THE USEFUL PLANTS OF TAMBOPATA, PERU: I. STATISTICAL HYPOTHESES TESTS WITH A NEW QUANTITATIVE TECHNIQUE[1]

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Phillips, Oliver *(Department of Biology, Washington University, One Brooking's Drive, Campus Box 1137, St. Louis, MO 63130-4899, U.S.A.),* and **Alwyn H. Gentry** *(Missouri Botanical Garden, Box 299, St. Louis, MO 63166-0299, U.S.A.).* THE USEFUL PLANTS OF TAMBOPATA, PERU: I. STATISTICAL HYPOTHESES TESTS WITH A NEW QUANTITATIVE TECHNIQUE. *Economic Botany 47(1):15–32. 1993. This paper describes a new, simple, quantitative technique for evaluating the relative usefulness of plants to people. The technique is then compared to the quantitative approaches in ethnobotany that have been developed recently. Our technique is used to calculate the importance of over 600 species of woody plants to non-indigenous mestizo people in Tambopata, Amazonian Peru. Two general classes of hypotheses are formulated and tested statistically, concerning (1) the relative importance of different species, and (2) the importance of different families. The plant families are compared with respect to all uses, and with respect to five broad groups of uses. Palms, Annonaceae, and Lauraceae were found to be the most useful woody plant families. On average, the 20 largest woody plant families are most important to mestizos for subsistence construction materials, followed in descending order by commercial, edible, technological, and medicinal uses.*

Las plantas útiles de Tambopata, Perú: I. Pruebas estadísticas de hipótesis etnobotánicas con una nueva técnica cuantitativa. *En éste estudio se describe una nueva técnica cuantitativa para la evaluación de la relativa utilidad de plantas a la gente. Esta técnica se compara con aquellas técnicas cuantitativas recientemente desarrolladas en etnobotánica. Con ésta técnica nosotros estimamos la importancia que las plantas leñosas, más de 600 especies, tienen para los mestizos de Tambopata de la Amazonía del Perú. Estadísticamente, se prueban dos hipótesis generales concernientes a (1) la relativa importancia de especies diferentes, y a (2) la importancia de diferentes familias. Las familias de plantas son comparadas entre ellas en relación a todos los usos, y con respecto a cinco grupos amplios de usos. Se descubrió que las familias leñosas mas útiles son las palmeras, Annonaceas, y Lauraceas. En término promedio, las 20 familias mas grandes de plantas leñosas tienen prioridad como materiales de construcción de subsistencia, seguidas en orden descendiente por sus usos comerciales, comestibles, tecnológicos, y medicinales.*

Key Words: quantitative ethnobotany; hypothesis tests; statistics; Tambopata, Peru; mestizo.

The fate of tropical forests and indigenous peoples have recently attracted considerable popular interest. Yet, paradoxically, the pace of research into the indigenous plant uses and vegetation management processes that could offer alternatives to the destruction is dwarfed by accelerating rates of cultural and biological extinction. In spite of ethnobotany's relatively high public profile, few institutions apparently see it as a real science worthy of significant financial support.

Historically, this negative perception of ethnobotany has had several causes. The science is intrinsically interdisciplinary, making it susceptible to charges of being vague and imprecise, and ethnobiologists study and learn from cultures that western science and biomedicine hold to be "primitive" and inferior. However, some criticism of the methods and philosophical approach of ethnobotany has certainly been justifiable. As several others have pointed out there is a lack of methodological rigor in much ethnobotanical research (cf. Johns, Kokwaro, and Kimanani 1990; Trotter and Logan 1986), and a frequent unwillingness to define falsifiable hypotheses.

[1] Received 15 June 1992; accepted 13 October 1992.

Partly in response to the long-standing perception of ethnobotany as not being "scientific," there is now a strong movement to modify the traditional compilation-style approaches to ethnobotany, by developing methods that allow researchers to quantitatively describe and analyze patterns in what they study (Prance 1991; Elvin-Lewis and Lewis n.d.). Quantitative and even statistical hypotheses-testing techniques have recently been applied to, inter alia, the following questions: (1) evaluating the importance of vegetation to one ethnic group (e.g., Prance et al. 1987; Unruh and Alcorn 1988; Anderson and Posey 1989; Balée and Gely 1989); (2) comparing the uses of, (a) hectare forest plots (Prance et al. 1987), and (b) entire or partial regional floras (Toledo et al. 1992; Bye n.d.), by different ethnic groups; (3) comparing the importance of different vegetation types to one people (Boom 1990; Anderson 1990, 1991; Salick 1992); establishing the relative importance of different (4) medicinal plant species (e.g., Adu-Tutu et al. 1979; Elvin-Lewis et al. 1980; Friedman et al. 1986; Johns, Kokwaro, and Kimanani 1990; Trotter and Logan 1986) and (5) families (Moerman 1979, 1991; But, Hu, and Cheung Kong 1980; Kapur et al. 1992); (6) comparing the importance of different plant families and uses among plants sold in a peasant marketplace (Martin 1992); and (7) testing a model of the origins of medicinal plant use (Johns and Kimanani 1991).

In cultural anthropology, a quantitative school has long been influential, and more recently there has been interest in integrating quantitative and qualitative types of research (e.g., Johnson 1978; Smith and Heshusius 1986; but see Hammersley 1992). Until recently, however, ethnobotanists had been more reluctant to appreciate the potential significance of quantification. Indeed, the very term "quantitative ethnobotany" was coined as recently as 1987 (Prance et al.). Here we define it, relatively broadly, "as the application of quantitative techniques to the direct analysis of contemporary plant use data." From the examples above alone, it is clear that quantitative ethnobotany has the potential to contribute to a wide range of important issues at the interface of science and development. A further benefit of applying quantitative techniques to data analysis is that they act as a spur for conscious attempts to refine the methodology of data collection (Johns, Kokwaro, and Kimanani 1990). Closer attention to methodological issues will not only improve the way ethnobotany is done, but it will also enhance the image of ethnobotany among other scientists.

It is possible to draw a close analogy between the hypothesis-testing aims of quantitative ethnobotany as outlined here, and the recent trend in systematics towards a more scientific methodology. This was mainly triggered by the application of cladistic methodology to plant systematics, which has forced taxonomists to reevaluate some of their assumptions about the nature of the characters they use and the way in which they use them (e.g., Wiley 1981; Gilmartin 1986; Sneath 1988; Stevens 1991). The traditional role of taxonomists as describers and compilers has now largely been superseded by a modern systematics in which the construction of phylogenies, using "refutation by experimentation" as a fundamental philosophical principle, occupies a central position. We believe that quantification, and the associated explicit hypothesis-testing approach, can have similar beneficial effects in ethnobotany. By attracting scientific respect, and hence more students and research funding, these approaches can help to generate sufficient high quality information to impact on conservation and development issues.

