15	6	2	0
Cenizo	1.3	15	16	5	3	0
Nogal	0.7	21	17	5	2	4
Rosa de Castillo	1.1	16	18	4	0	14
Hojas de Naranjo	2.2	7	19	4	2	0
Zacate de Limón	0.7	22	20	2	0	0
Romero	1.4	13	21	1	2	
Golondrina	0.7	23	22	0	2	2
Comino	0.7	24	23	0	0	2
Hojas de Mesquite	0.9	18	24	0	0	2
Salvia	1.0	17	25	0	0	0

[a]Taxonomic names for these plants are listed alphabetically in text note 3.

Table 2: Comparison of 25 Most Common Ailment Categories By IAR Score, Most Common Remedy, And Bioassay Rank Of Remedy

Ailment Category	IAR Score	Most Common Remedy§	Solution A Bioassay Rank
1. Earache	.571	Ruda	
2. Bladder Infection	.500	Pelos de Elote	7
3. Stomach Ache	.493	Manzanilla (Estafiate) #	4
4. Colic	.465	*Manzanilla	4
5. Eye Irritation	.455	Hojas de Mesquite	16
6. Arthritis/Pained Joints	.435	Marijuana ®	(no data)
7. Insomnia	.428	Albacar	6
8. Diarrhea	.424	Estafiate	8
9. Cough	.377	Orégano (Cenizo)	2
10. Intestinal Parasites	.375	*Epazote ¢	(no data)
11. Congestion	.364	Orégano	2
12. Insect Bites	.357	Ajo	5
13. Burns	.333	Savila	3
14. Kidney Infection	.316	Pelos de Elote	7
15. Fever	.316	Borraja	9
16. Upset Stomach/Nausea	.316	Estafiate	8
17. Heart Problems	.273	*Toronjil	11
18. Menstrual Cramps	.250	Comino (Canela; Ruda)	15
19. Sores (Granos)	.227	Golondrina	13
20. Diabetes	.222	*Nopal (Semilla de Aguacate)	12
21. Constipation	.179	Rosa de Castillo	10
22. Sore Throat	.111	*Miel y Limón ¢	(no data)
23. Headache	.091	Albacar	6
24. Boils	.077	Romero	14
25. Colds	.071	Orégano	2

Table 2: (Continued) begins at row 16.

§ Taxonomic names for these plants are listed alphabetically in text note 3.

Favored remedies cited in parentheses were not used to compute the Rank Order Correlation Coefficient, which is ROCC 326, T = 1.54, where $p < .10$ but $> .05$.

® Arthritis is not considered in our analysis due to the controlled nature of its favored remedy, Marijuana.

¢ Brine shrimp data for Epazote and Miel y Limón were not available at the time this paper was written.

* Remedies which do not appear in Table 1.

This bioassay, while a useful gauge for assessing pharmacologic activity, may not be sensitive to certain phytochemical compounds, ones that are indeed bioactive. Stated more simply, certain compounds may be lethal to brine shrimp while others are nontoxic. This is probably the case for those remedies which scored a 0 percent kill, for—as demonstrated below—each of the 21 favored remedies (except Cenizo) is cited in the literature as being bioactive (Table 3).

Statistical analysis of the correlation between frequency ranking (the dependent variable) and kill rates (the independent variable) confirmed the hypothesis: rank coefficient = .717; 23 df; $p<.005$.[5] This coefficient product not only supports our original suggestion (i.e., plant based remedies enjoying considerable popularity are very likely to be pharmacologically active), it also demonstrates that, at least in this test, the "strength" of biological activity varies in direct relation to the relative frequency ordering of the test species.

The second test of the hypothesis is based on a different measure of informant consensus. In this case the "remedy of choice" for the 25 most common ailment categories was selected for the brine shrimp bioassay. In this test we wanted to determine if the dependent variable (the relative IAR ranking of 25 ailment categories and their associated species) correlated significantly with the independent variable (ranking by kill rate for the test species). The results of this bioassay are presented in Table 2.

