Journal of Ethnobiology 17(1):69-96 Summer 1997

THE USE OF PLOT SURVEYS FOR THE STUDY OF ETHNOBOTANICAL KNOWLEDGE: A BRUNEI DUSUN EXAMPLE

JAY H. BERNSTEIN
St. John's University
Jamaica, NY 11439, USA

ROY ELLEN
Eliot College
University of Kent at Canterbury
Canterbury, Kent CT2 7NS, Great Britain

BANTONG BIN ANTARAN
Brunei Museum
Kota Batu
Negara Brunei Darussalam 2018

ABSTRACT.—This paper describes a technique for using plot surveys to measure individual informants' ethnobotanical knowledge of forests, as applied to the Dusun community of Merimbun in Brunei. Two knowledgeable but non-literate Dusun informants enumerated marked plots of both recent and old secondary growth mixed dipterocarp forest near the village. They were able to provide names (other than life-forms or the most general basic and intermediate categories) for 86-97% of species growing in the plots. Between 152 and 170 plant names were elicited by the surveys. In all cases, about 88% of the names were at the basic naming level and 12% below. The surveys reveal the breadth of biodiversity knowledge of particular types of forest and highlight differences in the knowledge of individual informants and the ways in which that knowledge is organized. The plot-survey technique provides a way of measuring the comprehensiveness of local knowledge of plants with reference to all plant types found within circumscribed plots in locally recognized biotopes, and may be useful as a rapid means of assessing local ecological diversity.

RESUMEN.—Este artículo describe una técnica para usar encuestas de parcela a fin de medir el conocimiento etnobotánico que tienen los informantes individuales acerca de los bosques, aplicada a la comunidad dusun de Merimbun en Brunei. Dos informantes dusun, conocedores del bosque si bien analfabetas, enumeraron parcelas marcadas de bosques secundarios mixtos de dipterocarpáceas, tanto de crecimiento reciente como bosques secundarios más viejos, cerca de la aldea. Fueron capaces de suministrar los nombres (aparte de las formas de vida o las categorías básicas o intermedias más generales) de entre un 86 y un 97% de las especies que crecían en las parcelas. Entre 152 y 170 nombres de plantas fueron elicitados por las encuestas. En todos los casos, alrededor del 88% de los nombres estuvieron al nivel básico de nombramiento, y 12% por debajo de éste. Las encuestas revelan la amplitud del conocimiento de la biodiversidad de determinados tipos de bosque, destacando las diferencias en el conocimiento de informantes individuales, y las formas como es organizado ese conocimiento. La técnica de encuestas de parcela proporciona una manera de medir la extensión del conocimiento local de las plantas con referencia a todos los tipos de plantas encontradas dentro de parcelas circunscritas en biotopos reconocidos localmente, y puede ser útil como un método rápido de valoración de la diversidad ecológica local.

RÉSUMÉ.—Dans cet article, nous décrivons une technique d'utilisation de levé de terrain pour mesurer la connaissance ethnobotanique d'informateurs individuels relative aux forêts, telle qu'exemplifiée dans la communauté dusun de Merimbun au Brunei. Deux experts dusun non scolarisés ont dressé un inventaire de terrains marqués, près du village, constitués de forêt de diptérocarpacées mixte de croissance secondaire ancienne et récente. Ils ont nommé (sans compter les termes utilisés pour désigner les formes de vie ou les catégories de base et les catégories intermédiaires les plus générales) entre 86 et 97% des espèces poussant dans ces lots. De 152 à 172 noms de plantes ont été élicités durant ces enquêtes. Dans tous les cas, environ 88% des noms étaient des termes de base et 12% de niveau inférieur. Cette étude montre l'envergure de la connaissance de la biodiversité de types particuliers de forêts, elle met en évidence la variation de la connaissance entre les informateurs et les façons dont la connaissance est organisée. La technique de levé de terrain permet de mesurer la totatité de la connaissance locale des plantes, par rapport à tous les types de plantes qui se trouvent à l'intérieur de terrains circonscrits dans des biotopes reconnus localement, et peut s'avérer utile comme moyen d'accès rapide à la diversité écologique locale.

INTRODUCTION

We address aspects of the knowledge and use of forest plant species by the Dusun, an indigenous minority group in Brunei. We analyze data on the composition of forest plots obtained through inventory surveys conducted with two Dusun informants. The standard technique in most ethnobotanical work has been the collection of herbarium specimens, sometimes acquired systematically, though more often opportunistically, from a range of different biotopes.[1] Through this method it is possible to discover what informants know about any individual plant collected, but it does not give an overall picture of what is known about a particular patch of habitat or forest type, in part because it is hard work collecting identifiable voucher specimens for all different kinds of plants in even a small area (Martin 1995:155). Indeed, until quite recently the diversity and biomass of the herbaceous component of tropical forests in particular have been greatly underestimated, partly because of the absence of appropriate plot surveys (Poulsen 1996). Moreover, a conventional ethnobotanical herbarium collection cannot be used to determine how many plants are recognized in a given habitat, and what proportion of these might be useful; nor can it tell us much about the plants people are unable to identify or recognize. Part of the work of assessing ethnobotanical knowledge involves assessing ethnobotanical ignorance (cf. Ellen 1979). More specifically, although we now have increasing evidence concerning indigenous knowledge of rainforest species, and although we know that to some extent that knowledge (measured in numbers of names for plants) broadly reflects biodiversity

(Berlin 1992:99; Ellen in press), in depth knowledge of individual species and general knowledge overall is always skewed to some degree by the uses to which plants are put. We know of no previously published attempts to test informants' knowledge of all plant life contained within designated patches of forest. It was for this reason that in the Brunei study we have chosen to supplement more conventional strategies with plot inventories.

We are concerned here with the problems and materials of both cognitive anthropology and rainforest ecology. By using a plot-survey technique we were able to measure individual informants' ethnobotanical knowledge, defined in terms of their ability to name plants. Our study also provides evidence for the organization of ethnobotanical categories. Finally, it enables an assessment of the biological character of uncultivated areas, the extent of diversity, and an estimate of the potential economic value of the areas. The results of plot studies can contribute to the development of what Hunn (1982) has called a "post-ethnoscientific ethnobiology," by situating knowledge about plants in a broader context of human-environment relations.

PLOT SURVEYS IN ETHNOBOTANICAL WORK

The use of quantitative studies of plots to understand the composition of particular biological habitats is long-established in plant ecology. The idea of a systematically or randomly-selected quadrat, "a square area marked off as a sample of any vegetation it is desired to study closely," was introduced by Tansley (Tansley and Chipp 1926:57; see also Tansley 1923:94-129). For Tansley and Chipp, quadrats could either be simple lists of all plants within a space (list quadrats) or graphic illustrations of the structure of an association as seen in a ground plan (quadrat charts), in which species were indicated using some kind of notation (Tansley and Chipp 1926:58). For early workers, quadrats were often thought to be inappropriate for woody vegetation, where line or belt transects were considered more convenient and quicker (Tansley and Chipp 1926:58, 61-62). Moreover, it was seldom possible in a forest to include woody and herbaceous vegetation in the same quadrat chart, the necessary scales being too divergent. Similarly, a single chart could not capture significant stratification of the kind now well demonstrated for tropical rainforests (Tansley and Chipp 1926:59; see also Tansley 1923:94-129; Richards 1952:22-38; Whitmore 1990:27). However, by the 1960s quadrats or plot surveys had become commonplace in ecological studies of even rainforest, having been pioneered by P. W. Richards in the 1930s (Richards 1939; Richards, Tansley, and Watt 1940). They are now an essential tool in all serious analyses of composition, structure, and dynamics. Since the work of Odum (1971:17), plots have also become a statistical device for obtaining limited sample areas from which total counts can be made to estimate a standing crop of plants or for measuring energy capture and release. In Brunei, the first permanent plots were established in 1957 by Peter Ashton at Kuala Belalong and Andulau (Ashton 1964:5-8).

