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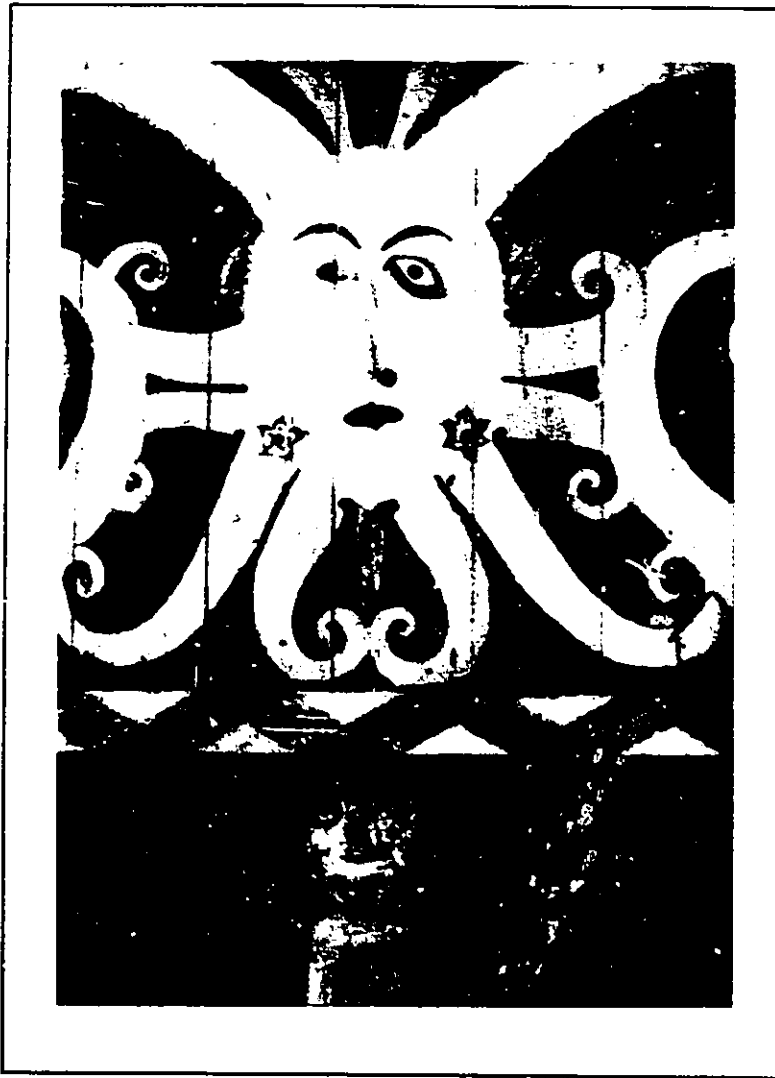
To the Kenyah, who  
petawei tuban tung udu ia majan  
(remember the medicinal plants used before)

and

to Mrs Rollo Keithahn,  
my grade 10 biology instructor,  
for encouraging revelations of extraordinary science in  
ordinary life, particularly when it involved  
losing ant colonies in filing cabinets

and

to my parents,  
for life filled with interest.



Dayak religion cannot be dismissed as superstition, nor does it encourage fear and anguish of the supernatural; still less does it cultivate fatalism. It is a rational response to the world in which rainforest dwellers live; it helps them to explain and come to terms with nature; it helps give meaning to existence; it is born out of contemplation of life and nature; it is a stimulus to further knowledge. Like all humans the Dayaks search for physical, psychological and a measure of material well-being. Much of Dayak thought and ritual is therefore concerned with the maintenance and promotion of life in its widest sense.

Victor King, *The Peoples of Borneo*

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I hope this work will contribute to the well-being of the Apo Kayan communities, not only by helping to revive a local interest in the science of traditional medicines, but also by lending support to local efforts to benefit from the best possible combination of the ancient and modern in science, health, and culture, that life can offer.

A pressing concern in conducting ethnobotanical research is the potential to do harm rather than good by appropriating knowledge that rightly belongs to those who developed it over years of trial and error and passing on from generation to generation. The knowledge reported in this document is the property of the Kenyah, and is reported here with the consent of councils of elders in the three villages surveyed. Knowledge of some remedies has traditionally been kept secret by individuals, in part to preserve an exclusive ownership of a body of knowledge, and in part because secrecy was believed to preserve the strength of the cure against the agents of disease and harm. As one of the most knowledgeable herbalists explained, the information reported

in this study would have remained secret had the local systems of belief and practice not changed so radically in recent years. Among the elders are some who prefer to preserve the secrecy of their own knowledge. I wish here to acknowledge and respect their right to do so.

My first visit to the Apo Kayan in October of 1988 was in the company of my friend and colleague Herwasono Soedjito. He had participated in a multi-disciplinary research programme, supported by the Man and the Biosphere Programme of the United Nations Educational, Scientific, and Cultural Organisation (UNESCO), to investigate the ecological interactions between people and forests in East Kalimantan. I owe my own warm reception into the Apo Kayan communities to the integrity and sensitivity of Herwasono and his colleagues Timothy Jessup, Cynthia Mackie, Harini Sangat-Roemantyo, Kuswata Kartawinata, and others. Their work provided a context and foundation for my own study of Kenyah ethnobotany.