In this paper we (1) develop a simple technique of analyzing ethnobotanical data, and (2) compare it with existing approaches in quantitative ethnobotany. We then (3) demonstrate how this technique can be used to test two kinds of hypotheses that are of interest to ethnobotanists to illustrate its potential for contributing to the development of quantitative ethnobotany. In a second paper (Phillips and Gentry 1993), we propose several more kinds of ethnobotanical hypotheses, and test them statistically with our data.

Ecological and Cultural Setting

The study area is located in the southeastern Peruvian department of Madre de Dios, and includes the Zona Reservada Tambopata (ZRT) and surrounding area (Fig. 1). The forest-types of the Tambopata region are representative of seasonal tropical moist forest in southwestern Amazonia. The regional climate and forest-types are described in detail by Erwin (1984), Gentry (1988), Phillips (n.d.), and Reynel and Gentry (n.d.).

This ethnobotanical study is unusual in that we worked with non-Indian tropical forest people. Recently, several scholars have drawn attention to the need for more ethnoecological work with such peoples (e.g., Hiraoka 1992; Padoch and de Jong 1992; Parker 1989; Prance 1991), who may have adapted techniques from extinct or endangered indigenous cultures.

Most of the current inhabitants of the Tambopata area are mestizos. The term "mestizo" covers a wide spectrum of people, from very recent migrants from the Andes, to colonists of >30 years in the region who came from elsewhere in Madre de Dios or further north in Peruvian Amazonia, and who, like Brazilian caboclos, are linked biologically and historically to native American cultures (Parker 1989). Eighty-three percent of our adult informants were born in Madre de Dios, but only about 55% had lived more than half their lives in the immediate area of the newly-formed La Torre community on the west bank of the Tambopata River. Such mobility is not unusual among non-indigenous Amazonians (e.g., Coomes n.d.; Padoch and de Jong 1990), and implies that conditions that allow a relatively free exchange of knowledge between mestizos about their environment have long existed.

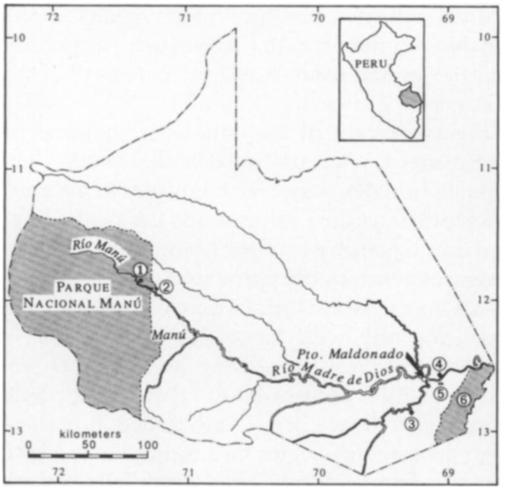

Fig. 1. Map of Madre de Dios: showing location of the Zona Reservada Tambopata, other protected areas, and principal rivers. Reproduced with permission from Duellman and Koechlin (1991). 1. Cocha Cashu Biological Station. 2. Pakitza Biological Station. 3. Zona Reservada Tambopata. 4. Reserva Cuzco Amazónico. 5. Reserva Lago Sandoval. 6. Santuario Nacional del Heath.

Methods

Data Collection

Most of the ethnobotanical data collection was done in a series of one hectare tree plots at the ZRT. The plots were originally laid out and tagged by T. Erwin and the Smithsonian BIOLAT program (Erwin 1984). Collections of all tagged tree and liana species ≥10 cm d.b.h. in the seven forest plots in the ZRT were made between 1984 and 1989 by AG, variously working with Proyecto Flora del Perú botanists Rodolfo Vasquez, Nestor Jaramillo, Percy Nuñez and Camilo Díaz, and with OP (Gentry collection numbers 45576–46250, 51064–51558 and 57535–58155, and Phillips 182–290 and 620–691). Collection duplicates, almost all of which have been determined (cf. Gentry 1988; Reynel and Gentry n.d.), are deposited at MO and USM, and in part at AMAZ and CUZ. The tagged, identified trees and lianas in a total of 6.1 ha, representing seven different forest types, were used for the ethnobotanical study, in a similar manner to other ethnobotany-inventory studies (Prance et al. 1987; Boom 1989, 1990; Anderson 1991; Piñedo-Vasquez et al. 1990). This approach explicitly ignores herbs, shrubs, small vines, and epiphytes, but the problems with identifying sterile vouchers make it almost impossible to do comprehensive ethnobotanical inventories of smaller plants (but see Salick 1992). We do include large lianas, otherwise only included in forest hectare-plot ethnobotanical analyses by Boom (1989) and Paz y Miño et al. (1991).

Ethnobotanical data were collected between 1986 and 1991 by OP and numerous assistants (see Acknowledgments). We interviewed a total of 29 people, to record their knowledge of some of the approximately 570 tagged plot species in the 6.1 ha surveyed, and of 35 additional tree, liana and arborescent palm species. In total, we recorded use data in 1885 independent "events." An "event" is defined as the process of asking one informant on one day about the uses they know for one species. Thus, if in one day we encountered the same species more than once, the informants' responses to our question in each encounter were simply combined, with one exception: when the same informant gave a different name to the same species on the same day, each encounter was then recorded as a separate event. (We supposed that the different identifications indicated that the initial response could not have influenced the subsequent responses, i.e., the second event was "independent" of the first.)

Eighty percent of the data were gathered by OP using a relaxed "walk-in-the-woods" approach. Initially, we worked only within the hectare plots, recording information on local names and uses together with stem tag numbers for later cross-reference to the plot lists. In 1991, further "walk-in-the-woods" data were collected by OP along more than 30 km of the area's trails; in these cases, local names and uses of trees and lianas that OP recognized to species in the field were asked. As the project proceeded, it became clear that some species had a unique and universally known local name, especially among heavily-used plants; for some of these well-known species supplementary data were collected simply by asking informants to relate the uses they knew.

Our interest in analyzing the data statistically made us conscious of the need to minimize the possibility of one informant's answers directly influencing another's. Therefore, on almost all occasions, we interviewed informants individually. This, together with the large divergence in the quantity and kind of uses reported even by similarly-aged informants (Phillips and Gentry 1993), gives us reasonable confidence in using statistical techniques that require that each informant not be directly influenced by other informants' responses.

In addition, we attempted to apply the following conditions consistently, in order to minimize the potential incentives to embellish information, give "wrong answers," or to treat the process as a chore:

(1) Make the data-gathering process as informal as possible.
(2) Fit it in when the informants had free-time.
(3) Compensate informants for their time, mostly with tools or clothing that they asked for. We tried to approximately equate the material value of such gifts with the monetary and/or subsistence value of the time and labor given to the project by the informant.