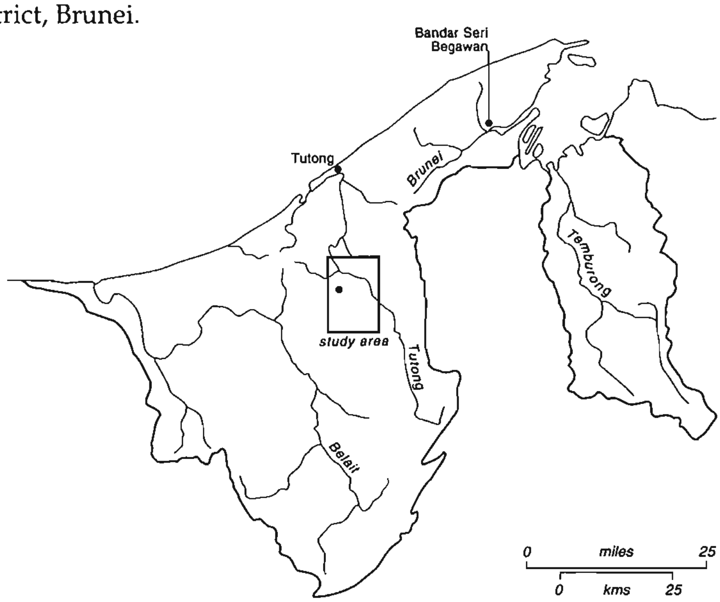
In ethnobotany and human ecology plot surveys first made an appearance in studies of swiddening, though less as a tool to assess plant knowledge and classification than as a means of establishing the agricultural and ecological character of swiddens by censusing their floral composition (initially Conklin 1957:85-86;

more recently, e.g., Boster 1983; Johnson 1983; Vickers 1983), and as a way of monitoring planting decisions in different years (Boster 1984). Plot surveys have also been used to measure the value of non-timber products in the context of debates relating to the economics of sustainable rainforest extraction (Peters, Gentry, and Mendelsohn 1989). Much of this work, which has been conducted largely in the Amazon basin, has been inspired by the research of botanists associated with the New York Botanic Gardens. However, despite this incentive and other work (Balée 1986, 1987; Balick and Mendelsohn 1992; Bennett 1992; Boom 1987), we are aware of no published accounts which report the use of plot surveys to complement general work on ethnobotanical knowledge, as opposed to those focusing on measurements of usefulness. There is, however, an important precedent for our work in the research of Stross (1973). Although not using a measured quadrat, Stross had Tzeltal informants name plants along a predetermined route, including both forests and cultivated areas, and thus he was able to measure and compare informants' ethnobotanical knowledge. Boster (1986) used a similar experimental method, guiding Aguaruna informants through gardens he had planted with up to 61 varieties of manioc.

ETHNOGRAPHIC BACKGROUND

The field site for the project reported here was the Dusun village of Merimbun, located in the Rambai mukim (administrative sub-district), Tutong district, the traditional homeland of the Brunei Dusun. Merimbun village comprises three hamlets, one at Lake (Tasek) Merimbun, consisting of seven houses, and smaller hamlets at Kuala Ungar (three houses) and Pulau Rita (four houses). The present population consists of about 100 people spread over an area of about five km^2 (Figure 1).

FIGURE 1.—Map of the research site, the Dusun village of Merimbun, Tutong district, Brunei.



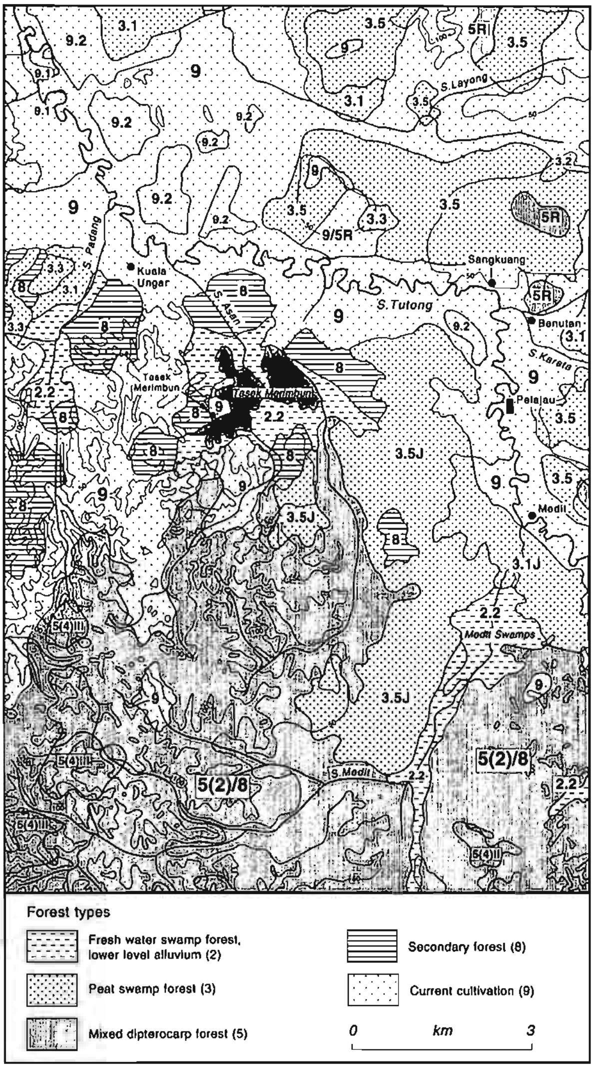
The Dusun are one of seven ethnic groups in Brunei constitutionally recognized as Malay. The Brunei Dusun seem to be a branch of the Bisaya, an ethnic group based in Limbang, a district once belonging to Brunei, but ceded to Sarawak in 1890.[2] Since they are officially classified as Malay there are no up-to-date demographic statistics specifically about the Dusun population, though a well considered estimate is that there are 5,000 non-Muslim Dusun in Brunei (Antaran 1993:19). (More recent information suggests that this estimate could be low.) It is clear, however, that the cultural population labelled "Dusun" by insiders and outsiders alike (defined usually in terms of adherence to language, ritual practices and beliefs, and through non-adherence to Islam) is decreasing as a result of marriages to Malays and Chinese, and through conversion to Islam. Furthermore, traditional Dusun language and culture is not being effectively reproduced (Kershaw 1994). In large part, this is due to social and economic mobility. With a large public sector economy, Bruneians are abandoning traditional economic pursuits to join a labor force away from their villages. As this occurs, traditional social formations, and the cultural knowledge which sustains them, decline (Ellen and Bernstein 1994; Bernstein in press).

The period of rapid growth in Brunei's economy in the 1950s corresponds with the transformation of Dusun culture and society, and its assimilation into modern Brunei society, including conversion to Islam and language shift converging on Malay. During this period of oil-based development, Dusun in large numbers began leaving their villages and seeking wage labor; education in Malay also became available through the building of rural schools. While the Dusun are now fluent in Malay, previous generations had imperfect command of the tongue, and if they spoke it at all, it was "falteringly or with strong accents" (Kershaw 1994).

Prior to this transformation, Dusun were almost entirely rice agriculturalists, supplementing their starch staple from cultivated fruit orchards and by hunting, gathering, and fishing. Some species in orchards and forest overlap, indicating long-standing human modification of the rainforest environment and selection of wild species for cultivation and genetic improvement. Examples are ***lalet*** (the durian, *Durio* spp., especially *D. zibethinus* L.), ***embokot*** *(Nephelium macrophyllum)*, and ***julok*** (*Lepisantes fruticosa* [Roxb.] Leenh). The most sought-after fruits are ***sibut*** (*Dacryodes expansa* [Ridl] H.J. Lam) and ***kalokog*** (*Willughbeia* sp). Besides fruit trees, a large number of vegetables are grown (Antaran 1993:71-72) and wild vegetables are gathered, particularly edible ferns. There is evidence of selective management of palms, such as ***dabor*** (*Daemonorps fissa* Blume) and ***benjiru*** (*Licuala paludosa* Griff. and *Licuala spinosa* Wormsb).

The forests in this region are of lowland mixed dipterocarp type, but show interesting variations (Figure 2). The drainage basin, of which Lake Merimbun is the center, contains freshwater swamp forest (both levee alluvium [***emparan***] and lower level alluvium); peat swamp forest and ***padang*** forest (both dominated by ***encarangan***, *Dactylocladus stenostachys* Oliver); mixed dipterocarp forest with uneven canopy, or moderately open with some medium or large emergents; dipterocarp forest with a dense uneven canopy, with medium-sized and large crowns on steep terrain (25-35°); secondary forest; and currently cultivated land (including some swamp rice land and plantation, but mainly swidden) (Brunei Forest Resources Planning Study, Forest Type Map 1984: Sheet 4; fieldnotes).[3]

FIGURE 2.—Schematic illustration of major forest types in the Dusun region.