Our hypothesis predicts a significant correlation between the IAR score rank and the ranking by kill rate for the "remedies of choice." The calculated rank correlation coefficient (rho = .326, 20 df) is significant below the .10 level. With the data presented in Table 3, this suggests that we are correct in pursuing this approach for identifying effective plant medicinals. The data support the hypothesis well enough to make further research essential.

Of the 21 plants enjoying the status of favored remedy (Table 2), 20 were encountered in the literature (Cenizo being the exception). These plants, with their relevant constituents and assessed degree of effectiveness, are listed in Table 3.)

It is readily seen from the data above that informant consensus, specifically that referring to the most favored remedy for given ailment categories, is a sensitive and useful gauge of bioactivity. Of the species surveyed here, all (save Cenizo) are known to be physiologically active, a finding consistent with our hypothesis.

The presence of active compounds does not, of course, clarify whether a given remedy should be considered effective in its ethnomedical context. This is where our categorizations in Table 3 become so important.[6] Again, the data above support the test hypothesis. Of 20 species considered, only 3 are probably ineffective (or at least not known to be effective) in reference to their ethnomedical application: Borraja when used as a febrifuge, Semilla de Aguacate to treat diabetes, and Toronjil for heart problems. The remaining 17 species are found to be either effective (14) or possibly effective (3). Therefore, informant consensus on remedy of choice must be accepted as a valid indicator of the effectiveness of ethnomedical therapy. This finding not only further clarifies the empirical basis of herbalism, it provides as well a tool for directing future research on the chemistry and bioactivity of ethnomedically important plants.

Table 3: Use, Relevant Phytochemical Constituents, And Assessed Effectiveness Of Favored Remedies (Presented Alphabetically)

Favored Remedy*		Administration	Relevant Phytochemicals	Bioactivity	Efficacy	References #
Ajo	Insect Bites	Poultice	Allyl disulphide; allyl propyl disulphide; allici allicetoin 1 and 2; allinase	Antibacterial, fungistatic hypoglycemic, hypocholesterolemic, expectorant, anthelmintic	Effective	a,b
Albacar	Insomnia	Tea	Estragol; lineol; linalool; eugenol; thymol; tannins; basil camphor; d-a-pinene; cineole methylchavicol	Sedative, antispasmodic, stomachic, carminative, galactagogue	Possibly Effective	a,b
Borraja	Fever	Tea, Enema	Mucilage; tannins; volatile oils; mineral acids	Emollient, demulcent diuretic, sudorific	In-effective	a,b
Canela	Menstrual Cramps	Tea	Myristicin; tyramine; camphor; tannin; volatile oil	Oxytocic, astringent	Effective	
Cenizo	Cough	Tea	(no data)	(no data)	(no data)	
Comino	Menstrual Cramps	Tea	Demaldehyde; cuminaldehyde; terpenes; pinenes A & B; cuminic alcohol; pentosan; p-cymene	Stimulant, carminative	Possibly Effective	a,b
Epazote	Intestinal Parasites	Tea	Ascaridole; l-limonene; p-cymene; menthadiene	Anthelmintic	Effective	
Estafiate	Diarrhea, Nausea	Tea	Santonine; thujone; thujyl alcohol; camphor; estafiatin; douglanin; arglanin	Stomachic, antispasmodic, anthelmintic	Effective	

Table 3: (Continued)

Favored Remedy*	Ailment	Administration	Relevant Phytochemicals	Bioactivity	Efficacy	References #
Golondrina	Skin Sores ("granos")	Poultice	Germanicol; b-amyrin; pulcherrol; kaempferol	CNS depressant, hypotensive, antimicrobial antiseptic	Effective	d,e
Hojas de Mesquite	Eye Irritation	Eye Wash	Serotonin; luteolin; quercetin; tryptamine; prosopine	Diuretic, laxative, anti-microbial	Effective	d,f
Manzanilla	Stomach Ache, Cholic	Tea	Volatile oil; inositol; bitter glycoside; anthemic acid	Antiseptic, anti-inflammatory, antispasmodic, sedative, carminative	Effective	b
Miel y Limón	Sore Throat	Tea, Gargle	[lime] Ascorbic acid; pectin hesperidin; citral; citronellal; d-limonene; phellandrene; sesquiterpene. [honey] Inhibine; galangine	[lime] Diuretic; carminative; antiseptic. [honey] Relatively high hydrostatic pressure, bacteriostatic	Effective	a,g
Nopal	Diabetes	Tea	Glucose-6-phosphate isomerase	Hypoglycemic	Effective	h
Orégano	Cough, Colds Congestion	Tea	Tymol; origanene; car-vacrol; tannic acid; resin	Expectorant, antiseptic, anti-spasmodic, anti-inflammatory	Possibly Effective	b
Pelos de Elote	Bladder and Kidney Infections	Tea	Quercetin; isoquercetin; salts of potassium; saponon; tannin; sterols; L-arabinose; betaine; galactose; maizenic acid; phlobaphene	Diuretic, antiseptic	Effective	a,i,j,