We also tried to work with a representative sample of the local people, of all ages (cf. Appendix 1), professions, and of both sexes. Our informants are mostly farmers along the lower Tambopata River, although many worked in various other activities (e.g., collecting and processing non-timber forest products for subsistence and commercial uses (≥20 informants), hunting (≥8), felling timber trees and/or making furniture, canoes etc. (≥7), working in a tourist lodge (6), selling herbal remedies (≥4), boat-driving (3)). As a mostly male team we found it easier to work with mestizo men than women, and this is reflected in the male bias in our informants (24:5). Given that our investigation is of uses of woody forest plants, however, this is probably not a severe handicap, as most mestizo men spend more time in primary forest than most women, and we predict therefore that they should know those plants better. However, our impression is that women are frequently more knowledgeable about herbaceous and non-forest plants than men, and especially for medicinal uses (cf. Lewis and Elvin-Lewis 1990; Kainer and Duryea 1992). As far as we are aware, there are no published studies that systematically compare the degree and kind of ethnobotanical knowledge of women and men, in any tropical forest culture. Notwithstanding the potential methodological difficulties, there is a clear need for such work to address this large gap in our understanding of such cultures.

Primary Data Analysis

Over 116 uses were defined by the informants. The uses are listed in Appendix 1, to give the reader an indication of both the astonishing variety of ways in which even non-indigenous people may exploit their natural resources, and to show how some uses (especially some medicinal and technological ones) are highly species-specific, whilst other requirements (especially construction needs) can be satisfied by a broader range of species. The condensed definitions we give to each use listed in Appendix 1 are intended to match the informants' concepts as concisely as possible, and as far as we are able to determine the categories reflect emically defined concepts of functional equivalence. In general, then, the level of resolution of the analysis approaches that of a mestizo taxonomy of uses. The one notable exception is among commercial uses, where we considered several separately described uses together to simplify the analysis. However, this grouping barely affects the results of the analytical process described below because one single use (the selling of sawn planks) dominates the commercial category.

The distribution of number of species per use loosely approximates a log-normal distribution (Fig. 2). From the position of the "veil line" (Hubbell and Foster 1990; Preston 1948, 1962), we calculate that the informants we worked with would tell of an additional 25 to 30 uses (mostly technological and medicinal) if we could have sampled all the large woody plant species in the ZRT. Thus, we predict that the 29 informants know of up to 150 separate uses for the ZRT large woody plants.

By contrast, our broad categories of uses (Edible, Construction, Commerce, Medicinal, and Technology and Crafts) are based on an explicitly etic perspective. For example, among our data there are instances where the ingestion of a plant part is inseparably both medicinal and nutritive (cf. Etkin 1986; Iwu 1986), and in such cases we had to make a judgement to assign the use to one category and not another. These categories are thus, in part, artificial constructs (Prance et al. 1987), erected for analytical convenience.

We first analyzed the data with a technique we developed related to other "informant-indexing" or "informant-consensus" methods (Adu-Tutu et al. 1979; Friedman et al. 1986; Johns, Kokwaro, and Kimanani 1990; Perez Salicrup 1992; Trotter and Logan 1986). The differences in our technique from those of Adu-Tutu et al., Perez Salicrup, Trotter and Logan, and Friedman et al. result partly from the different nature of the data. For example, apparently none of these investigators reinterviewed the same informants about the same plant. Similarly, Johns, Kokwaro, and Kimanani developed a technique to factor out the influence of a species' abundance on the likelihood of its being used, a refinement not directly relevant to the questions we ask here. Although each of the techniques is designed to address different questions, all share the valuable property that they make statistical analyses of ethnobotanical data possible.

Our estimate of the use value of each species s for each informant i, UV_{is}, is defined as:

$$UV_{is} = \frac{\Sigma\ U_{is}}{n_{is}}$$

where U_{is} equals the number of uses mentioned in each event by informant i, and n_{is} equals the number of events for species s with informant i.

Our estimate of the overall use value for each species s, UV_s, is then:

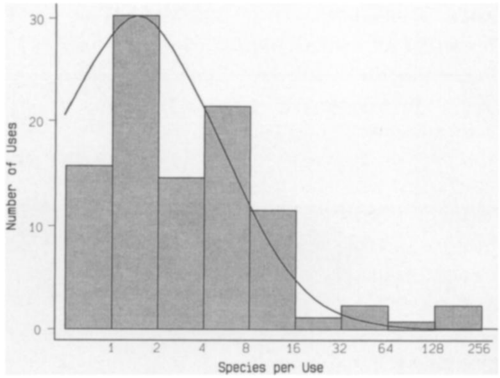

Fig. 2. Number of uses vs. species per use. The distribution approximates a truncated log-normal distribution; the "veil-line" is the vertical axis.

$$UV_s = \frac{\Sigma_i\ UV_{is}}{n_s}$$

where n_s equals the number of informants interviewed for species s.

Table 1 illustrates the technique with a typical example, *Clarisia racemosa* R.&P. (Moraceae). Table 1A shows data from three events with one informant; for each event each individual use cited by the informant is recorded. The number of uses are totaled for each event, and each use is averaged across events. These mean values are transferred to Table 1B, after totalling within the use categories (two uses were recorded in the medicinal category, one in each of the other categories). Table 1B lists the UV_{is} values of *Clarisia racemosa* for each of the six informants interviewed, by category and by total. UV_s values for the species, by category and total, listed in Table 1C, represent the mean values of UV_{is} from Table 1B.

This example highlights two important aspects of the technique. Firstly, out of the 13 *C. racemosa* events, one use—the commercial use of sawn wood—is only mentioned once. The averaging process reduces its contribution to an appropriately negligible 3% of the total UV_s; thus, given a sufficient number of events and informants interviewed, the technique guarantees that unimportant uses or even informants' mistakes will not unduly influence the UV_s.

Secondly, it is clear that the answers given by the same person to the same question can vary enormously. In events #1 and #3, the informant mentioned just one, medicinal, use, but in event #2 he mentioned five uses in four broad cate-

TABLE 1. CALCULATING USE VALUES (UV_S) USING THE DATA PROCESSING TECHNIQUE: *CLARISIA RACEMOSA* AS AN EXAMPLE.

A. Informant 1: all the C. racemosa uses mentioned in three separate events.

Use:	Total	Sawn-wood[1]	Edible Fruit[1]	Wood: Sold[1]	Med,A[1]	Med,B[1]	Tec[2]
Event #1	1	0	0	0	0	1	0
Event #2	5	1	1	1	1	1	0
Event #3	1	0	0	0	0	1	0
Means	2.333	0.333	0.333	0.333	0.333	1	0

B. Use values of C. racemosa (UV_{is}) for informants 1 to 6.

Informant	Total	Con[2]	Edi[2]	Com[2]	Med[2]	Tec[2]
1	2.333	0.333	0.333	0.333	1.333	0
2	2.667	0	1	0	0.667	1
3	0	0	0	0	0	0
4	2	0.5	0.5	0	1	0
5	2	1	0	0	0	1
6	1	0	0	0	0	1

[1] Specific uses: Sawn-wood = wood sawn to build house; Edible Fruit = fruit eaten raw; Wood: Sold = sawn wood sold by mestizos; Med,A = bark scrapings applied as a poultice to leishmaniasis sores; Med,B = latex mixed with latex from other species and applied as a poultice to reduce swellings and bruises.