The Dusun language has no overall term for uncultivated land. The Dusun word for forest ***(entalun)*** refers only to land never known to have been under cultivation. ***Gapu'*** refers both to abandoned fields and secondary forest, that is, land known to have been brought under cultivation. Habitats are classified as 'hilly' ***(bukid),*** 'swampy' ***(payoh),*** and 'alluvial' ***(gana).*** Ground types are classified into 'compressed' ***(pidot)*** and 'uncompressed' ***(padang)*** land, the latter being sparsely covered with small plants. Grassy swamp land in secondary forest is known as ***emparan.***

METHODOLOGY

The plot-survey technique was used to supplement data on Dusun ethnobotany obtained through herbarium collection, interviews, and participant observation. In the course of the Merimbun study, Bernstein and Antaran used local Dusun guides to locate suitable forest from which to collect plant specimens. The main guides were four men in their late 50s or older. Five hundred and thirty-five plants were collected, among them 436 with different and non-synonymous names. Plants collected (mostly fertile specimens) were discussed with informants, labeled, pressed in newspaper, and delivered to the Brunei Forestry Centre herbarium at Sungei Liang. Here they were sorted and provisionally identified. The first set of each voucher specimen was retained by the Forestry Centre (BRUN), the duplicates sent to the Royal Botanic Gardens at Kew (K), and triplicates deposited at the University of Kent Ethnobiology Laboratory (UKC) where they were available for further examination and despatch to other herbaria.

By presenting the names of plants that had been collected to a wide range of Dusun informants it became clear that substantial knowledge of forest plants was limited to a few people, mainly older men. Division of knowledge by age has been reported quite widely in the ethnographic literature (Hays 1974; Ellen 1979:346; Boster 1980; Berlin 1992:119-21; Zent 1994), and we know something of how botanical knowledge is acquired and lost (Dougherty 1979). In the Brunei Dusun case, however, the asymmetry between young adult males and men over 50 would appear to be more marked. Young men generally failed to recognize large numbers of plant names elicited through fieldwork with older men. This may, in part, reflect the disappearance of ethnobotanical knowledge due to rapid transition to a wage-based economy, universal primary education, and movement away from rural settlements to peri-urban residences (Ellen and Bernstein 1994). While certain women are knowledgeable about uncultivated plants, the male informants selected were judged to have greater knowledge of plants found mainly in more remote forests, because of their hunting activities, in which no women participate. Moreover, women could not be used as guides because of prevailing social mores.

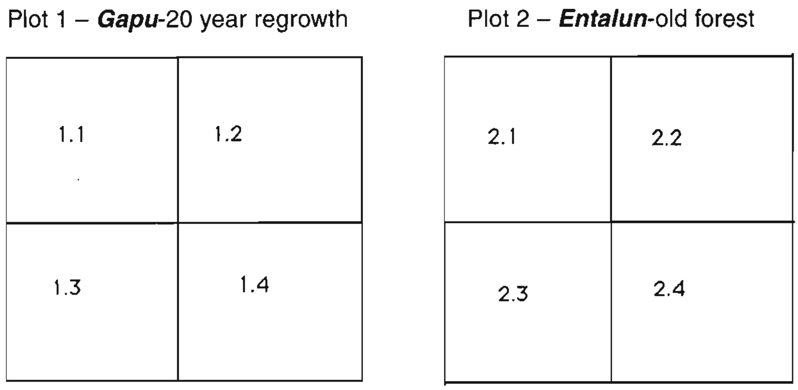
In effect, our study of Dusun ethnobotanical knowledge was to a great extent one of salvage ethnography, documenting for posterity a fast-disappearing body of knowledge. To gain a measure of the extent of the knowledge of plant diversity in given forest vegetation types, rather than the global ethnobotanical knowledge of particular informants, or the maximum knowledge of some omniscient speaker-hearer, it was decided to supplement other methods with a plot survey approach. At this stage in the work we were unaware of the existing techniques of plot survey employed by other ethnobotanists (Martin 1995).[4]

On 18 and 19 August 1993 two different sites of uncultivated land were selected, representing two different vegetation types (cf., Phillips and Gentry 1993a, 1993b): a forest area that had been utilized by Merimbun residents but never brought under cultivation in living memory, and another area that had been brought under cultivation more than 20 years previously, but which had subsequently regenerated. We were advised in this task by an informant. Both sites were within a few minutes of the asphalt-paved road from Merimbun to Bukit Sawat and one to two km from the houses of the informants. Both had a similar underlying geology and soil composition.[5] From mid-August until 2 September, for a total of 11 days (including three half-days), the plots were enumerated by two Dusun men. Both were locally born; neither had received any formal education, though both were able to write their names. Both were traditional non-Muslim Dusun, though in common with many Dusun, some of their children had converted to Islam. The first informant, Umpoh bin Madah (aged 68), spoke Malay and Iban as well as Dusun, and the second, Gumpol bin Payor (aged 77), spoke Penan in addition to those languages. (He is married to an Iban woman.) Gumpol could also understand some spoken Chinese and could read Chinese numerals, since he had associated closely with Chinese and worked for them many times over the years. Both men had supported themselves through hunting, and Umpoh still did so at the time of fieldwork. The two men chosen for this task were also the primary informants used in plant-collection. They were considered within their community to be the most knowledgeable about forest plants. Others who may have been comparably competent could not be used because of their poor health.

The two plots described in this paper were located in areas described as ***gapu' bukid*** and ***entalun bukid***. Selection of sites was based on typicality as judged by the informant, and also accessibility. The ***gapu'*** plot (plot 1) at Pok Lutong was on a 15-25° east-facing slope estimated by our informants to have been cleared at least 20 years previously. The largest trees were between 17 and 36 cm dbh (diameter at breast height), with five m or more between them. The ***entalun*** patch (plot 2) at Pok Kalod (alternatively Pok Ajong) is nearer the lake, on a 20-30° northeast-facing slope never known to have been cleared for cultivation. Here, the largest trees included a few between 54 and 70 cm dbh. Plot 1 was located in an area indicated as "under cultivation" and plot 2 as "secondary forest of at least 25 years" in the Forestry Planning Map dated 1984. The data on which compilation of this map was based must in some cases have been rather old and partial, though the match between official records, field observations, and informant judgements is encouraging.

The sides of the plots were in each case 48 meters. These were then each divided into four giving a total of eight quadrats of about 576 m^2 each (Figure 3).[6] These were marked off with tape for study. Informants were asked to name every plant they could identify within a quadrat and to indicate those plants they could not name, either because they did not know the name, because they had forgotten the name, or because they thought the plant had no basic name. Umpoh surveyed quadrats 1.1, 1.4, 2.1, and 2.4, while Gumpol surveyed 1.2 and 2.2. To be sure a plant had been counted, the informant or Antaran would mark it with spray paint. Bernstein recorded data on a clipboard and entered it into a laptop computer the same evening.

FIGURE 3.—Tasek Merimbun plot quadrat notation



As others have found in practice, not every plant can be registered in this way. It is very time-consuming to record smaller plants, and seedlings are not readily identifiable using non-laboratory techniques. Although informants undertook to name as many individual plants as they could, a decision was taken to eliminate the smallest plants for the purposes of the quantitative survey. This was done by ignoring plants less than 3 cm high. Effectively, this meant grasses, moss, mushrooms, the common fern ***engkubuk*** (*Nephrolepis biserrata* [Sw.]), and most very small seedlings, especially of ***ubor*** (*Eugenia* or *Syzigium* spp.).[7] Secondly, a distinction was made between "large" plants and all others. This physical distinction corresponded approximately to a functional one: namely distinguishing trees which were regarded as having any use in their observed state. Thus, trees observed as immature seedlings and saplings with no uses were eliminated from the survey. In practice, "large" plants surveyed included trees with a diameter of at least 8 cm at breast height (dbh), and vines and rattans of at least 2 cm diameter. Our goal was not to map out or measure particular plants, but more simply to assess the ethnobotanical knowledge of our two informants. For this reason, we did not limit our study to plants having a diameter >10 cm. dbh, but included all plants noticed by our informants, whether or not they could name them. Informants were also asked individually about the uses of each of the plants registered in the surveys. A short subsequent visit in April 1994 enabled us to check the plots and, with the aid of photography, make estimates of average canopy height, emergent tree formations, and to measure the distances between larger trees.

As our informants enumerated the plants found growing in each quadrat, they also found plants they were unable to identify with a basic (generic) name. In these cases they would say that they did not know which plant it was, or else that they had forgotten the name. In virtually all cases they assigned the plant to some higher-order category. It should be stressed that the names our informants provided were free responses to stimuli, and were not elicited through some test where they had to choose one answer or another.