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## ABSTRACT

The hypothesis that plant materials are selected and valued for use in traditional remedies based on their biological activity was examined in the context of the health, culture, and environment of the Kenyah people of the Apo Kayan Plateau, East Kalimantan, Indonesian Borneo. In an ethnobotanical survey conducted in three Kenyah villages in the Apo Kayan, 403 remedies involving 203 species of plants were documented. Locally important remedies and taxa were identified, and the distribution of knowledge within the Kenyah communities was evaluated using a new quantitative medicinal importance value index based on consensus.

Plants with a high importance value as malaria remedies ( $IV_{mal}$ ) produced extracts that inhibited cultured *Plasmodium falciparum* more effectively than extracts of remedies with low  $IV_{mal}$  and control plants. Several species were identified for further research directed toward safe and effective treatments for malaria.

The relationship between Kenyah selection of medicinal materials from the surrounding Apo Kayan flora according to locally defined plant attributes, their medicinal importance value (IV), and biological activity was investigated through field bioassays for larvicidal, antifungal, and phototoxic activity using brine shrimp (*Artemia salina* Leach) and brewer's yeast (*Saccharomyces cerevisiae*). The distribution of biological activity within the medicinal flora suggests selection by the Kenyah for antifungal activity. Within the medicinally used flora, biologically active tissues are selected over inactive tissues. Biological activity is significantly related to medicinal importance value (IV) at the levels of plant part ( $r^2 = .64$ ;  $P < .05$ ) and species ( $r^2 = .64$ ;  $P < .01$ ), and selection frequency is significantly related to biological activity at the level of taxonomic

superorder ( $r^2 = .32$ ;  $P = .01$ ). Primary and secondary forest species are exceptionally active.

A model combining traditional science and modern science to identify priorities for research on safe and effective uses of traditional remedies, and conservation of medicinal plant and animal resources, is proposed.

## RÉSUMÉ

Dans un contexte de santé, de culture et d'environnement des peuplades Kenyah du plateau Apo Kayan dans l'Est du Kalimantan au Bornéo Indonésien, nous avons testé l'hypothèse selon laquelle la sélection des parties des plantes, et la valeur qui leur est accordée dans les remèdes traditionnels, sont basées sur leur activité biologique. Ceci est documenté par l'étude ethnobotanique conduite dans trois villages Kenyahs de l'Apo Kayan, rassemblant 403 remèdes et 203 espèces de plantes. L'utilisation d'un nouvel index quantitatif de valeur d'importance médicinale, basé sur un consensus, a permis d'identifier les remèdes et les taxa d'importance locale, ainsi que d'évaluer la distribution des connaissances au sein des communautés Kenyah.

Les plantes à haute valeur d'importance médicinale, comme les remèdes contre la malaria ( $IV_{mal}$ ), donnent des extraits qui inhibent les cultures de *Plasmodium falciparum* avec une plus grande efficacité que les extraits des plantes à faible  $IV_{mal}$  et que les extraits des plantes contrôles. Nous avons pu identifier ainsi plusieurs espèces de plantes cibles pour une recherche ultérieure de traitements sûrs et efficaces contre la malaria.

Pour étudier la relation entre l'activité biologique et la sélection par les Kenyahs des matériaux au sein de la flore Apo Kayan environnante, telle que définie localement par les caractéristiques des plantes et leur valeur d'importance médicinale, nous avons testé leur activité larvicide, antifongique et phototoxique à l'aide de la crevette (*Artemia salina* Leach) et de la levure de boulanger (*Saccaromyces cerevisiae*). La distribution de l'activité biologique au sein de la flore médicinale suggère une sélection par les Kenyahs de l'activité antifongique. Au

sein de la flore médicinale utilisée, il y a sélection des tissus avec activité biologique plutôt que des tissus inactifs. Il existe une relation significative entre l'activité biologique et la valeur d'importance médicinale (IV) au niveau des parties des plantes ( $r^2 = .64$ ;  $P < .05$ ) et des espèces ( $r^2 = .64$ ;  $P < .01$ ), ainsi que entre l'activité biologique et la fréquence de sélection au niveau taxonomique des Superordres ( $r^2 = .32$ ;  $P = .01$ ). Les espèces des forêts primaires sont exceptionnellement actives.

Nous proposons un modèle qui combine la science traditionnelle et la science moderne et permet d'identifier les priorités de conservation, recherche et de promotion des remèdes traditionnels.

## ABSTRAK

Tulisan ini menguji hipotesa bahwa bahan tumbuh-tumbuhan dipilih dan dinilai untuk penggunaan dalam pengobatan tradisional berdasarkan kegiatan hayatinya, dilihat dalam konteks kesehatan, budaya dan lingkungan masyarakat Kenyah di Dataran Apo Kayan, Kalimantan Timur. Survei etnobotani yang dilakukan di tiga desa Kenyah di Apo Kayan mencatat 403 cara pengobatan yang menggunakan 203 jenis tanaman. Pengidentifikasian cara pengobatan dan klasifikasi lokal yang penting juga dilakukan, serta penyebaran pengetahuan didalam masyarakat Kenyah dievaluasi menggunakan suatu indeks nilai kegunaan medis kuantitatif yang berdasarkan konsensus.