[2] Categories of use: Con = construction uses; Edi = edible uses; Com = commercial uses; Med = medicinal uses; Tec = technological uses.

TABLE 1. CONTINUED.

C. C. racemosa use values (UV_s) (= mean of six UV_{is} values).

Clarisia racemosa	Total	Con[2]	Edi[2]	Com[2]	Med[2]	Tec[2]
UV_s = mean of each UV_{is}	1.667	0.306	0.306	0.056	0.500	0.500

gories (construction, commerce, edible, and medicinal)! There are several possible reasons for this variation, but this example clearly shows how the accuracy of our estimate for UV_{is} will increase as the number of events increases. Similarly, Table 1B displays the contrast in averaged responses for different informants, showing that the same principle holds for our estimate of UV_s. The observation that accuracy increases with sample size is hardly surprising, but one of the benefits of using techniques like these is that they can give a quantitative description of the relationship between sample size and the accuracy of the estimate of UV_s, and thereby provide valuable insight into the reliability of ethnobotanical data.

This notion is explored further in Fig. 3, in which the running mean UV_s of *Clarisia racemosa* is plotted against the number of informants. The error bars represent normal theory 95% confidence intervals, for each UV_s estimator based on 1 through 6 informants. Each distribution is based on all possible combinations of recorded UV_{is} values, for a given number of informants. The graph underscores the need for working with several informants, but also shows how the rate of improvement in our confidence of the UV_s estimate rapidly decreases as the number of informants increases. This allows us to make a clear prescription about ethnobotanical methodology: given limited time, researchers seeking to quantify the utility of a fixed number of species to an ethnic group will maximize statistical confidence in their data by spreading their research effort as equally as possible across all the species.

COMPARISON OF METHODS IN QUANTITATIVE ETHNOBOTANY

Although a number of different approaches have been taken to the collection and analysis of quantitative data in ethnobotany, those that are primarily focused on direct non-market value ("Consumptive Use Value" sensu McNeely et al. 1990) can be grouped into three categories (Table 2): (1) the importance of different plants or uses is directly related to the percentage of informants mentioning a given use (Adu-Tutu et

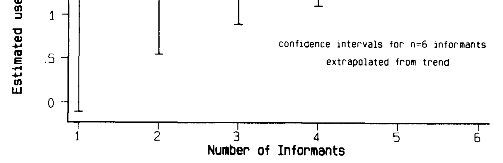

Fig. 3. *Clarisia racemosa* use values. Range represents normal theory 95% confidence intervals for the UV_s estimates, based on the population of all possible UV_s estimates for a given informant sample size. (For one informant n = 6 possible UV_s values, for two n = 15, for three n = 60, for four n = 15, for five n = 6.)

TABLE 2. A COMPARISON OF THE APPROACHES USED TO ESTIMATE CONSUMPTIVE USE VALUE.

Aspect/technique	Use values indexed by informants	Use values assigned by researchers	Uses counted
Methods explicit and results potentially reproducible?	Yes	Unlikely (because values are assigned *a posteriori* by researchers)	No (simply counting uses cannot account for unequal levels of research effort[1])
Objectivity of use values generated	Relatively objective	Relatively subjective	Relatively subjective
Distribution of use values generated	Continuous	Discrete	Discrete
Negative data useable in analysis?[2]	Yes (negative data is used directly to calculate use values)	Yes (negative data may help differentiate "minor"/"major" uses)	No
Statistical comparisons possible between uses?	Yes (score from each species or informant represents one observation)	No	No
Statistical comparisons possible between species?	Yes (score from each informant represents one observation)	No	No
Statistical comparisons possible between informants?	Yes (knowledge of well-studied species can be compared)	Yes, but less precise than A; no such study known	Yes, but less precise than A; no such study known
Statistical comparisons possible between ethnic groups, plant communities?	Yes, and such comparisons could be valid even with different researchers	Yes, but such comparisons are less valid with different researchers	Yes, but interpretation is difficult because no two studies involve an equal level of research effort
Valid comparisons possible between subsistence and commercial uses?	Yes, the relative importance of each is directly determined from the informants' responses	Unlikely (researchers value-judgements may obscure the comparison)	Unlikely (one commercial use is unlikely to be of equivalent importance to one subsistence use)
Speed of data collection and analysis	Most time-consuming	Less time-consuming	Potentially the least time-consuming

[1] This problem is redundant in Moerman's (1991) study because he analyzed a plant use universe, not a sample.
[2] "Negative data," defined as informant either not recognizing plant or recognizing it but knowing no uses.

al. 1979; Friedman et al. 1986; Johns, Kokwaro, and Kimanani 1990; Kainer and Duryea 1992; Perez Salicrup 1992; Trotter and Logan 1986; this study); (2) use values are assigned by the researchers (Piñedo-Vasquez et al. 1990; Prance et al. 1987; Turner 1988), and (3) the uses in separate categories of different taxa are listed as part of the taxon's activity signature (Balée and Gely 1989; Hunn 1982) or simply counted (e.g., Anderson 1991; Paz y Miño et al. 1991; Toledo et al. 1992; Unruh and Alcorn 1988).

Table 2 compares the three groups of methods for some selected important attributes. The one significant drawback to the approach of indexing of use values by informant response is that it is more time-consuming than other methods. It is clearly easier and quicker to subjectively assign importance values, or simply count the number of uses recorded, than it is to calculate an importance value for each use for each informant and/or species, but with access to spreadsheet software the averaging process is not unduly time-consuming. More importantly, this averaging process incorporates more information about the relative importance of species than a simple count of the number of uses per species can do. (For comparative purposes, using our data, we regressed each species' UV_s on the number of uses per species. The r^2 value of the regression equation is 0.563; i.e., simply totalling the number of uses per species explains 56.3% of the variance in UV_s values; the remaining 43.7% is accounted for by the process of indexing each use by its relative importance.)

The most important advantages of the informant-indexing method are related to the range of detailed statistical analyses of ethnobotanical data it permits, and the increased likelihood of obtaining significant results. This is because it makes efficient use of the research effort. (More information is contained in continuous data than in discrete data; furthermore, the approach allows inclusion of negative data.) It is also clearly the closest to satisfying established scientific methodology—both because the method of assigning importance is explicit and relatively independent of the researcher (so that the results are potentially reproducible by different researchers), and because it permits the testing of specific, falsifiable null hypotheses (Popper 1963). Indeed, null hypotheses can be tested in a broad sweep of botanical, ecological and human categories interesting to ethnobotanists, e.g., between uses, taxa, informants, ethnic groups, and plant communities. To our knowledge, until now this broad approach has never been used to test hypotheses other than those relating to the popularity and/or effectiveness of different medicinal plants (Adu-Tutu et al. 1979; Friedman et al. 1986; Johns, Kokwaro, and Kimanani 1990).