Table 3: (Continued)

Favored Remedy*			Relevant Phytochemicals	Bioactivity		
Romero	Boils	Cleansing Solution	Bornyl acetate; borneol; linabol; choline; sapono-side; heterosides; tannins	Diuretic, stomachic, carminative, antiseptic	Effective	b
Rosa de Castillo	Constipa-tion	Tea	Essential oils; tartaric and malic acids; glycosides; tannic acid; resins	Astringent, vulnerary, laxative	Effective	b
Ruda	Earache, Menstrual Cramps	Mashed Plant in Ear, Tea	Ketones; tannins; rutin; rhamno glycoside; coumarin; bergaptin; xantotoxin; alkaloids; ascorbic acid; furocoumarins	Emmenagogue, abortifacient, anthelmintic, stomachic diaphoretic, antiseptic	Effective (Earache & Menstrual Cramps)	b
Savila	Burns, Acne	Applied as Jel	Barbaloin; isobarbaloin; aloe-emodin; volatile oils	Bacteriostatic	Effective	a,b
Semilla de Aguacate	Diabetes	Tea	[for leaves—seeds not known] Methylchavicol; d-a-pinene; hydrocyanic acid	Emmenagogue	Ineffec-tive	
Toronjil	Heart Problems	Tea	Citral; citronellal; linalol; geraniol; resins; succinic acid	Carminative, diaphoretic, antispasmodic; sedative, hypotensive	Ineffec-tive	b

* Taxonomic names for these plants are listed alphabetically in text note 3.

\# a) Morton 1981; b) Stewart 1979; c) Ortiz de Montellano 1975a; d) Ortiz de Montellano 1975b; e) Jiu 1966; f) Martinez 1969; g) Majno 1975; h) Ibañez-Camacho and Roman-Ramos 1979; i) Karer 1958; j) Uphof 1968; k) Browner and Ortiz de Montellano [this volume].

Summary and Conclusions

Anthropologists and other researchers have used a variety of approaches to identify potentially effective plant based remedies. However, most of these approaches necessitate investigations that range over broad geographic regions, through extensive periods of time, or across multiple cultures. We have demonstrated that it is also possible to establish directions for chemical and pharamacologic research by focusing on informant consensus, a method that is suitable to single populations, narrow geographic regions, and groups for whom significant time depth cannot be established.

Two aspects of informant consensus were explored. The first, consensus pertaining to the total range and variety of remedies employed in our sample, led to the discovery that the remedies most commonly encountered show a high degree of biological activity and, therefore, they are excellent targets for additional research. The second, consensus regarding preferred treatment of a particular ailment, also produced valuable results. Twenty of the 21 species constituting remedy of choice for the most commonly encountered ailments are known to be bioactive; and in the overwhelming majority of cases such remedies could directly affect the progress or severity of the ailments being treated. Obviously there is a significant level of empiricism in the Mexican-American ethnomedical system.

Our analysis of this system has several implications—methodological, theoretical, and applied. All too frequently anthropologists limit their investigations of herbalism to a small number of informants. Not having a sufficiently large and representative sample surely restricts the ability of an ethnographer to suggest which remedies enjoy a high probability of being pharmacologically active as well as therapeutically effective. While other criticisms regarding the anthropological study of medicinal botany have been advanced (Logan 1982), we trust that this discussion illustrates both the need for, and the utility of, quantitative data on herbalism and informant consensus.