In retrospect, some important shortcomings of our technique are apparent. When we conceived the study we thought that by having informants survey adjoining plots it would be possible to increase the range of plant names (and hence species) included in the study. We did not take into account our informant's comparative fallibility, which only emerged in the analysis of the data. As a result of choosing this tactic, and by using only two informants for this work, we are unable to establish a consensus on plant names even within the Tasek Merimbun Dusun community (see Romney *et al.* 1986 on methodological questions surrounding informant competence, reliability, and consensus; cf. Boster 1986). Most villagers deferred to the authority of a few older individuals who were reputed to have superior knowledge of the forest environment and were considered to be "experts." The reputation of our informants for highly reliable knowledge of forest plants was borne out in plant collection work. In the course of the study we repeatedly interviewed our informants to check earlier statements, and Umpoh and Gumpol were very consistent in their answers. In very rare cases they provided different names for the same plant. One such plant was called ***akau bina manunggul*** by Umpoh and ***akau bina entakad*** by Gumpol. (In either case, the plant is Fabaceae.) When this discrepancy was mentioned to Gumpol, he said that ***akau bina manunggul*** was a different plant. Umpoh avoided saying that Gumpol was mistaken.

We did not insist at the outset on a standard measure of a hectare, but rather let our informant determine the size of the plot in terms of an "acre," as this unit is used and defined in contemporary Brunei. It would have been preferable to have used a plot of a standard size, such as 100x100 m, subdivided into plots of 10x10 m, and to have used a quantitative rather than qualitative and subjective measure of "large" plants. Given the opportunity to re-do this study we would have used three size categories: < 10 cm dbh, 10-20 cm dbh, and >20 cm dbh. Finally, a potential for error is introduced in that we did not collect voucher specimens of plants surveyed in the plots, but relied on linking common names with species, as determined in the general ethnobotanical survey and other sources.

Despite all these drawbacks, we feel that our findings may be useful to ethnobotanists and ecologists working in Southeast Asian rainforests, and we present them in the interest of stimulating further research. The advantage of our methodology is that vernacular names for all but the tiniest of visible plants within a quadrat were collected; thus we are able to represent informants' overall knowledge of plants within an environment. The technique also produced a number of unknown plants and forgotten plant names, allowing us to calculate a ratio of known to unknown plants. In this way, the study yields a quantitative measure of ethnobotanical knowledge in terms of self-reporting. Since we do not define knowledge in terms of consensus (Romney, *et al.* 1986; Boster 1986), our technique does not require the use of a large number of informants, but may be carried out with only one informant.

The floristic composition of the two plots is summarized in Table 1. Most identifications of Dusun plant names are based on our herbarium study. Plant names elicited in the plot studies were keyed to the names given for voucher specimens (usually collected with the same informants), which have been identified at Kew. Additional identifications were obtained from the Kew Brunei Checklist Project

Database and Pukul and Ashton (1964). It is important to note, following Berlin's seventh general principle of ethnobiological classification (1992:25-26), that vernacular terms at the folk-generic rank, as used by knowledgeable speakers of a language, are generally coterminous with the names of Linnaean taxonomy; that is, they tend not to refer to a variety of similar-looking plants in a number of genera or families. While some discrepancies and ambiguities remain, it is possible to identify all but a few Dusun plant names at least to botanical family and usually to genus (Table 1). But given the effect of the large number of plants unidentified at the basic level, at present it is possible to identify only 77.6% of enumerated plants in plot 1 and 82.0% of enumerated plants in plot 2.

Table 1.—Inventory of number of genera and individual plants for each botanical family in two Tasek Merimbun forest plots.

	Plot 2: Old Secondary Growth			*Plot 1: 20 Year Re-Growth*		
FAMILY	*genera*	*plants*	*%*	*genera*	*plants*	*%*
Anacardiaceae	1	18	.3	1	36	.9
Anisophylaceae	2	231	3.6	2	58	1.5
Annonaceae	3	34	.5	5	22	.6
Apocynaceae	1	3	.0	2	24	.6
Araceae	1	200	3.1	3	45	1.1
Araliaceae	0	0	.0	1	1	.0
Arecaceae	8	571	9.0	4	206	5.2
Asteraceae	0	0	.0	1	2	.0
Bombacaceae	1	2	.0	0	0	.2
Burseraceae	2	49	.8	2	10	.2
Celastraceae	1	1	.0	1	7	.2
Commelinaceae	1	17	.2	1	6	.2
Connaraceae	2	94	1.5	2	109	2.7
Costaceae	1	1	.0	1	1	.0
Cyperaceae	2	31	.5	3	15	.4
Dilleniaceae	2	50	.8	2	72	1.8
Dipterocarpaceae	1	19	.3	1	8	.2
Ebenaceae	1	2	.0	1	1	.0
Eleacapaceae	1	55	.9	1	10	.2
Euphorbiaceae	3	153	2.4	5	62	1.6
Fabaceae, Mimosoideae	3	401	6.3	5	19	.5
Fabaceae, Caesalpinoideae	1	40	.6	1	10	.2
Fabaceae, Papilinoideae	2	464	7.3	1	493	12.4
Fagaceae	1	31	.5	1	1	.0
Flacourtiaceae	0	0	.0	2	2	.0
Flegellariaceae	0	0	.0	1	2	.0
Gnetaceae	1	6	.1	1	8	.2
Guttiferae	1	18	.3	1	22	.6
Hypoxidaceae	1	14	.2	1	252	6.4
Irvingiaceae	1	17	.2	1	3	.1
Lauraceae	2	209	3.3	1	56	1.4
Lecythidaceae	1	28	.4	0	0	.0
Loganiaceae	1	68	1.1	1	18	.5

TABLE 1.—Continued.

	Plot 2: Old Secondary Growth			Plot 1: 20 Year Re-Growth		
FAMILY	*genera*	*plants*	*%*	*genera*	*plants*	*%*
Marantaceae	0	0	.0	2	9	.2
Melastomataceae	2	61	1.0	2	122	3.1
Meliaceae	3	11	.1	2	7	.2
Meliosmaceae	1	52	.8	1	1	.0
Menispermaceae	1	16	.2	1	15	.4
Moraceae	2	37	.6	2	243	6.1
Myristicaceae	2	23	.3	2	20	.5
Myrsinaceae	1	2	.0	1	21	.5
Myrtaceae	2	1041	16.3	3	56	1.4
Nepenthaceae	1	1	.0	0	0	.0
Nephrolepidaceae	0	0	.0	1	*	
Ochnaceae	1	81	1.3	0	0	.0
Olacaceae	0	0	.0	1	15	.4
Ophilossuceae	1	1	.0	0	0	.0
Oxalidaceae	1	9	.1	1	8	.2
Pandaceae	1	18	.3	1	28	.7
Piperaceae	1	4	.0	1	1	.0
Polygalaceae	0	0	.0	1	6	.2
Poaceae	0	0	.0	1	*	
Rhizophoraceae	2	15	.2	2	32	.8
Rubiaceae	7	174	2.7	7	162	4.1
Rutaceae	1	3	.0	1	38	.8
Sapindaceae	3	493	7.7	2	324	8.2
Schizaeaceae	0	0	.0	1	5	.1
Simaroubaceae	2	57	.9	2	42	1.0
Sterculiaceae	1	202	3.2	2	191	4.8
Theaceae	1	3	.0	1	6	.2
Thymeleacaceae	1	3	.0	1	5	.1
Tiliaceae	1	10	.2	3	12	.3
Triurdaceae	0	0	.0	1	7	.2
Ulmaceae	0	0	.0	1	1	.2
Verbenaceae	2	12	.2	1	76	.2
Zingiberaceae	2	39	.6	4	15	.4
RESIDUAL PLANT TYPES						
Ferns		9	.1		12	.3
Fungi		*			6	.2
Mosses		*			0	.0
TOTAL ACCOUNTED FOR		5226	82.0		3077	77.6
UNDETERMINED RESIDUE		1145	18.0		890	22.4
TOTALS	55 families 93 genera	6371 plants	100.0	62 families 109 genera	3967 plants	100.0

*Uncounted

These results show that Fabaceae-Papilionoideae is overwhelmingly the most common family in plot 1 (recent secondary growth), with 12.4% of all plants. The second best represented family is Sapindaceae with 8.2%, followed by Hypoxidaceae with 6.4%, and Moraceae at 6.1%. In all, at least 109 genera in 62 families were enumerated for this 20 year regrowth plot.

In plot 2 (old secondary growth), five families dominated: Myrtaceae (16.3%), Arecaceae (Palmae) (9.0%), Sapindaceae (7.7%), Fabaceae-Papilionoideae (7.3%), and Fabaceae-Mimosoideae (6.3%). Ninety-three genera in 55 families were present, including eight palm genera and seven Rubiaceae. (these numbers are all minimal).

In a recent study, Poulsen *et al.* (1996) inventoried a hectare of hill dipterocarp forest in Temburong District. This involved the enumeration of all trees >10 cm. dbh. They identified 231 species in 43 families. Dipterocarpaceae and Euphorbiaceae were dominant, followed by Anacardiaceae, Ebenaceae, Flacourtiaceae, and Myristicaceae. The Temburong study was botanically more thorough than our own work and was undertaken in an area with far less recent disturbance. The number of families represented is roughly comparable, though both the rank order and content of the most common families is noticeably different.