Hypothesis Tests

To demonstrate the potential of this broad approach for analyzing ethnobotanical data, we (a) apply use values generated by the specific technique described in this paper to make comparisons between the utility of different species to mestizo people. We then use modified use values as a basis for comparing (b) the utility of different plant families to mestizos. In a second paper (Phillips and Gentry 1993), we compare (c) the contributions of ecological, physiognomic, and phylogenetic factors to determining a species' utility, and (d) the relative knowledge of different informants; and (e) investigate the relationship between informant knowledge and age.

For each hypothesis test we used a modified version of the raw UV_s data. We merged use data of congeneric species when those species consistently shared the same or similar mestizo names and uses (cf. e.g., Adu-Tutu et al. 1979:323). For example, all *Salacia* (Hippocrateaceae) liana species ≥ 10 cm d.b.h. share the same names "sapote de liana" and "chuchuhuasillo" and uses (edible fruits, and bark as an ingredient in a drink that has an invigorating effect): we calculated the modified use value of each species that comprises this one "folk-species" from our data on all *Salacia* sapote de liana and chuchuhuasillo species. The principal reason for making this modification is that it creates taxa that more closely approximate mestizo concepts of their environment than do botanical species alone. A further benefit is the improvement in quantity and quality of ethnobotanical data for each taxon. Thus, from more than 605 species with data (mean number of events per botanical species = 3.16, mean number of informants per botanical species = 2.05), we create 380 folk-species (mean number of events per folk-species = 4.96, mean number of informants per folk-species = 2.59). Henceforth we use the term "species" as shorthand for "folk-species."

Comparisons of Species

H_0 = *two species are equally useful (for each pair-wise comparison)*

Each species' use value (UV_s) can be compared statistically with any other species' use value(s) by the non-parametric Kruskall-Wallis test (equivalent to the Wilcoxon rank sum and Mann-Whitney U-tests for pair-wise comparisons), using each species' set of UV_{is} values as data. (Because we collected ethnobotanical data for as many as possible of the 570 plot tree and liana species, we had relatively few informants for most species, and so could not compare the use values of most species this way.) Table 3 illustrates the results for species with nine or more informants each (for each of these, folk-species and botanical species are equivalent). The null hypothesis is rejected at the 5% level for 20 out of 28 comparisons. Note that, by chance alone, we would expect the null hypothesis to be rejected for 5/100 × 28 = 1.4 comparisons.

It is worth noting that, of the species compared

TABLE 3. USE VALUES OF EIGHT SPECIES COMPARED.

(Read downwards for first species in each pairwise comparison; shaded squares indicate the column species has a higher use value than the row species)

	D[1]	E[1]	F[1]	I[1]	J[1]	O[1]	P[1]	S[1]
D	XXXXX XXXXX	16.2 ***	0.6	13.0 ***	7.0 **	11.6 ***	2.5 s	4.3 *
E	16.2 ***	XXXXX XXXXX	14.2 ***	0.4	6.6 **	14.9 ***	16.2 ***	12.6 ***
F	0.6	14.2 ***	XXXXX XXXXX	11.7 ***	4.2 *	8.3 *	11.7 ***	1.9
I	13.0 ***	0.4	11.7 ***	XXXXX XXXXX	3.1 s	7.1 **	14.1 ***	7.4 **
J	7.0 **	6.6 **	4.2 *	3.1 s	XXXXX XXXXX	0.3	12.8 ***	1.0
O	11.6 ***	14.9 ***	8.3 *	7.1 **	0.3	XXXXXX XXXXXX	15.8 ***	1.7
P	2.5 s	16.2 ***	11.7 ***	14.1 ***	12.8 ***	15.8 ***	XXXXXX XXXXXX	10.9 ***
S	4.3 *	12.6 ***	1.9	7.4 **	1.0	1.7	10.9 ***	XXXXX XXXXX

All values are chi-squared values for pairwise comparisons.

Significance levels for the chi-squared values: *** = $P < 0.001$, ** = $P < 0.01$, * = $P < 0.05$, s = $P < 0.10$; all pairwise tests are Kruskall-Wallis non-parametric comparisons. (Wilcoxon rank sum or Mann-Whitney U test generate identical P-values for pairwise comparisons.) Note that these are P-values for individual pairwise comparisons. The true P-values for the most significant column or cell would be subject to a Bonferroni correction.

[1] Species with ≥9 informants: D = *Dipteryx odorata* (Fab: Papilionoid), $UV_s = 1.70$, $n_i = 9$. E = *Euterpe precatoria* (Palm), $UV_s = 4.30$, $n_i = 14$. F = *Ficus insipida* (Moraceae), $UV_s = 2.17$, $n_i = 9$. I = *Iriartea deltoidea* (Palm), $UV_s = 4.41$, $n_i = 11$. J = *Jessenia bataua* (Palm), $UV_s = 3.12$, $n_i = 9$. O = *Oenocarpus mapora* (Palm), $UV_s = 2.81$, $n_i = 12$. P = *Pouteria macrophylla* (Sapotaceae), $UV_s = 1.00$, $n_i = 9$. S = *Scheelea phalerata* (Palm), $UV_s = 2.67$, $n_i = 12$.

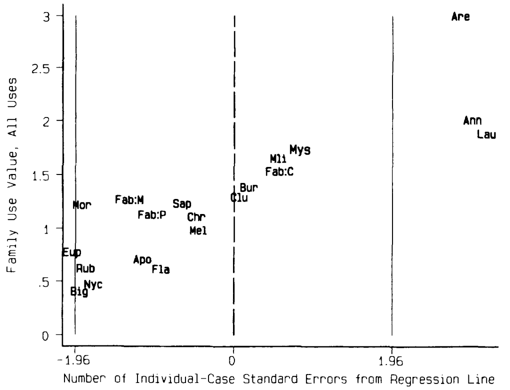

Fig. 4. Family use values vs. standard error of their residuals.

here, palms clearly dominate (two, *Iriartea deltoidea* R.&P. and *Euterpe precatoria* Mart. are the most useful species of all to mestizos). The pattern of dominance of palms is confirmed by our familial analyses (COMPARISON OF PLANT FAMILIES, below). There is clear potential for applying this technique to other kinds of inter-specific comparisons. Thus, with sufficiently focused data, the relative importance of different plants as medicinal species, or even as remedies or preventatives for one important health problem, could be statistically evaluated. Information of this kind may be helpful in setting priorities for conservation, and would clearly be an important factor in discriminating between candidate species for applications as diverse as pharmacological screening, or promotion in traditional medicine, agroforestry, or enrichment planting.

TABLE 4. FAMILIES WITH FAMILY USE VALUES HIGHER THAN EXPECTED.

Family	Number of species	Family use value[1,2]
Clusiaceae	11	1.261
Burseraceae	12	1.353
Fabaceae (Caesalpinoids)	16	1.555
Meliaceae	12	1.559
Myristicaceae	18	1.686
Lauraceae	62	1.847**
Annonaceae	38	1.976**
Arecaceae	11	2.978**

[1] Null hypothesis: the average total use value of a species in a given family is not significantly more or less than the predicted mean total *FUV* of families of equivalent size.