Tumbuhan dengan kegunaan tinggi seperti obat malaria ( $IV_{mal}$ ) menghasilkan ekstrak yang menghambat pertumbuhan kultur *Plasmodium falciparum* secara lebih efektif dibandingkan dengan ekstrak dari obat dengan kadar  $IV_{mal}$  rendah dan tumbuhan kontrol. Identifikasi telah dilakukan terhadap beberapa jenis sasaran untuk penelitian lebih lanjut bagi pengobatan malaria yang aman dan efektif.

Hubungan antara cara orang Kenyah melakukan penyeleksian bahan-bahan obat dari flora di lingkungan Apo Kayan menurut sifat-sifat tanaman yang ditentukan setempat, nilai guna medis (IV), dan kegiatan hayatinya diteliti melalui bioesai lapangan untuk kegiatan larvisida, antifungi, dan aktifitas fototoksik menggunakan udang air asin (*Artemia salina* Leach) dan kapang (*Saccharomyces cerevisiae*). Distribusi kegiatan hayati dengan flora medis menunjukkan adanya penyeleksian kegiatan antifungi. Dalam flora yang digunakan untuk pengobatan, jaringan yang aktif secara hayati dipisahkan dari jaringan yang tidak aktif. Kegiatan hayati nyata kaitannya dengan nilai kegunaan medis pada tingkat bagian tumbuhan ( $r^2 = .64$ );  $P < .05$ ) dan jenis ( $r^2 = .64$ ;  $P < .01$ ),

dan seleksi frekuensi nyata kaitannya dengan kegiatan hayati pada tingkat induk bangsa taksonomi ( $r^2 = .32$ ;  $P = .01$ ). Jenis hutan primer dan sekunder ditemukan sangat aktif.

Tulisan ini mengajukan suatu model yang menggabungkan pengetahuan tradisional dengan pengetahuan modern guna mengidentifikasi prioritas untuk konservasi, penelitian, dan penggalakan cara pengobatan tradisional.

## CHAPTER I

### INTRODUCTION

This report presents an analysis of the relationships between one human society, that of the Kenyah of East Kalimantan, Indonesian Borneo, and the natural environment from which their medicines are derived. The focus of the research and analysis reported here is on the biological nature of the interactions between people and the plants they use as medicines and poisons. These interactions are considered in the context of the ecological and cultural milieu in which Kenyah beliefs and practices related to health and healing have developed, and the setting in which these beliefs and practices exist today.

The research described here belongs to the field of inquiry called "ethnobotany" in that it attempts to describe and evaluate the "direct interrelations between humans and plants" (Ford 1978:44) and the "evolutionary consequences" of these relationships (Johns 1990:10). It also belongs to the field of inquiry called "chemical ecology" in its focus on biochemical interactions between organisms, in this case, plant-human interactions, apparent through field and laboratory observations (Harborne 1988).

Throughout this work, the term *traditional* is used to describe beliefs and practices informed and modified by generations of adaptation to the demands of the natural and social environment, and that are recognizable elements of a particular culture (cf., Johns 1990:2; Schmink, Redford, and Padoch 1992:7). The phrase *modern science* is used, lacking a better alternative, in reference to quantitative methods and experimental examination of falsifiable hypotheses.

### 1.1. Importance of Traditional Remedies

An important element of human adaptation to the demands and stresses of the microscopic as well as the macroscopic environment is the use of biologically active materials from the natural environment as medicines to maintain and restore health (Alland 1966; Johns 1990). All human societies use plants as medicines. Medicine is as fundamental a feature of human culture as is use of fire, tools, and speech. Having evolved over millennia, however, the knowledge, cultural traditions, and medicinal resources of many human societies, particularly those indigenous to tropical forests, are rapidly disappearing with the loss of cultural and biological diversity (Poore 1976; Ayensu 1983; Principe 1991; Schultes 1991).

The World Health Organization (WHO) estimates that traditional medicine is the major source of health care for approximately 80% of people in developing countries (Farnsworth et al. 1985). The modern development of many important drugs currently in use is based on traditional use of active principles extracted from plants (e.g., Lewis and Elvin-Lewis 1977; Farnsworth et al. 1985). Farnsworth and Soejarto (1991) list 121 chemical substances extracted from 95 plant species currently used as drugs throughout the world. The use of nearly 75% of these compounds is similar to the traditional application. Compounds from many other plant species used as traditional medicines have contributed indirectly to modern pharmacology as phytochemical leads for development of more complex drugs, as models for synthetic drugs, and as taxonomic pointers to other plant sources of useful drugs (Oldfield 1981; Plotkin 1988; Principe 1991). The use of ethnobotanical reports may increase the yield of phytochemicals active against cancer and AIDS over a random screen (Spjut and Perdue 1976; Balick 1990). More recently,

laboratory and clinical studies of traditional preparations have verified the therapeutic efficacy of many remedies, both within the cultural context of their use (e.g., Ortíz de Montellano 1975; Bannerman, Burton, and Ch'en 1983; Riddle 1985; Riddle and Estes 1992), and apart from it (e.g., Caceres et al. 1987; Caceres et al. 1991; Robineau 1991).

## 1.2. Ethnobotany and Human Chemical Ecology

Thousands of plants are known to have been used as medicines in home remedies, ritual cures, poisons, and tonics. The WHO has developed a list of 20,000 plants with potentially efficacious uses (Principe 1991). Perry and Metzger (1980) summarized the use of at least 6,500 plant species in home remedies in Asia. However, these represent a small sample of the flora available. Farnsworth and Soejarto (1991) estimated that 28% of the plant species on earth have been used as traditional medicines.