PLANT ENUMERATION STUDIES AS EVIDENCE OF CLASSIFICATORY KNOWLEDGE

Primary Dusun plant categories.—There is no single, overall word in the Dusun language that encompasses all plant life, but plants can be grouped into various categories above the basic naming (generic) level (Bernstein 1996). The major named categories are ***kayuh*** ('tree'), ***akau*** ('vine'), and ***uwai*** ('rattan'). A smaller and less important, but physically salient category is ***kulat*** ('fungus'). These categories are life forms in Berlin's (1992) sense, being highly distinctive morphotypes containing a large number of sub-categories. However, there are a number of other general categories the content of which is less well defined: ***usak*** 'flower', ***sakot*** (alternately ***sakot tanah*** or ***sakot bumi***) 'weed', ***raun*** 'leaf', and ***umbus*** or ***sancam*** 'vegetable'. These are neither morphotypes nor completely exclusive. Some plants can be placed by informants in one of these categories as well as in a more obvious morphotypical life-form or other category; in other words, they cut across morphotypical categories and overlap amongst themselves. But while these plant categories are problematical in not conforming to the tidy analytic distinctions of ethnobotanists, they are not simply plant partonyms (e.g., "flower," "leaf"), and are regularly used by Dusun to classify plants into more inclusive groups. Both life forms and these more problematical categories comprise primary plant categories, in that they are characterized by maximal inclusion within their particular domain (Ellen 1993:91). It would violate the Dusun perception of their plant world to separate them out cognitively as special-purpose rather than general-purpose categories.

Neither grasses nor herbaceous plants are labeled by a single Dusun life-form term, though there is some covert recognition that grasses are physically distinctive. Several named types of grass are placed in the categories ***kumpau, telasai,*** and ***rumput,*** which are conceptually linked. A similar pattern prevails for gingers ***(tumid-lingkuas-layoh),*** ferns ***(gerajai-paku-limputong-engkubuk-kuban),*** bananas ***(punti-rutai-binci-encarawan-powow)***, and palms of the genus Licuala ***(silad-benjiru-ukang)*** (Bernstein and Ellen in press). All are covert categories at the intermediate rank (Bernstein 1996). Other primary categories, the existence of which is demonstrable, but which have an ambiguous classificatory status, are a group of palms, ***pinang***, focused on *Areca catechu*, and ***bulu'*** (bamboo). These primary categories are summarized in Table 2.

TABLE 2:—Main primary Dusun plant categories encompassing forest species.

Life-forms
- ***kayuh*** 'tree'
- ***akau*** 'vine'
- ***uwai*** 'rattan'
- ***kulat*** 'fungus/mushroom'

Covert Intermediates
- ***punti/rutai/binci/encarawan/powow*** 'bananas'
- ***gerajai/paku/limputong/engkubuk/kuban*** 'ferns'
- ***tumid/lingkuas/layoh*** 'gingers'
- ***kumpau/telasai/rumput*** 'grasses'
- ***silad/benjiru/ukang*** 'licuala palms'

Problematic: indeterminate rank
- ***bulu'*** 'bamboo'
- ***pinang*** '*Areca* and similar palms'

Problematic: non-taxonomic
- ***usak*** 'flower'
- ***sakot/sakot tanah*** 'weed'
- ***raun*** 'leaf'
- ***umbus/sancam*** 'vegetable'

Not surprisingly, the great majority of plants named in the plots were placed in the ***kayuh*** 'tree' life form, followed by ***akau*** 'vine' and ***uwai*** 'rattan'. Other categories were less salient: fewer both in number of individual plants and in number of kinds. For example, in his survey of two quadrats of plot 2 totaling 1152 m^2, Gumpol identified 158 different plant names. Of these, 103 were ***kayuh***, 26 were ***akau***, and 8 were ***uwai***. Twenty-one were other kinds of plants. In Gumpol's plot 2 survey , 111 ***kayuh***, 19 ***akau***, and 9 ***uwai*** were named. Only 14 were other kinds of plants. These findings support the proposition that the category ***kayuh*** dominates Dusun ethnobotanical classification, with ***akau*** a distant second. The salience of ***kayuh, akau***, and ***uwai*** is reflected in their frequency, in contrast to all other terms listed in Table 2, confirming their special life-form status (Bernstein 1996).

Breadth of knowledge.—For the most part informants had no trouble providing names even for small seedlings, though we have no independent confirmation of their identifications.[8] However, there was in each of the surveys a residual fraction of plants our informants were unable to identify. As Table 3 shows, in both surveys conducted by both men, there were some plants for which the informant either did not know the name or said he knew it but could not remember it. When "un-

TABLE 3.—Plot survey summaries.

Plot 1, 20 year regrowth	Umpoh		Gumpol	
All plants counted	2917		1052	
Large plants counted	*476*	*16.3%*	*186*	*17.7%*
Basic name unknown - all	357	12.2%	38	3.6%
Basic name unknown - large	*9*	*0.3%*	*0*	*0.0%*
Basic name forgotten - all	63	2.2%	0	0.0%
Basic name forgotten - large	*0*	*0.0%*	*0*	*0.0%*
Total labeled categories identified	170		152	
Basic and primary categories	151		135	

Plot 2, old secondary growth	Umpoh		Gumpol	
All plants counted	5206		1162	
Large plants counted	*398*	*7.6%*	*119*	*10.2%*
Basic name unknown - all	611	11.7%	44	3.8%
Basic name unknown - large	*41*	*0.8%*	*11*	*1.0%*
Basic name forgotten - all	71	1.4%	10	1.0%
Basic name forgotten - large	*12*	*0.2%*	*0*	*0.0%*
Total labeled categories identified	158		156	
Basic and primary categories	132		139	

known" and "forgotten" plants are added together and divided by the total number of plants enumerated, it can be seen that Umpoh failed to identify 14.4% of plants in plot 1 ***(gapu')*** and 13.1% of plants in plot 2 ***(entalun).*** Gumpol failed to identify 3.6% of plants in plot 1 and 4.8% of plants in plot 2. Thus, informants were very consistent in their ability to identify plants, regardless of forest type.

"Failure to identify" in this case means failure at the basic naming level (Berlin's generic rank).[9] As can be seen from Table 4, only one plant in the entire survey could neither be recognized nor classified in any way by one of our informants. All other plants were classified in some more inclusive grouping. From Table 4 we can see exactly which categories these are. The data indicate the indistinctiveness of the category ***usak*** 'flower'. Some unknown plants were classified as both ***akau*** 'vine' and ***usak,*** while others are classified as both ***usak*** and ***gerajai*** (a kind of fern), even though they were non-flowering. Data acquired in the course of herbarium collection reveal that some plants are included in the ***kayuh*** category along with ***usak.*** In short, the ***usak*** category appears to lack any definite, essential core (Atran 1990); instead, it appears to be a heterogeneous grab-bag capable of including many incompletely known plants.

TABLE 4.—Breakdown of unidentified and incompletely identified plants in plot surveys.

	Umpoh		Gumpol	
Plot 1 survey.				
Primary category	All plants (%)	Large plants only	All plants (%)	Large plants only
kayuh — unknown	139 (4.7)	9	27 (2.5)	
kayuh — forgotten	38 (1.3)	16		
akau — unknown	91 (3.1)			
akau — forgotten	21 (0.9)		11 (1.0)	
akau-usak — unknown	1 (0.0)			
usak — unknown	113 (3.8)			
usak — forgotten	2 (0.0)			
kuban — unknown	10 (0.3)			
layoh — forgotten	1 (0.0)			
uwai — forgotten	1 (0.0)			
layoh group *	1 (0.0)			
bakong group *	4 (0.1)			
Plot 2 survey.				
Primary category	All plants (%)	Large plants only	All plants (%)	Large plants only
akau — unknown	286 (5.5)	19	19 (1.6)	5
akau — forgotten	25 (0.5)	6	1 (0.0)	
akau-usak — unknown	2 (0.0)			
usak — unknown	35 (0.7)			
usak-gerajai — unknown	1 (0.0)			
lingkuas group — unknown	17 (0.3)			
gerintik group — unknown	2 (0.0)			
kuban group — unknown	1 (0.0)			
gerajai group — unknown	2 (0.0)			
bakong group *	2 (0.0)			
tumid group — unknown	1 (0.0)			
barasan tanah'*	1 (0.0)			
tisil *			12 (1.0)	