[2] H_0 rejected at the following levels: ** = $P < 0.01$.

TABLE 5. FAMILIES WITH FAMILY USE VALUES LOWER THAN EXPECTED.

Family	Number of species	Family use value[1,2]
Bignoniaceae	15	0.424 s
Nyctaginaceae	14	0.433 s
Rubiaceae	16	0.525 s
Flacourtiaceae	10	0.575
Apocynaceae	13	0.669
Euphorbiaceae	22	0.734 *
Melastomataceae	11	0.945
Chrysobalanaceae	13	1.019
Fabaceae (Papilionoids)	29	1.152
Fabaceae (Mimosoids)	38	1.179
Moraceae	54	1.184 s
Sapotaceae	25	1.202

[1] Null hypothesis: the average total use value of species in a given family is not significantly more or less than the predicted mean total *FUV* of families of equivalent size.

[2] H_0 rejected at the following levels: s = $P < 0.10$, * = $P < 0.05$.

COMPARISONS OF PLANT FAMILIES

H_0 = *on average, a species in a given family is no more or less useful than predicted for species in families of equivalent size (for each family)*

In order to evaluate the importance of different plant families to mestizos, we analyze our use-value data with a regression technique modified from Moerman (1991). (We could also have used Kruskall-Wallis or Mann-Whitney comparisons to test pair-wise null hypotheses, in the same way that we compared species, using as separate observations each UV_s value, as opposed to each UV_{is} value. We use regression analysis here to demonstrate some of the choice in analytical technique available when working with use value data.)

For each family, Moerman regressed the total number of Native American medicinal species in North America on the total number of species, and calculated residuals for each family. Families with positive residuals (i.e., above the regression line) have more uses than predicted by the number of species in the family, families with negative residuals have fewer. Unlike Moerman, we have only a sample of each family's set of UV_s values, so we modified the technique to calculate individual-case standard errors of departure for each Family Use Value (*FUV*) from the regression, where *FUV* = $Sum(UV_s)$/(number of species). For a given family size, residuals for in-

TABLE 6. FAMILY USE VALUES (CONSTRUCTION USES).

Family	Number of species	Family use value[1,2,3]
Moraceae	54	0.174 *** −
Bignoniaceae	15	0.202 s −
Fabaceae (Mimosoids)	38	0.248 ** −
Apocynaceae	13	0.259 −
Rubiaceae	16	0.301 −
Sapotaceae	25	0.392 −
Euphorbiaceae	22	0.396 −
Melastomataceae	11	0.409 −
Burseraceae	12	0.424 −
Nyctaginaceae	14	0.433 −
Flacourtiaceae	10	0.500 −
Fabaceae (Papilionoids)	29	0.537 −
Chrysobalanaceae	13	0.669 +
Clusiaceae	11	0.682 +
Arecaceae	11	0.791 +
Myristicaceae	18	0.848 s +
Fabaceae (Caesalpinoids)	16	0.852 s +
Meliaceae	12	1.034 s +
Annonaceae	38	1.143 ** +
Lauraceae	62	1.205 *** +

[1] Null hypothesis: the average construction use value of species in a given family is not significantly more or less than the predicted mean construction *FUV* of families of equivalent size.

[2] H_0 rejected at the following levels: s = $P < 0.10$, * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$.

[3] + and − indicate that *FUV* is respectively above/below the predicted value for a family of equivalent size.

TABLE 7. FAMILY USE VALUES (COMMERCIAL USES).

Family	Number of species	Family use value[1,2,3]
Flacourtiaceae	10	0 −
Chrysobalanaceae	13	0 s −
Hippocrateaceae	16	0 * −
Rubiaceae	14	0 * −
Moraceae	54	0.026 ** −
Euphorbiaceae	22	0.039 * −
Sapotaceae	25	0.104 −
Bignoniaceae	15	0.111 −
Fabaceae (Mimosoids)	38	0.151 −
Apocynaceae	13	0.154 −
Arecaceae	11	0.265 +
Melastomataceae	11	0.318 +
Clusiaceae	11	0.364 +
Burseraceae	12	0.364 +
Fabaceae (Papilionoids)	29	0.371 +
Meliaceae	12	0.481 s +
Fabaceae (Caesalpinoids)	16	0.489 * +
Annonaceae	38	0.495 ** +
Myristicaceae	18	0.512 ** +
Lauraceae	62	0.615 *** +

[1] Null hypothesis: the average commercial use value of a species in a given family is not significantly more or less than the predicted mean commercial *FUV* for families of equivalent size.

[2] H_0 rejected at the following levels: s = $P < 0.10$, * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$.

[3] + and − indicate that commercial *FUV* is above/below the predicted value for a family of equivalent size.

dividual-case predictions of more than 1.96 standard errors from the regression line are significantly different than expected from the number of species in the family; i.e., the null hypothesis is rejected.

In Fig. 4, the significance of the departure of each *FUV* from its predicted value is displayed graphically, for families with ten or more woody species. Tables 4 and 5 list families with *FUV* higher and lower than predicted, together with significance levels. The null hypothesis is rejected at the 5% level for four, at the 10% level for eight, out of 20 families; there is also a strong suggestion that the residuals would have been significant for several other families had the species sample been larger. Table 5 lists the families in rank order, according to the fraction of their FUV_s that reflects construction (Table 6), commercial (Table 7), edible (Table 8), technological (Table 9), and medicinal uses (Table 10).

The tables highlight several interesting points. First, the importance of forest palms to neotropical peoples that is often remarked upon (e.g., Balick 1989; Pinheiro and Balick 1987; Prance et al. 1987) is confirmed here statistically, illustrating the need for effective conservation of this supremely useful family. In fact, species for species, palms are between half and three orders of magnitude more important to mestizos than one third of all the other woody plant families analyzed.

Second, most of the families that stand out as being exceptionally useful are important mostly because of their importance as timber—both as subsistence uses for rural families (the main item in the construction category) and for commerce. Averaged across the 20 most speciose families, construction uses contribute 47% to total value, with 20% from commerce, 19% from edibles, 8% from technology, and just 6% from medicinals. The relative importance of these destructive uses to mestizos parallels Piñedo-Vasquez et al.'s (1990) findings with ribereños in northeast Peru. At both localities, timber harvesting has been practiced in a non-sustainable way, and at both localities establishment of firm land or resource

TABLE 8. FAMILY USE VALUES (EDIBLE USES).

Family	Number of species	Family use value[1,2,3]
Myristicaceae	18	0 s –
Flacourtiaceae	10	0 –
Nyctaginaceae	14	0 s –
Lauraceae	62	0.011 ** –
Meliaceae	12	0.015 –
Burseraceae	12	0.019 –
Bignoniaceae	15	0.022 –
Euphorbiaceae	22	0.030 –
Rubiaceae	16	0.037 –
Apocynaceae	13	0.058 –
Fabaceae (Caesalpinoids)	16	0.073 –
Clusiaceae	11	0.080 –
Chrysobalanaceae	13	0.088 –
Fabaceae (Papilionoids)	29	0.095 –
Melastomataceae	11	0.218 –
Annonaceae	38	0.254 –
Moraceae	54	0.593 * +
Sapotaceae	25	0.673 * +
Fabaceae (Mimosoids)	38	0.727 ** +
Arecaceae	11	1.529 ** +

[1] Null hypothesis: the average edible use value of a species in a given family is not significantly more or less than the precicted mean edible *FUV* of families of equivalent size.