A theoretical problem central to ethnobotany is explaining how empirical knowledge of plant uses originates (Ford 1981; Johns 1990); i.e., What is the basis for selection and use of plants by humans as medicine? (Throughout this report, *selection* is meant principally as the human expression of choice, rather than in the evolutionary sense of differential reproductive rates of phenotypes.) Much of the ethnobotanical and ethnopharmacological literature attempts to answer this question indirectly. Etkin (1988), for example, proposed that selection of medicinal plants is not merely a function of epidemiological patterns, and diversity and availability of local flora and fauna, but also of cultural attitudes about treatment and expectations of outcome. Selection of medicinal plants in traditional medicine is also assumed to result from a rational

appreciation of the beneficial or harmful effects of plant treatments on human health. Phytochemical and pharmacological evaluation of the relationships between traditional use and biological activity suggests a rational basis for traditional knowledge of medicinal plants (e.g., Arnason, Hebda, and Johns 1981; Trotter and Logan 1986; Marles 1988; Etkin and Ross 1991). This understanding is indicated not only by non-random selection of medicinal plants (Moerman 1991), but also by preferences for plant parts used, collecting times and locations (Croom 1983), and methods of preparation and application (Johns 1990).

Johns (1990) has proposed that the ecological origin of human systems of medicine was the manipulation by primates of plant toxicity to pathogens and parasites (e.g., Wrangham and Nishida 1983), and presents a model of human chemical ecology featuring "the three-way interaction between body, pathogen, and plant chemical" as "the probable basis for herbal medicine and modern pharmacology" (Johns 1990:22). The active principles of plant-based medicines are secondary metabolites, compounds that are biosynthetically derived from primary metabolites but have no apparent function in primary metabolic processes such as photosynthesis, mineral nutrition, and carbohydrate metabolism. Biologically active secondary metabolites are believed to have evolved in plants as chemical defenses against attack by herbivores and pathogens, and such compounds have been shown to have a broad range of inhibitory, pharmacological, and toxic effects (Rosenthal and Janzen 1979; Luckner 1984; Harborne 1988).

Among the main premises of Johns' model of human chemical ecology is that cultural traits are powerful forces of selection in human interactions with plant chemical constituents (Johns 1990). In the work described here, this premise will be examined by considering the relationship

between human choice (indicated by selection), importance (indicated by consensus), and biological activity of medicinal plants.

### **1.3. Quantitative Methods in Ethnobotany**

A current focus of ethnobotanical research is the development and application of quantitative techniques for assessing the relative value of plants to the people who use them, based on degree of consensus among users. These techniques, recently reviewed by Phillips and Gentry (1993), provide tools for quantitative analysis of ethnobotanical survey data and a means of identifying targets and priorities for further research. Although it has been argued that careful documentation is sufficient to advance hypotheses in ethnobiological research (e.g., Posey 1992), quantitative methods enable the examination of falsifiable hypotheses about traditional science and its relationship to modern science. Accelerating loss of indigenous cultures, traditional knowledge, and biotic diversity make these approaches exceptionally relevant.

### **1.4. Hypothesis and Objectives of the Study**

The principal hypothesis examined in this research is that plant materials are selected and valued for use in traditional remedies based on the biological activity of these materials. This hypothesis is examined by means of the following specific objectives:

1. to describe Kenyah knowledge of plants as medicines in the context of health, culture, and environment (chapters 2 and 3);

2. to quantify the relative importance of Kenyah remedies (Chapter 3);
3. to evaluate the relationship between the relative importance and potential therapeutic efficacy of Kenyah remedies for malaria, an ailment that affects the health and livelihoods of many Kenyah (Chapter 4);
4. to examine the relationship between biological activity in the Kenyah medicinal flora and the non-medicinal flora of the Apo Kayan (Chapter 5); and
5. to compare patterns of Kenyah preference for particular plant attributes in traditional remedies with the distribution of biological activity among these attributes in the medicinal flora (Chapter 5).

The research reported here also has a management and conservation objective, which is:

6. to propose a model combining traditional and modern science to derive culturally and biologically relevant criteria for (a) safe and effective remedies for continued local use and possible promotion elsewhere; (b) unsafe or ineffective remedies; and (c) conservation and management concerns about the continued availability of useful remedies (Chapter 6).

**CHAPTER 2**  
**THE APO KAYAN AND THE KENYAH**  
**IN THE CONTEXT OF BORNEO AND ITS PEOPLES**

**2.1. The Borneo Flora**

The island of Borneo lies within the biogeographic region known as Sundaland, which also includes the islands of Java, Sumatra, and Palawan, and the Malay peninsula on the Sunda continental shelf (Ashton 1989). There are strong similarities between the flora and fauna of the islands and the continental landmasses of this region, and distinct dissimilarities to the landmasses of the Sahul shelf, chiefly to New Guinea and Australia, from which they are divided by a deep submarine trench (Whitmore 1984).

Borneo is included within the Indo-Malayan block of tropical rainforest and within the Malesian phytogeographic region delimited by the Isthmus of Kra, the Bashi Channel, and the Torres Strait (van Steenis 1950; Whitmore 1984). Jacobs (1974) estimated that the Malesian region contains 25,000 to 30,000 species of flowering plants, representing more than half the families, one quarter of the genera, and more than one tenth of the species known on earth.