* Name at folk-specific rank not provided

Layoh, tumid, and ***lingkuas*** are different kinds of ginger. ***Gerintik, kuban,*** and ***gerajai*** are all kinds of fern. Plants identified in the survey as "a kind of ***bakong,***" "a kind of ***layoh,***" or "a kind of ***tumid***" presumably indicate kinds below the basic naming level, though their precise intermediate status is ambiguous. From data accompanying the systematic collection of ethnobotanical herbarium vouchers we found that, besides plants called ***tumid*** (including ***tumid entalun*** ['forest ***tumid***', Costaceae] and ***tumid lamatai*** ['ghost ***tumid***', *Plagiostachys strobilifera* (Baker) Ridl.]), the ***tumid*** category also includes plants called ***encalongon*** (*Plagiostachys crocydocalyx* [K.Schum.] Burtt & R.M. Smith), ***kunyit*** ('turmeric', *Curcuma longa* Valeton), ***sagang*** (*Etlingera punicea* [Roxb.] R.M. Smith), and ***sumbang*** (*Hornstedtia reticulata* [K.Schum.] K. Schum.), as well as the various binomially-labeled sub-categories (e.g., ***kunyit lamatai*** ['ghost turmeric', *Hedychium longicornutum* Griff.]).[10] These terminal categories differ in a number of ways from the unmarked, common form of a generically identified plant. Some data in Table 4 refer to unknown kinds of the basic categories ***bakong*** (Crinum) and ***tisil*** (*Urophyllum*). These are identifications at the basic naming level. Another plant, ***barasan tana'*** (*Pandanus* sp.), is presumably a contrasting sub-category, since there are other kinds of ***barasan***. An unknown kind of ***barasan tana'*** presumably indicates the existence of contrasting categories at a more specific level.

Some plants may not be given names at the basic (generic) level. Umpoh could not identify many plants he classified as ***usak***, saying they had no name, i.e., no basic name.[11] However, Gumpol identified no plants as unknown ***usak*** in either of his two surveys. ***Kulat*** 'fungi' found in the plot surveys, all lacked basic names. Only edible mushrooms are known by basic names within the Dusun community under study (with the exception of ***kulat jelundong*** 'shade mushroom' and its sub-type ***kulat jelundong purak*** 'white shade mushroom'), and no edible mushrooms were encountered in any of the places surveyed.

In other cases, while plants may be identified in the sense that they represent familiar forms previously encountered, their "true" basic names may be unknown or lacking. Thus, in the surveys, some plants were identified as ***akau uru lanok*** 'burn medicine vine', ***kayuh penawar racun*** 'poison antidote wood', ***kayuh unun sigup*** 'tobacco cure wood', and ***akau unun sigup*** 'tobacco cure vine': descriptions rather than proper names (Berlin *et al.* 1974:49-51). In some cases synonyms exist. For example, the weed *Sciaphila* is commonly known as ***penawar racun*** 'poison cure', but the name ***piurag*** is also used by some informants. Similarly, ***akau unun sigup*** may refer to the plant known as ***akau kapal*** (*Luvunga* sp.).

A small fraction of plants were identified below the basic naming level. As can be seen in Table 3, 152-170 named folk categories were identified in each of the surveys, but 17-28 of these are classified below the basic level. For example, two kinds of ***jimpalang*** were identified in plot 2 by Umpoh: 'small-leafed' (*Vitex vestita* Wall., Verbenaceae) and 'large-leafed' (*Barringtonia lanceolata* [Ridley] Payens, Lecythidaceae). Umpoh also found three kinds of ***benawar*** in the same plot: 'red' ***benawar***, 'white' ***benawar***, and 'hill' ***benawar***. Of the 158 categories he named in this plot, only 132 different basic categories are indicated. This corresponds well to the results of the inventory made by Gumpol of an adjacent quadrat of plot 2, in which 156 categories were identified, including 139 basic categories. In all cases, about 12% of all categories are below the basic naming level.

This figure is somewhat less than the 18-20% of polytypic generic taxa in folk biological classification estimated by Berlin (1992:123) for horticultural peoples. Our lower proportion of polytypic to monotypic taxa may be explained by the fact that the areas surveyed were all untreated, and thus were not subject to recent human interference. Although the surveyed grounds contained plants that may have been saved from previous destruction in shifting cultivation, they contained no deliberately planted species. According to Berlin, it is these managed species that are particularly prone to polytypy. Thus, our quadrat studies do not reflect the full compass of Dusun ethnobotanical classificatory knowledge.

The most differentiated basic category is that labelled ***ubor,*** referring to a number of *Eugenia* and *Syzigium* species (Myrtaceae).[12] In all, 12 kinds of ***ubor*** were identified by the two informants in the surveys, the unmarked reference type ***(ubor),*** plus 11 contrasting marked subcategories.

The differences between the two informants are instructive. Umpoh, who was also the main informant used in the voucher collection phase of the study, was meticulously thorough in counting plants, which partly explains why he counted almost five times as many plants in plot 2, and 2.9 times as many plants in plot 1, as Gumpol, despite the fact that he surveyed areas only twice as large in both cases. Greater densities of plants classified as "large" are also found in Umpoh's surveys, particularly for plot 2. But a slightly higher fraction of plants are categorized as large in both of Gumpol's surveys than in Umpoh's.

Umpoh was unable to identify a large number of plants, particularly those he categorized as ***usak*** 'flower', suggesting that he was using this term in a residual sense (Hunn 1977:57-58; Hunn 1982:834-835; Taylor 1990:64-65; Ellen 1993:83). As can be seen from Table 4, he found 113 unknown ***usak*** in Plot 1 plus two for which he had forgotten the names, and 35 unknown ***usak*** in plot 2. Gumpol, on the other hand, identified no plants in either patch he surveyed as unknown or forgotten ***usak.*** In the other plant categories, too, the greater breadth of Gumpol's knowledge compared with Umpoh's is evident, though, as noted, Umpoh appears to have been more thorough in counting plants, and this may account, in part, for the discrepancy. Moreover, very few Dusun individuals could recognize as many plants as Umpoh, and those who did lacked the stamina, patience, or eyesight needed to undertake the strenuous and tedious work of surveying the plots. Umpoh, who provided basic names for 86 to 88% of plants, can be said to be about 90% as competent in terms of supplying names as Gumpol.[13] His rate of failure to identify plants by basic names was three times as great as Gumpol's. However, it cannot be automatically concluded that these measures reflect their overall ethnobotanical knowledge.

PLACING VALUE ON FOREST

One of the factors which initially drew us towards the use of plot surveys was the debate on the valuation of tropical rainforest, and of attempts to place values on specific delineated patches (Peters, Gentry, and Mendelsohn 1989).

Let us turn now to the makeup of the areas surveyed in terms of the usefulness of plants identified.[14] We have already noted that the admittedly crude category of "large plants" (mainly mature trees) corresponds approximately to those regarded by our informants as useful in their observed state. In other words, immature plants are less useful than mature plants. By looking, therefore, at the figures for "large" plants compared to those for all plants assessed in the study, we can see what trees and other plants are of use at the present time or at some time in the future, and in what numbers. It was interesting to discover that the number of such plants in proportion to the total number of plants in the ***gapu'*** 'recent secondary growth' plots was about double that in the ***entalun*** 'old secondary growth' plots. The informants found 10.2% and 7.6% "large" plants in the ***entalun*** survey, but 17.7% and 16.3% in the ***gapu'*** survey. These findings are particularly striking, in the context of the debate on the valuation of tropical rainforests (Peters, Gentry, and Mendelsohn 1989), because they are the opposite of what we might have expected, namely that older forest contains a higher density of larger, and therefore more useful, trees.

Some variation between the plots can be seen in Table 5, in which the five most commonly named plants in one informant's surveys are ranked and keyed against the ranking (in parentheses) of that same plant in the other informant's survey for the same plot. While the rankings within plots 1 and 2 for the total number of plants are very similar for both informants, there is quite a divergence in the rankings for large plants. In part, this may be explained by Umpoh's inability to provide many basic names, especially for small plants.

TABLE 5.—Ranking and use of the five most common plants: Old forest and secondary forest compared.

Plot 1, ***Gapu'*** '20-year regrowth' survey, ranked according to Umpoh's survey, all plants.

Rank	Name	Identification	Frequency —Umpoh	Frequency —Gumpol	Uses
1	***tawir***	*Fordida splendidissima*	267	140(1)	firewood, medicinal, calendrical
2	***lamba***	*Curculigo villosa*	252	uncounted	vegetable
3	***julok***	*Lepisantes fruticosa*	195	77(3)	edible fruit and leaves
4	***leginit***	*Ficus uncinata*	114	52(4)	edible fruit
5	***lalet manuk***	*Leptonychia heteroclita*	89	79(2)	medicinal leaves

Plot 1, ***Gapu'*** '20-year regrowth' survey, ranked according to Umpoh's survey, large plants only.