[2] H_0 rejected at the following levels: s = $P < 0.10$, * = $P < 0.05$, ** = $P < 0.01$.

[3] + and – indicate that edible *FUV* is above/below the predicted value for a family of equivalent size.

TABLE 9. FAMILY USE VALUES (TECHNOLOGICAL USES).

Family	Number of species	Family use value[1,2,3]
Lauraceae	62	0 *** –
Melastomataceae	11	0 s –
Nyctaginaceae	14	0 * –
Meliaceae	12	0.019 –
Sapotaceae	25	0.025 s –
Myristicaceae	18	0.046 –
Fabaceae (Papilionoids)	29	0.050 –
Fabaceae (Mimosoids)	38	0.061 –
Flacourtiaceae	10	0.075 –
Apocynaceae	13	0.077 +
Annonaceae	38	0.083 +
Fabaceae (Caesalpinoids)	16	0.088 +
Bignoniaceae	15	0.089 +
Rubiaceae	16	0.098 +
Euphorbiaceae	22	0.120 +
Arecaceae	11	0.131 +
Clusiaceae	11	0.136 +
Moraceae	54	0.185 ** +
Chrysobalanaceae	13	0.282 s +
Burseraceae	12	0.446 ** +

[1] Null hypothesis: the average technological use value of a species in a given family is not significantly more or less than the predicted mean technological *FUV* of families of equivalent size.

[2] H_0 rejected at the following levels: s = $P < 0.10$, * = $P < 0.05$, ** = $P < 0.01$.

[3] + and – indicate that technological *FUV* is above/below the predicted value for a family of equivalent size.

tenure is needed to encourage sustainable levels of extraction in the future.

Third, however, some forest plant families remain important sources of non-timber forest products (NTFPs) to mestizos, in the edible, medicinal and technological categories, as well as leaf thatch in the construction category. Moreover, the relative importance of the forest as a source of medicine is probably underestimated by our emphasis on the most speciose tree and large vine families, and possibly by the bias towards male informants. NTFP collection in the area is often relatively non-destructive (cf. Phillips n.d.).

We should point out that our definition of FUV_s (i.e., the average of the family's set of UV_s values, similar to Prance et al.'s definition (1987)) is only one of several possible ways to measure family usefulness based on UV_s values. Thus, familial importance might also be defined as: (a) the sum of the component UV_s values; or, the mean of the UV_s values weighted by each species' (b) relative density, or (c) relative frequency. For example, Moraceae, whose *FUV* ranks as one of the least important, would be one of the most important families by technique (a) (it is a large family), and of near-average importance using technique (b) or (c) (since the more abundant and frequent species tend to be more useful). Ultimately, of course, the choice of technique depends on the precise nature of the hypotheses being investigated.

CONCLUSIONS

We have shown how a relatively simple data-processing technique can be applied to large ethnobotanical data sets, to generate a quantitative use value index. The index helps to make a number of important kinds of ethnobotanical questions tractable, using statistical, hypothesis-testing analyses. Here, we used use values to compare the relative usefulness of different species and families of woody plants in Amazonian Peru; in subsequent papers we will further explore the technique's potential for testing other hypotheses about patterns and processes in plant use.

We hope that students and practicing ethno-

TABLE 10. FAMILY USE VALUES (MEDICINAL USES).

Family	Number of species	Family use value[1,2,3]
Nyctaginaceae	14	0 s −
Flacourtiaceae	10	0 −
Fabaceae (Mimosoids)	38	0 ** −
Bignoniaceae	15	0 s −
Clusiaceae	11	0 −
Annonaceae	38	0 ** −
Melastomataceae	11	0 −
Sapotaceae	25	0.008 * −
Meliaceae	12	0.009 −
Lauraceae	62	0.016 s −
Chrysobalanaceae	13	0.038 −
Fabaceae (Caesalpinoids)	16	0.054 +
Rubiaceae	16	0.089 +
Fabaceae (Papilionoids)	29	0.099 +
Burseraceae	12	0.100 +
Apocynaceae	13	0.122 +
Euphorbiaceae	22	0.149 +
Moraceae	54	0.207 * +
Arecaceae	11	0.261 * +
Myristicaceae	18	0.279 ** +

[1] Null hypothesis: the average medicinal use value of a species in a given family is not significantly more or less than the predicted mean medicinal *FUV* of families of equivalent size.

[2] H_0 rejected at the following levels: s = $P < 0.10$; * = $P < 0.05$, ** = $P < 0.01$.

[3] + and − indicate that medicinal *FUV* is above/below the predicted value for a family of equivalent size.

botanists will see our approach as part of the challenge to develop a science that is both capable of testing specific hypotheses, and of providing better quality information about how and why people use plants. If ethnobotany can move from the scientific sidelines to center-stage, we believe it will make a greater contribution to the conservation and ethical use of biological and cultural diversity.

ACKNOWLEDGMENTS

We are indebted to the residents of the community of La Torre and the surrounding area for generously sharing their knowledge of the Tambopata forest with us. Michel Alexiades, Claudia Gálvez-Durand Besnard, Flor Chavez, Gavin Nicholson, and Paul Wilkin all helped with plant use data collection, and were present during some of our walks and interviews. Camilo Díaz, Nestor Jaramillo, Percy Nuñez, and Rodolfo Vasquez helped collect voucher specimens in the inventory plots. We also owe special thanks to the Tambopata Reserve Society, Max Gunther, Marcia Morrow, and the staff at the Explorer's Inn for invaluable logistical help. We thank Michel Alexiades, Walter Lewis, Eugene Shultz, Paul Wilkin, and two anonymous reviewers for their constructive advice on ways to improve the text, and for provoking us to confront some philosophical problems with our approach and analysis. Rogerio Castro helped to translate the abstract, and Stanley Sawyer made several valuable suggestions on statistical methodology. We thank Bill Duellman and Linda Trueb for permission to reproduce the map from Duellman and Koechlin (1991). OP was funded by grants to the Tambopata Flora Study Group (1986), and by Cambridge University grants (1988); and by an NSF Doctoral Dissertation Improvement Award (BSR-9001051), a WWF-US Garden Club of America Award (1991), and a Conservation International Plants Program Grant (1990–1992), whilst a doctoral student at Washington University. AG is a Pew Scholar in Conservation and Environment and a Senior Curator at the Missouri Botanical Garden; fieldwork and herbarium work with the Proyecto Flora del Perú is also supported by the Mellon Foundation and the MacArthur Foundation.