The flora of Borneo is considered among the richest in the world (Whitmore 1984) and the richest in species of the Sunda islands (Ashton 1989). Borneo is thought to support 9000 to 15,000 species of seed plants, of which nearly 50% may be endemic (Merrill 1921; Kiew 1984; Ashton 1989). The large degree of floristic diversity and endemism is attributed in part to extraordinary habitat diversity on the island, and in part to conditions leading to speciation during the Pleistocene, when Borneo is believed to have

provided a refuge for Laurasian/Malesian species (Ashton 1989).

Merrill (1921) listed 4924 species of flowering plants and gymnosperms found in Borneo. Masamune (1942) listed 7201 species of angiosperms and gymnosperms, as well as a supplementary inventory of ferns (Masamune 1945). This literature has been reviewed by Burley (1990), who estimated that at least 15% of the Borneo flora is undescribed.

Most botanical study and collecting in Kalimantan (Indonesian Borneo) has been done in the lowland areas; the less accessible upland forests have never been surveyed thoroughly. Kalimantan's 540,000 km<sup>2</sup> make up three-quarters of the land area of Borneo, but the flora is more poorly known than that of Sabah, Sarawak, and Brunei. The region is believed to contain exceptional levels of species and ecosystem diversity, rare species, and endemics (MacKinnon and MacKinnon 1986). Ashton (1989) and Burley (1990) included Kalimantan among the least adequately collected areas in the world.

Comprehensive lists of Borneo fauna include descriptions of approximately 221 species of wild land mammals, nearly half of which are bats, as well as some domesticated and marine mammals (Payne, Francis, and Phillips 1985). A recently revised treatment of Borneo bird species is found in Smythies (1981).

## **2.2. The Apo Kayan Plateau (the Study Site)**

The Apo Kayan is a hilly plateau at the headwaters of the Kayan River in the centre of the island of Borneo, approximately 2°N latitude, 115°E longitude, within Bulongan district (*kabupaten*), East Kalimantan province, Indonesia

(Figure 2.1). The region is located to the north and east of the Müller and Iran mountain ranges on the borders of Central Kalimantan (Kalimantan Tengah) and Sarawak (Malaysia). Elevations range from 450 to 2000 meters above sea level (Soedjito 1986). Long Sungai Barang, the principal site of the present study, is located at approximately 800 m. The regional climate is continuously wet, although there is a drier period (*kamerau*) in July and August (Directorate of Land Use 1981; Voss 1982). Rainfall in the Apo Kayan is approximately 4000 mm per year; mean daily temperature at Long Sungai Barang is 20° C, fluctuating between 15 and 25° C (Soedjito 1986).

Vegetation in the Apo Kayan encompasses approximately 10,000 km<sup>2</sup> of montane forest rich in the families Fagaceae, Myrtaceae, and some Dipterocarpaceae, interspersed with patches of heath (*kerangas*) forest on acidic, nutrient-poor, white sandy soils (podzols). Near settlements, on relatively good soils (red-yellow podzolic, or latisols), there is a mosaic of forest age classes, old and new fields, and cultivated gardens (Kartawinata and Vayda 1984; Soedjito 1984, 1986).

### 2.3. Borneo Peoples

The aboriginal peoples of Borneo comprise an extraordinary diversity of ethnic and social groups, based on often confusing and ambiguous cultural, linguistic, and geographic relationships. These groups have been divided by ethnographers into three principal categories: Dayak, Punan, and Malay (Hose 1926; Avé and King 1986). Dayak is a collective term that refers to inland tribal peoples who live along rivers in longhouse settlements and are primarily swidden (slash and burn) agriculturists. Punan (also Penan) is a collective term for small groups of forest nomads who