Patterning in the use of medicinal plants, whether seen among Mexican Americans or other societies, reflects a fundamental human condition—adaptation to a complex web of socioenvironmental challenges including, of course, sickness and the maintenance of health. Because informant consensus is, as we have attempted to show, a useful measure of empirical adaptation, it can be used to exemplify the general nature of human culture, as well as to advance a series of important hypotheses. After all, cultures are dynamic, interrelated systems where conditions in one realm (e.g., health problems) are mirrored or projected into another realm (e.g., patterning in medicinal plant use). This is why, as shown in this study, the most frequently employed therapies—and particularly those which constitute the "remedy of choice"—are typically biologically active in a manner that might render them therapeutically effective. Similarly, as the conditions affecting a given society change, so too will the patterns of use of home remedies. With acculturation and increasing reliance on Western medicine eroding more traditional forms of health care, such as plant based remedies, our data would suggest that the therapies enjoying the highest levels of consensus would also be the last to fall into disuse. Data on informant consensus are of such theoretical significance that it is truly surprising that anthropologists have not given their collection and analysis more emphasis.

Finally, there is a pragmatic side to the present report. Millions of people throughout the world still have little or no access to Western health care (cf. Bannerman 1977; Bryant 1969; Velimirovic 1978). Yet informant consensus data, coupled with simple bioassays of the remedies involved and review of the literature to confirm a species' activity, could provide a means by which countries could amplify the availability of their existing pharmacologic resources, as well as a means for developing new resources. Plant based remedies represent a low cost, culturally appropriate, and biomedically sound means with which to reach many who do not typically rely on Western medicine.

One note of caution should be struck, however. The discovery of new pharmacologic resources in natural products is currently beset by what one author has termed the "orphan drug" and the "orphan disease" syndrome (Randal 1982). Basically, an orphan drug is one which cures a disease that has an insufficient number of victims to make the development and manufacture of that drug attractive to a pharmaceutical company, or one whose profit forecast fails to surpass its development costs. An orphan disease is one which has too few victims to make it attractive for either research support or drug development. Natural products research is particularly beset with the orphan drug syndrome, since natural products or their direct derivatives cannot be patented. No drug company will willingly commit the several million dollars necessary to clinically "prove" a drug, be it ever so effective, only to have other companies manufacture it virtually for free, since it cannot be protected under current patent law. Therefore, mechanisms will have to be devised to circumvent the orphan drug syndrome, or in some other way support the cost of clinically testing the drugs from natural products, before the research presented here could be applied on a significant scale.

Notes

1. The authors wish to thank Robert I. Lonard (Department of Botany, Pan American University) for his assistance in identifying several of the plants discussed in this chapter.

2. We are fully aware of the problems associated with identifying plants solely on the basis of their popular names (cf. Mead 1970).

3. Ajo (Garlic) *Allium sativum* L.

Albacar (Sweet basil) *Ocimum basilicum* L.
Anis (Anise) *Pimpinella anisum* L.
Borraja (Borrage) *Borago officinalis* L.
Canela (Cinnamon) *Cinnamomum* spp.
Cebolla (Onion) *Allium cepa* L.
Cenizo (Purple sage) *Leucophyllum texanum* Benth.
Comino (Cumin) *Cuminum cyminum* L.
Epazote (American wormweed) *Chenopodium ambrosioides* L.
Estafiate (Wormwood) *Artemisia mexicana* Willd.
Flor de Azajar (Orange blossoms) *Citrus aurantium* L. (same species as Hojas de Naranjo)
Golondrina (Swallowort) *Euphorbia prostata* Ait.
Hojas de Mesquite (Mesquite leaves) *Prosopis glandulosa* Torr.
Hojas de Naranjo (Orange leaves) *Citrus aurantium* L. (same species as Flor de Azajar)
Hojas Se (American tar bush) *Fluorensia cenura* D.C.
Manzanilla (Chamomile) *Matricaria chamomilla* L.
Marijuana (Marijuana) *Cannabis sativa* L.
Miel y Limón (Honey and Lime juice) *Citrus aurantifolia* Swingle
Nogal (Walnut and Pecan) *Juglans* spp., *Carya illinoensis* Koch.
Nopal (Prickly pear cactus) *Opuntia* spp.
Orégano (Oregano) *Origanum vulgare* L.