Rank	Name	Identification	Frequency —Umpoh	Frequency —Gumpol	Uses
1	***uwai selika***	*Korthalsia jala*	35	1(31)	frame for carrying basket
2	***leginit***	*Ficus uncinata*	30	10(3)	edible fruit
3	***pawu***	*Euodia*	26	8(5)	none
4	***tembagan***	*Artocarpus elasticus*	22	2(19)	bark for straps
4	***benawar bukid***	*Pternandra*	22	10(3)	firewood

TABLE 5.—Continued.

Plot 2, ***Entalun*** 'old secondary growth' survey, ranked according to Gumpol's survey, all plants.

Rank	Name	Identification	Frequency —Umpoh	Frequency —Gumpol	Uses
1	***tawir***	*Fordida splendidissima*	241(3)	141	firewood, medicinal, calendrical
2	***julok***	*Lepisantes fruticosa*	396(2)	67	edible fruit and leaves
3	***ubor***	*Syzygium* or *Eugenia*	897(1)	66	dye for fish net
4	***uwai buluh giok***	*Calamus sarawakensis*	181(4)	49	tying
5	***tisil***	*Urophyllum*	90(11)	44	none except firewood

Plot 2, ***Entalun*** 'old secondary growth' survey, ranked according to Gumpol's survey, large plants only.

Rank	Name	Identification	Frequency —Umpoh	Frequency —Gumpol	Uses
1	***tawir***	*Fordida splendidissima*	27(2)	18	firewood, medicinal, calendrical
2	***royon***	(unidentified)	9(8)	12	house frames
3	***tisil***	*Urophyllum*	3(27)	11	none except firewood
4	***libas ropungur***	*Sauropus?*	29(1)	10	firewood, houseposts
4	***sarapa'***	(unidentified)	12(5)	10	eaten with Piper beetle

We will concentrate further on the five most common plants in Umpoh's Plot 2 surveys and Gumpol's Plot 1 survey, shown in Table 5. By considering only the five most common plants in each group it is possible to capture a surprisingly high percentage of plants in the plots as a whole. In both plots 1 and 2, the five most prevalent plant names account for slightly more than 30% of all plants. The frequencies for the 25 most commonly occurring plant categories in the two plots, illustrated in the histograms in Figures 4 and 5, show reverse J-curves representing the pronounced fall-off from initial high frequencies.

When we look at "large" plants there is more variation. In plot 1, the ***gapu'*** plot, 28.4% of large plants in the area surveyed (37.6% of those identified) by Umpoh were in the top five, compared to 36.0% in the area surveyed and identified by Gumpol. Turning to Gumpol's survey of plot 2, the five most common large plants totalled 61, accounting for over 53% of all large plants (56.5% of identified plants) counted in the survey. In Umpoh's plot 2 survey, by comparison, the first five named plants[15] totalled 117, and accounted for only 29.4% of large plants enumerated (33.8% of those identified) by Umpoh in that plot. It must be noted that "unknown ***kayuh***" and "unknown ***akau***" together account for 10.3% of large plants surveyed by Umpoh in plot 2, and ***kayuh*** and ***akau*** for which basic names have

FIGURE 4.—Frequency of the 25 most common identified plants in Umpoh's plot 1 *(Gapu')* survey

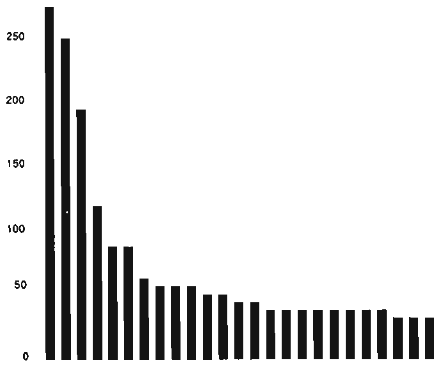
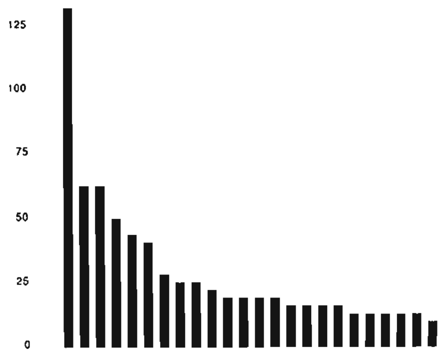


FIGURE 5.—Frequency of the 25 most common identified plants in Gumpol's plot 2 *(Entalun)* survey

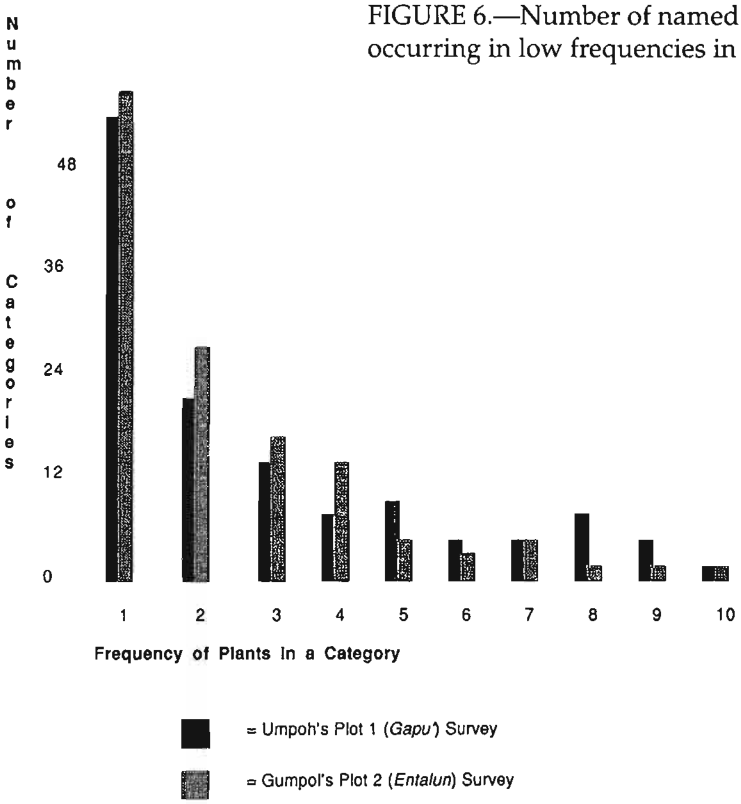


been forgotten account for another 3.0%. Apart from the high proportion of large plants in Gumpol's plot 2 survey, the figures are quite consistent with the generalization that the five most common plant categories, regardless of size, account for about 30% or slightly more of the plants in a plot. This observation can be tested empirically through further use of the plot survey methods described here.

The inverse of this finding is that a large number of plant types are sparsely distributed, and have only a few representatives in a plot. In Gumpol's plot 2 survey, 56 named kinds of plants had only one representative, while another 27 had two. The total kinds of plants represented by only one or two individuals (83), is about half the number of named categories found in the survey (83/156 = 0.54). This relationship holds in Umpoh's survey of plot 1, in which 49 named categories were found only once, and another 21 were found twice, which together are nearly half (70/170 = 0.41) of the categories enumerated in the survey. The long tails of the frequency charts illustrated in Figures 4 and 5 can be seen in Figure 6, showing that, in both surveys under inspection, increasing numbers of taxa are represented by ever fewer individuals.

As far as the most inclusive categories are concerned, Table 5 shows that tree *(kayuh)* is the most common, as in the ethnobotanical voucher data. However, rattan *(uwai)* is the fourth most common plant in Gumpol's plot 2 survey and the most common large plant in Umpoh's plot 1 survey. ***Lamba,*** which is classified in the problematical categories ***sancam*** (vegetable) and ***raun*** (leaf), is the second most common plant in Umpoh's plot 1 survey. Also, among those plants not in the first five most common categories, many non-***kayuh*** plants feature. For example, in Gumpol's survey of plot 2, the top fifteen plants identified at the basic level include three ***akau*** and three ***uwai;*** Umpoh's survey of plot 1 includes in the top fifteen three ***akau*** and one ***uwai.***

FIGURE 6.—Number of named plant categories occurring in low frequencies in two plots



Let us now consider the use-values of the five most common plants in all categories. Table 5 indicates a range of uses mentioned for each plant, but none of the first five most common plants are especially valued, using any measure. Two exceptions are ***uwai selika*** (*Korthalsia ferox* Becc.), a useful rattan cord, though not regarded as the best, and ***royon*** (unidentified), a preferred wood for house construction. The other plants are of less value, some much less. For example, while it is true that the fruit of the ***leginit*** (*Ficus uncinata* [King] Becc.) tree is edible, it is not especially collectable or marketable. Similarly, the root of the ***tawir*** tree (*Fordia splendidissima* [Miq.] Buijsen) is medicinal, but very few people know of this use or would make or use a medicine from it if they did. And while ***sarapa*** (unidentified) is an important ingredient in the ***betel*** quid and is thus useful for habitual ***betel*** chewers, the tree is common and not highly valued. Many valuable fruit trees, hardwoods, and other economic products are found in small numbers within the small patches we surveyed.