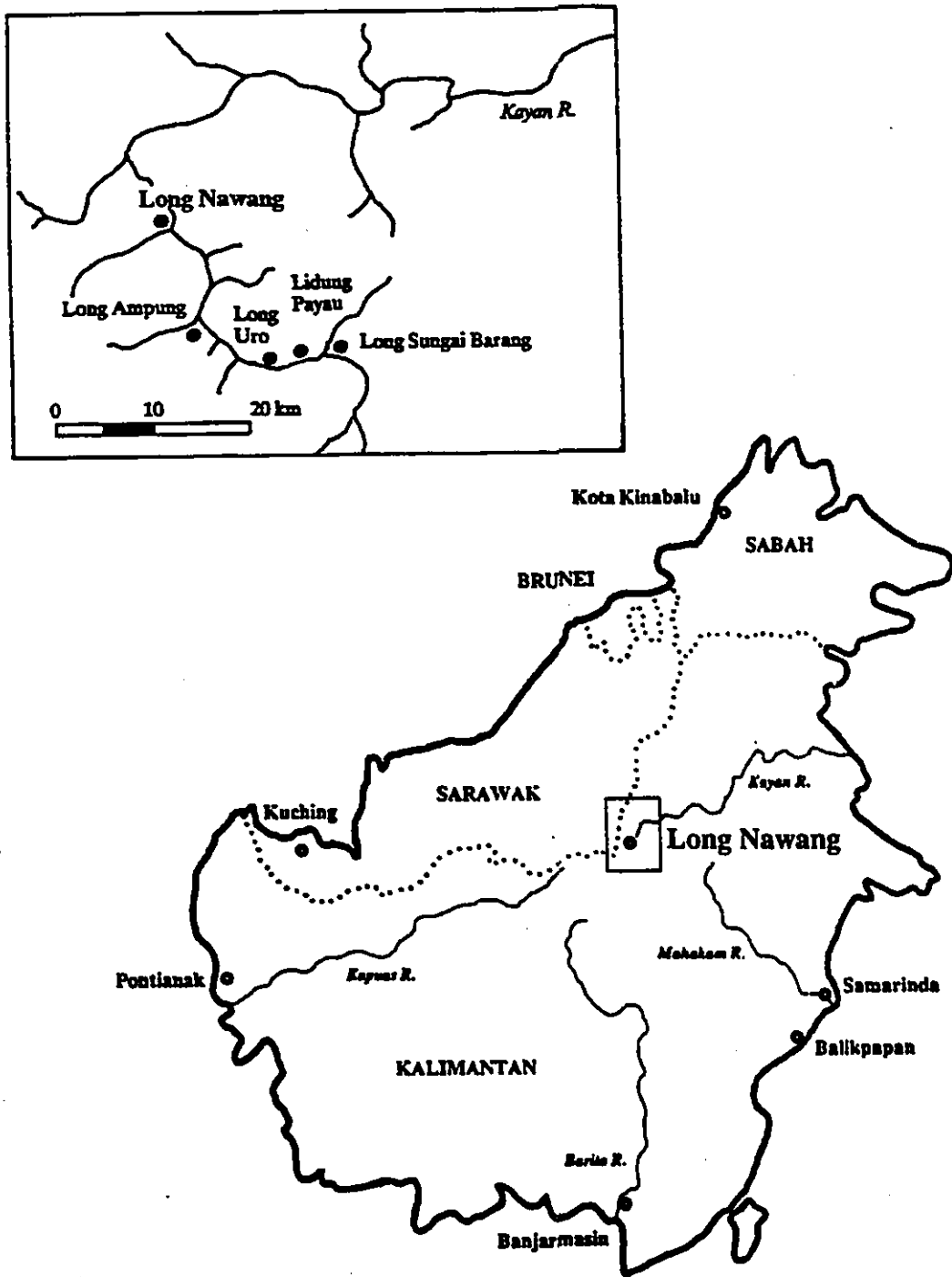


Figure 2.1. Island of Borneo and Apo Kayan Plateau (inset)

are primarily hunters and gatherers of forest produce. The term *Malay* generally refers to coastal groups that speak Malay, practice the Islamic faith, and have an economy based on sea-fishing, trade, and cultivation of wetland rice and plantation crops.

Recent anthropological studies have revealed that these collective terms obscure important differences in origin, culture, social organization, and economy not only among the specific ethnic groups included within the larger categories, but also between ethnic groups in different categories (Rousseau 1990, Hoffman 1986, Avé and King 1986; Sellato 1994). Among the central Borneo peoples, for example, Kayan communities are largely homogeneous in culture and language, while Kenyah communities can be more different from each other than from other Dayak or Punan groups with whom they have traded or lived in close proximity (Rousseau 1990; Sellato 1994).

Dayak and Punan groups speak a variety of related languages that are Malayo-Polynesian in origin, and share a tradition of customary practices and beliefs that historically included taking omens from the behaviour of birds and animals, head-hunting, and belief in a largely malevolent spirit world (Avé and King 1986; King 1993).

### *The Kenyah*

Among the many peoples who occupy the mountainous interior of Borneo, the Kenyah are one of the most numerous and diverse. There are approximately 40,000 Kenyah in Borneo. Most live in the Kayan River basin and its tributaries in East Kalimantan; others live along the Rajang and Baram river systems in Sarawak (a province of Malaysia). More recently, Kenyah from the Apo Kayan have migrated to

communities in the Mahakam River basin in East Kalimantan (Whittier 1973; Jessup 1981; Vayda and Jessup 1986; Rousseau 1990).

The Kenyah share many general characteristics with other non-Islamic, settled, highland peoples of Borneo: they live in multi-longhouse communities, practice shifting cultivation of rice, and, until recently, had strictly stratified societies of aristocrats, commoners, and slaves (Whittier 1973; Rousseau 1990; King 1993). There are more than 40 Kenyah subgroups with different dialects, customs, and histories, united chiefly by the fact of calling themselves "Kenyah" (Ngau 1966; Whittier 1973). These subgroups may be descended from diverse groups of forest-dwelling nomads (Punan) who gradually settled and adopted the social customs and livelihood strategies of the Kayan, another Borneo people with whom the Kenyah traded forest products for salt, cloth, and other goods (Whittier 1973; Sellato 1994).

Some oral histories place the origin of the Kenyah in the Apo Kayan, but it is more likely that most Kenyah subgroups now in the Apo Kayan migrated into the area from the highlands of what is now Sarawak over the past few hundred years, as Kayan and other groups moved out. At the end of the Nineteenth Century, there were roughly 23,000 Kenyah in the Apo Kayan (Jessup 1989; Rousseau 1990). Outmigration, principally for economic reasons such as better access to paid work, trade goods, cash labour, schools, and clinics, had reduced the population of the Apo Kayan to less than 6000 in 1983 (Jessup 1989; Rousseau 1990). The population of Long Sungai Barang had decreased from 375 in 1980 (Soedjito 1986) to 343 at the time of this study.