Pelos de Elote (Corn silk) *Zea mays* L.
Romero (Rosemary) *Rosmarinus officinalis* L.
Rosa de Castillo (Rose) *Rosa centifolia* L.
Ruda (Rue) *Ruta graveolens* L.
Salvia (Sage) *Salvia leucantha* Cav.
Savila (Aloe vera) *Aloe vera* L.
Semilla de Aguacate (Avocado seed) *Persea americana* Mill.
Toronjil (Balm) *Melissa officinalis* L.
Yerba Buena (Spearmint) *Mentha spicata* L.
Zacate de Limón (Lemon grass) *Cymbopogon citratus* Stapf.

4. The list of remedies in Table 1 is modified slightly from those published in Trotter (1981a, 1981b). This variation has resulted from the omission of Marijuana and Nopal from the first brine shrimp bioassay. The next two most common remedies were therefore selected from this bioassay. Moreover, the frequency listing of ailment categories in Table 2 does not include folk illnesses—e.g., "Susto," "Nervios," etc.—and disorders which are not treated with herbs, such as bleeding.

5. Procedures for calculating the rank correlation coefficient (r^1) and t are drawn from Edwards (1958).

6. The authors gratefully acknowledge the assistance of Bernard Ortiz de Montellano in evaluating the pharmacological activity of the relevant phytochemicals associated with these species.

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CHAPTER 6

Aztec Medicinal Herbs: Evaluation of Therapeutic Effectiveness

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Introduction

At the time of the Spanish conquest Aztec medicine was a mixture of magic, religion, and science. The etiology of a particular ailment would dictate the appropriate remedy. For example, the renewal of vegetation, i.e., the skin of the earth, symbolized spring. Thus, ailments on the surface of people—such as diseases of the eyes or skin blisters—were attributed to punishment for offenses against Xipe Totec (Our Lord of the Flayed One), the God of Spring. Patients would make vows to wear the skin of a sacrificed victim on the festival dedicated to that god in order to be cured (Dibble and Anderson 1970:39). When diseases of the eyes were believed to be caused by sorcery, the remedy would require the help of a specialist, the *teixocuilanque* ("the persons who remove worms from the eyes")—i.e., a "good" witch (Dibble and Anderson 1970:15). Eye diseases presumably resulting from natural causes, such as excessive heat, would require the application of a demulcent anti-inflammatory drug such as *Prosopis* spp. (Dibble and Anderson 1963:120). These approaches were not mutually exclusive, and a particular cure might have involved all three elements.

Most studies of Aztec medicine have focussed on the religious and magical characteristics of the treatment (Aguirre Beltrân 1963; Guerra 1966; Coury 1969; Lopez Austin 1980). However, the successful use of ethnographic and ethnohistoric sources for the identification of active hallucinogens (Schultes and Hofmann 1973), as well as recent advances in ethnobotany (Berlin et al. 1974), demonstrate that native people possess a detailed and accurate knowledge of the nautral world. This paper summarizes an attempt to develop a methodology to evaluate the empirical content of non-Western medicine and to apply it to the case of Aztec medicine (Ortiz de Montellano 1974/75, 1975, 1976, 1979a, n.d.).

Briefly, an Aztec plant which has been identified as a particular botanic species in more than one source (to compensate for the fact that identifications were done from illustrations of plants rather than from actual specimens) is chosen for evaluation. The literature is searched to identify its chemical components. Data before 1969 can be obtained from the usual compendia (Karrer 1958; Kerrer et al. 1977; Gibbs 1974; Hegnauer 1962-77) as well as by manual search of *Chemical Abstracts*. Computer searches of both *Chemical Abstracts* and *Biological Abstracts* can be done of the literature after 1969. The physiologic and pharmacologic activities of these components are then noted and compared to the effects that an Aztec physician would logically desire,