The clearest finding concerning the value of the ***entalun*** patch is the high number of economically useful ***royon*** trees in proportion to their total number in the patch (12 of 13), while the useful rattan ***uwai buluh giok*** (*Calamus sarawakensis* Becc.) is found in high absolute numbers (49), though only two, or four percent, were of sufficient maturity to be worth extracting. In the ***gapu'*** survey we find large numbers of the edible but not highly valued ***lamba*** (*Curculigio villosa* [Kurz] Merrill). Among the harvestable plants in this patch are 35 valued ***uwai selika*** rattans (*Korthalsia ferox* Becc.). Both plots are characterized by an abundance of ***tawir*** (*Fordia splendidissima* [Miq.] Buijsen) and ***julok*** (*Lepisantes fruticosa* [Roxb.] Leenh.) trees.

CONCLUSION

Plot surveys have a long history in quantitative ecology, and have been used in rainforest research for more than half a century. However, in ethnobotany they are relatively novel. In this paper we have described a technique using plot surveys to measure the ethnobotanical knowledge individual informants have of particular patches of forest.

By using the plot method Bernstein and Antaran were able to measure the completeness of their herbarium collection, and supplement the database with information on 132 kinds of plants that had not been otherwise collected, but which had been identified by informants in the surveys. In most cases the plants matched those found elsewhere for which voucher specimens were available. (As few species in the plots yielded fertile specimens, the collection of vouchers in any case would not anyway have provided firm determinations.) The same technique also provides a rapid means of assessing local ecological diversity using folk terms keyed to determinations obtained through the systematic collection of voucher specimens. Of course, folk-botanical nomenclature does not correspond perfectly with scientific determinations, and informants cannot always provide names and may be inconsistent or wrong in their judgment. Nevertheless, such a method is less time-consuming than the possible alternatives, and is sufficiently precise for many useful applications. It might well complement other participatory rural appraisal (PRA) and rapid rural appraisal (RRA) techniques.

Our principal discovery, however, has been the utility of plot surveys as an instrument for the study of ethnobotanical classification. Knowledgeable but non-literate Dusun informants provided names (other than life-forms or the most general basic and intermediate categories) for 85.6-96.4% of plants growing in marked plots. Of those plants named, the more expert of our two informants provided 158 names in two plots (each 24x24 m) of secondary dipterocarp forest totalling 1152 m^2, 88% of the names being at the basic naming level and 12% below. Furthermore, informants found little difficulty in allocating both named and un-named plants to more-inclusive, life-form-like and intermediate groupings. The rank order of numbers of identifiable plants per category varied depending on whether all plants, or only those of sufficient size to be useful, were counted. We have also found that in each of the plots examined the five most common folk categories of plants account for about a third of all enumerated plants. Plants occurring only once or twice in a plot account for about half of all named plants.

Although our survey dataset is small, we believe it indicates a new way of measuring the comprehensiveness of local knowledge of plants with reference to all types found within the boundaries of specified sample plots in locally recognized biotopes, and provides a useful angle on the question of the empirical "adequacy" of such knowledge when compared with existing measures, such as that based on the correspondence of folk categories to scientific species. The surveys also reveal the breadth of biodiversity knowledge of particular types of forest, highlight differences in the knowledge of individual informants, and the ways in which that knowledge is organized. In turn, this sheds light on the uneven character of indigenous knowledge distribution and how this relates to the intrinsic patchiness of species distribution.

NOTES

[1]For a classic statement on method see Berlin, Breedlove, and Raven 1974:46-61. For older accounts of conventional ethnobotanical collecting techniques, see e.g., Barrau n.d.; Parham 1955. Since this research was completed, information on the methodology of ethnobotanical studies has been synthesized and substantially updated by the publication of a methods manual by Martin (1995).

[2]See Peranio (1972, 1976, 1977). The Brunei Dusun are distinct from another ethnic grouping, indigenous to Sabah (another part of northern Borneo), also known as Dusun (see Appell 1978; Appell and Harrison 1968). The dialect spoken by the Dusun of Kuala Penyu in Sabah is very close to Bisaya (Roger Peranio, personal communication). While similarities in ritual and folklore suggests a relationship between the "Dusunic peoples" of Sabah and the Brunei Dusun, the exact nature of the connection between them has not been demonstrated.

[3]See Cranbrook and Edwards (1994) for a report on an interdisciplinary study of the rainforest in the Batu Apoi Forest Reserve at Kuala Belalong in Brunei.

[4]For an excellent summary of recent use of plot surveys in ethnobotany and for a discussion of field techniques published since we conducted our own study see Martin (1995:156-9).

[5]This part of the Middle Tutong Plain is characterized by Quarternary alluvium consisting of clays and loams, sand, and gravelstone sometimes overlain by swamps (Franz 1980:34-35; Wilford 1961).

[6]By comparison, Balick and Mendelsohn (1992) surveyed 2 plots, one 0.28 and one 0.25 ha; while Peters, Gentry, and Mendelsohn (1989) undertook a systematic botanical inventory of 1.0 ha of forest.

[7]Other miniscule plants occurring in large numbers in some surveys, and thus not counted, include ***natu gapu*** *(Araceae)* and ***akau genonop*** *(Jacquemontia tomentella)*.

[8]Our two informants did not always agree on plant names. Disregarding synonyms which both informants recognized, we estimate that informants provided different basic names for approximately one-two percent of the plants identified. This estimate is based in part on discrepancies in the identification of plants collected as herbarium specimens.

[9]Ellen (1993:65) has distinguished identification from classification on the grounds that though both entail class inclusion, the distinction is one recognized in many languages and, pragmatically, by local experts. Thus, an informant may "know" that a certain plant is a distinctive "kind of" ***akau*** (classification) yet be unable to provide a label or relate it to something identical he or she has seen (identification).

[10]A possible explanation for this phenomenon is that ***tumid*** is a polysemous term referring to taxa at two levels of inclusiveness: ***tumid***$_1$ refers to the plant category including ***kunyit,***

sagang, and ***sumbang*** and ***tumid***$_2$ refers more specifically to plants contrasting with ***kunyit, sagang,*** and ***sumbang,*** within this category. The alternative explanation is that the term for one sub-category of ginger plants is used casually to label various other kinds of gingers in the absence of a fully acceptable overall cover term.

[11] Both Hunn (1982) and Turner (1974) have described similar instances of "empty" spaces within life-forms.

[12]*Syzigium* is often included within *Eugenia*, but this is a point on which taxonomists differ, and "the differences between *Syzigium* and *Eugenia* are obscure" (Forest Department 1978:174).

[13]In plot 1, Umpoh identified 85.6% as against Gumpol's 96.4%: 0.856 ÷ 0.964 = 0.888. For plot 2, Umpoh identified 86.9%, as against Gumpol's 95.4%: 0.869 ÷ 0.954 = 0.911.

[14]Voeks (1994) describes a use of the plot survey method to elicit information specifically about the utility of rainforest plants among settled Penan (former subsistence hunter gatherers) in Brunei. Voeks' 44 year-old Penan informant recognized a total of 53 useful species in a 0.96 ha mixed dipterocarp plot, out of about 300 species of trees over 5 cm dbh.

[15]***Libas gapunguh*** (29), ***tawir*** (27), ***ubor*** (25), ***semerutu*** (24), and ***teratus*** (12).

ACKNOWLEDGEMENTS

The research reported here was undertaken as part of a project entitled "The Ecology and Ethnobiology of Human-rainforest Interaction in Brunei," organized jointly by the University of Kent at Canterbury and the Brunei Museum, and funded by the Economic and Social Research Council (R000 23 3088), with additional support from the British Academy and the British Council. We would like to thank the Brunei Forestry Centre, the Royal Botanic Gardens at Kew (particularly Dr. John Dransfield), the Tutong District Office, and the people of Kampong Merimbun for their cooperation.

An earlier version of this paper, entitled "Rainforest Ethno-ecology of the Brunei Dusun," was presented by J. H. Bernstein at a conference on "The Environment in Southeast Asia" held at the Royal Holloway College by the Association of South-East Asian Studies in the United Kingdom, March 1994. We thank Dr. Robert Voeks for his extensive and very helpful comments on an earlier draft, and the editor and reviewers of this journal for their suggestions for revision.

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