## 2.4. Sickness, Healing, and Medicine

Prior to widespread conversions to Christianity among most inland indigenous Borneo peoples, and to Islam among coastal groups, most Borneo peoples recognized numerous deities and spirits capable of bestowing good luck and prosperity, or of creating mischief, misfortune, and illness (Hose and McDougall 1912; Avé and King 1986). Religious practices varied among groups, but most included many types of ritual to enlist the aid of or placate these spirits. Headhunting and the associated *mamat* rituals were widely practiced, as was augury - reading omens in the behaviour of birds and other animals (Freeman 1960; Galvin 1972; Richards 1972). Observation of taboos and prohibitions was also widespread, particularly those concerning fertility of people and fields (Howell 1906; Galvin 1975). Most groups shared the belief that breaking a taboo, failing to observe a bad omen, or breaching traditional law could offend spirits who caused serious illnesses and misfortune (Metcalf 1982).

### 2.4.1. Kenyah beliefs and practices

The Kenyah believed serious illness was caused by a variety of unknown, supernatural sources: entry of the body by a bad spirit (*bali ja'at*), the soul (*berua'*) wandering away from the body, or breach of traditional law (*adat*) (Conley 1973). *Adat* was breached if restrictions or taboos (*malan*) were ignored. *Malan* restrictions were thought to be dictated by the goddess Bungan Malan. These sanctions controlled many activities, such as comings and goings during special ceremonies, the eating of certain foods by pregnant women and aristocrats (*paran*), and inappropriate handling of powerful objects such as tiger teeth. Violation of *malan* restrictions (*parit*) resulted in a state of impurity or ritual imbalance that could either endanger the entire community (*sial*) or result in the perpetrator's

failing health or death (*parib*). Infertility and skin diseases were particularly likely to result from *parit* (Whittier 1973, 1978). Sickness could also be caused by natural sources such as venomous insects, snakes, poisonous plants, and invasion of the body by worms (Conley 1973).

Spirits (*bali*) were believed to live on mountains and travel along rivers, and were believed to be the souls of people who died in the forest rather than at home (*bali jaka, bali matei*), women who died in childbirth (*pontianak*), and people who died of unusual causes or were abducted (*bali salung*) (Whittier 1973).

Kenyah practices associated with health and healing as they existed in the Apo Kayan at the beginning of the Nineteenth Century, upon first contact with the colonial administration of the Netherlands East Indies (now Indonesia), were principally interventions by ritual healers and spirit mediums (*belian*) to prevent, identify, and undo the malevolent or mischievous actions of spirits (Elshout 1923; Hose 1926; Nieuwenhuis 1929; Tillema 1938). Ritual healers identified the human error and the spiritual source of illness through chants, and effected a cure through sacrifices and offerings of pigs and chickens (Avé and King 1986; Whittier 1973).

In addition to observation of *malan* restrictions, various rituals of propitiation were intended to prevent misfortune for the community, family, and individuals. Among the Kenyah and other Borneo peoples, headhunting rituals (*mamat*) were associated with the Upperworld, the cult of heads, war, and male fertility, while rituals involving the rice spirit (*bali padai*) were associated with the Underworld, the cultivation cycle, and the domain of female fertility (King 1993). The behaviours of animals (such as the circling direction of hawks and the direction from which a barking

deer was heard) were interpreted by augurs as omens, indicating whether rites had been successful or whether *malan* had been violated (Whittier 1973).

Recent ethnographic studies have documented radical changes in beliefs and customs resulting from conversion of the majority of Apo Kayan Kenyah to Christianity (a variety of Protestant sects and Catholicism) between the 1940s, when the first missions were established in the region, and 1970, when conversion was 90% complete (Conley 1973; Whittier 1973). Many traditional practices have disappeared, particularly those associated with communication with or propitiation of Kenyah deities and spirits (Conley 1973; Whittier 1973; Avé and King 1986). Many Kenyah now speak of these practices as "*adat lama*" (the old ways), and "*adat waktu kafir*" (ways of the pagan time).

#### 2.4.2. Kenyah health conditions

Physicians who visited the Apo Kayan within the last century reported malaria and dysentery as the principal causes of infant mortality and of chronic infection among large numbers of older children and adults (Elshout 1923; Nieuwenhuis 1929; Tillema 1938). A variety of skin afflictions, particularly scabies and yaws (the latter known also as *framboesia tropica*) affected large numbers of Kenyah. Hose (1926) described frequent cuts and other wounds as occupational hazards of hunting and tree-felling. Tillema (1938) observed that the nomadic Punan suffered less from all but the dermatological ailments. He associated the high rate of malaria infection among the Kenyah with the creation of anophiline mosquito habitat in water-filled holes made by domestic pigs, dysentery with unsanitary disposal of faeces, particularly those of infants, and goiter and cretinism with the high cost and limited availability of sea salt. A few treatments were

administered by physicians on these journeys: quinine pills for malaria, salicylic spirit for skin diseases, neosalvarsan injections for framboesia, and cough powders (Tillema 1938).

## 2.5. Ethnobotanical Research in Borneo

References to plants used by Borneo peoples are found throughout a vast and scattered literature on Borneo's natural history and peoples. Many name the plant only in the local language; most are not supported by collections, and therefore provide ambiguous records for the ethnobotanical literature.