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APPENDIX 1. MESTIZO USES OF TAMBOPATA WOODY PLANTS.

Use[1] (defined by informants)	Number of Spp.[2]	Number of Informants[3]
C: Sawnwood for floors, walls	223	8
O: Commerce in unfinished construction products (e.g., planks, posts; wood for parquet, plywood)	171	10
E: Raw fruit eaten	144	16
C: Roundwood for beams in house construction	122	5
E: Hunters wait close to fruiting tree for game	49	5
C: Roundwood for house posts (*postes, horcones*)	42	6
T: Fuelwood	35	3
M: Remedy for broken bones	17	4
C: Sawnwood for furniture	16	3
M: Remedy for hernias	13	3
C: Thatch for housing and temporary buildings	12	6
C: Sawnwood for house posts (*postes, horcones*)	12	5
M: Remedy for rheumatism and/or muscle-aches	11	2
O: Commerce in edibles (fruits, nuts, palm hearts)	10	9
M: Remedy for diarrhea (chronic & acute not always distinguished)	10	5
M: Remedy for fever (sometimes specified as malaria)	10	4
T: Resin burnt for light when kerosene unaffordable or unavailable	10	3

APPENDIX 1. CONTINUED.

Use[1] (defined by informants)	Number of Spp.[2]	Number of Informants[3]
E: Cooked seeds eaten	9	6
O: Commerce in finished construction products (e.g., furniture, canoes)	9	5
C: Canoes made from hollowed trunk	9	4
M: Remedy for swellings and bruises	9	3
O: Commerce in technology/craft items (e.g., necklaces, charcoal, cured skins)	9	3
M: Remedy for *patico* (=sore spots in childrens' mouths, presumably a gum infection)	9	2
E: Soaked fruit eaten	8	11
E: Palm heart eaten raw/cooked	7	10
E: Beetle larvae (*surí*) from rotting trunk eaten raw/cooked	7	7
E: Edible oil extracted from fruit	7	7
O: Commerce in medicines	7	6
C: Roundwood/split-trunk for fence-post construction	7	5
E: Immature seed eaten raw	7	5
M: Remedy for bronchitis	7	2
E: Mature seed eaten raw	6	8
M: Remedy for cutaneous leishmaniasis	6	5
M: Remedy for colds (*resfrio*)	6	4
M: Prevents hairloss	6	4
M: General tonic (sometimes specified as blood or digestive system)	6	3
E: Fruit juice (*refrescos*) extracted	6	2
T: Bark used for tanning skins	6	1
C: Split-trunk for partition wall construction	5	7
M: Remedy for liver-complaints (possibly including hepatitis)	5	5
T: Rope for carrying heavy loads and/or for tying	5	5
T: Bark ashes mixed with clay to make ceramics	5	1
T: Resin used as glue, mixed with clay to make ceramics	5	1
C: Split-trunk for outside house-wall construction	4	10
T: Bait for fishing	4	6
C: Sawnwood for canoe construction	4	6
T: Wood used to make tool-handles (axes, hammers, brushes, etc.)	4	3
E: Tree produces fruit eaten by pigs	4	3
T: Canoe paddles	4	2
M: Headache remedy	4	2
T: Press for sugar-cane processing (*trapiche*)	4	2
C: Split-trunk for floor construction	3	6
C: Split-trunk for roofing and floor supports	3	5
M: Topical antibiotic (e.g., treating fungal skin infections)	3	4
M: Remedy for coughs	3	3
T: Seeds used for necklaces	3	2
T: Aerial traps made to protect livestock from vampire bats	3	1
M: Wound-healing	2	6
E: Bark used for flavouring alcohol	2	4
M: Remedy for kidney-complaints	2	4
M: Aphrodisiac (enhances sexual desire and/or performance)	2	3
T: Dyes	2	3
M: Remedy for cancer (internal cancers only)	2	3
T: Latex used to waterproof cloth and canvas	2	3
C: Split-trunk for roof-gutters construction	2	3
E: Beetle larvae (*surí*) from seed eaten raw/cooked	2	2
T: Buttress-root sections used as boards for washing gold (*bateas*)	2	2
E: Fruit fermented for alcoholic drink	2	2
E: Latex drinkable	2	2
M: Local anaesthetic	2	2

APPENDIX 1. CONTINUED.

Use[1] (defined by informants)	Number of Spp.[2]	Number of Informants[3]
M: Purge	2	2
M: Love charm	2	1
T: Mortar to remove chaff from rice	2	1
T: Soap	2	1
M: Remedy for varicose veins	2	1
M: Anthelmintic	1	4
C: Trunk for foot-bridge construction	1	4
T: Charcoal	1	3
C: Temporary canoes (*tarapotos*)	1	3
M: Remedy for anaemia	1	2
M: *Candiru* removal (causes the fish to be excreted from orifice)	1	2
M: Remedy for eye cataracts	1	2
T: Fruit used as a football	1	2
T: Leaves used as hand-fans	1	2
E: Seeds processed to make chocolate	1	2
T: Spear for fishing	1	2
M: Remedy for witchcraft (counteracts *daño*)	1	2
M: Antiseptic (e.g., treats pustulent abscesses)	1	1
T: Arrow strings for childrens' toys	1	1
M: Remedy for asthma	1	1
E: Cooked fruit eaten	1	1
E: Edible fungi collected from fallen/cut tree	1	1
E: Edible macaw chicks taken from nest in tree	1	1
M: Remedy for *carnosidad* (loss of vision due to growths over the eye, including cataracts)	1	1
T: Fibre used in weaving	1	1
T: Fish poison	1	1
E: Fruit made into jam	1	1
T: Garden mulch	1	1
T: Leaves used as brooms	1	1
T: Liana cut for drinking water	1	1
T: Sections cut to make living fences	1	1
T: Ornamental plants	1	1
E: Palm heart fermented for alcoholic drink	1	1
M: Penis extender	1	1
T: Petiole used as leverage to adjust tension in canoe-making	1	1
M: Prevents tuberculosis	1	1
C: Rafts	1	1
T: Rat poison	1	1
T: Resin used as wood sealant (e.g., for canoe caulking)	1	1
E: Seed for cooking oil	1	1
T: Spathes or seedling leaves used for carrying and wrapping food	1	1
T: Spathes used as temporary drinking vessels	1	1
C: Split-trunk for shelving	1	1
C: Split-trunk for paths	1	1
C: Split-trunk for temporary building	1	1
T: Stem cut and decorated at Carnival time	1	1

[1] All uses are subsistence uses except when specified as commerical: C = Construction uses; E = Edible uses; O = Commercial uses; M = Medicinal (and "Magic") uses, including both remedial and preventative uses; T = Technological and Craft uses.

[2] All tree and liana species ≥ 10 cm d.b.h. in 6.2 ha of forest plots at Tambopata are included, together with 35 other non-plot woody species.

[3] We interviewed 29 mestizo informants (aged approximately from 5 to 67, mean age = 34 years, median age = 35 years, including 20 men, three women, and six children and youths).