The major ethnobotanical references for the region are encyclopedic treatments of broad regions that include Borneo. Burkill (1935) provided a dictionary of economic plant uses that includes economic and cultural uses of some lower plants, lichens, animals, and minerals. This work remains the most comprehensive reference in English for the cultivated and wild economic flora of Malaya, which includes the Malay peninsula and the Malay archipelago. Perry and Metzger (1980) reviewed medicinal properties and uses of plants throughout East and Southeast Asia from sources published before 1962, including notes from herbarium collections. Uses of plants and animals in Malay poisons and charms were described by Gimlette (1915). Non-timber economic uses of plants and animals harvested from forests in Southeast Asia have been reviewed by de Beer and McDermott (1989).

Compendia of useful plants found in the Indonesian archipelago published in Dutch (Kloppenburger-Versteegh 1907; Heyne 1927) have been translated and supplemented by numerous treatments in Indonesian (e.g., Departemen

Kesehatan Republik Indonesia/Indonesian Department of Health 1977, 1978, 1979; Sastrapradja 1978; Hargono et al 1986).

Encyclopedic treatments of useful plants particularly relevant to the Borneo medicinal flora include Chai (1975, 1978); and Chai, Lee and Ismawi (1989) for Sarawak; and Guntavid (1982, 1984) for Sabah. Numerous lists have a more limited focus, for example, Dyak "magic plants" (van Steenis 1958) and forest species collected for trade (Peluso 1983) or sold in local markets (Dixon, Rediti, and Silverman 1991). Chin (1981) described 41 species of edible and poisonous fungi found in Sarawak forests. Research on forest-swidden agriculture in Borneo, much of it among the Apo Kayan Kenyah, has examined the ecological basis for this significant interaction between people and forests (Jessup 1981; Kartawinata et al. 1984; Kartawinata and Vayda 1984; Dove 1985; Mackie 1986).

Ethnobotanical studies based on original investigations of specific cultural groups in Borneo and for which the botanical information has been authenticated with the collection of voucher specimens are few (Table 2.1). Pearce, Amen, and Jok (1987) described plants used by four Iban communities in Sarawak to produce handicrafts, in construction, as food, as medicines and poisons, as wrappings and fastenings, and for a variety of other purposes. Chin (1985) listed domesticated and wild plants used by the Kenyah community at Long Selotong, Sarawak, as foods, in local technologies, as fish poisons, in social activities and rituals, as marketable produce, and as ornamental plantings. Soedjito (1982) and Sangat-Roemantyo (1982) listed plants used by the Kenyah village Long Sungai Barang, East Kalimantan, as foods, in local construction and handicrafts, as medicines, in association with hunting and fishing, and as indicators of soil quality for swidden cultivation of rice. Kedit (1982) listed plants used as

Table 2.1. Summary of ethnobotanical studies in Borneo<sup>a</sup>

Cultural group	Location	Reference	No. of plant species collected and described				
			Food <sup>b</sup>	Medicine <sup>c</sup>	Poison	Utility	Total
Iban	Pantu sub-district, Sri Aman, Div. 2, Sarawak	Pearce, Luna, and Jok 1987	50	46	10	122	228
Kenyah	Long Selotong Ulu Sarawak	Chin 1985	132	5	6	21	164
	Long Sungai Barang East Kalimantan	Soedjito 1982	123	43	4	99	269
	Long Sungai Barang East Kalimantan	Sangat-Roemantyo 1982	67	25	0	100	192
Penan	Genung Mulu area Sarawak	Kedit 1982	-	38	1	26	65
<b>Total</b>			<b>372</b>	<b>167</b>	<b>21</b>	<b>368</b>	<b>918</b>

<sup>a</sup> Encyclopedic treatments (e.g., Chai 1975, 1978; Chai, Lee, and Ismawi 1989; Guntavid 1982, 1984) and references without voucher numbers are not included.

<sup>b</sup> Food category includes beverages and species fed to animals.

<sup>c</sup> Medicinal category includes masticatories and smokes, veterinary medicines, magic and ritual cures and charms, and cosmetics.

foods, medicines, and for domestic purposes by the nomadic and settled Penan whose territory includes Gunung Mulu National Park in Sarawak, but only the palms and rattans listed have been identified from voucher specimens.

Given the richness of the Borneo flora, and the diversity of peoples who rely upon it for food, medicine, and other needs, local knowledge is likely far more extensive than has yet been reflected in the literature. The potential loss of this knowledge, both to the indigenous cultures and to the world at large, makes the study of Borneo ethnobotany a matter of urgency.

## CHAPTER 3

### KENYAH MEDICINES: PATTERNS OF KNOWLEDGE AND USE

#### 3.1. Introduction

The Apo Kayan (the Kayan plateau) is one of the more remote and inaccessible regions of Borneo by virtue of dense forest, mountainous terrain, and rivers made unnavigable by impassable rapids. Consequently, the Kenyah of the Apo Kayan, like other indigenous Borneo peoples, have developed sophisticated livelihood strategies that require extensive knowledge and manipulation of the surrounding forest and cultivated swiddens for food, building materials, and products for trade (Jessup 1981; Kartawinata and Vayda 1984; Mackie 1986; Jessup and Vayda 1988). These strategies are strongly influenced by complex systems of belief and social interaction (Whittier 1973; Avé and King 1986; Rousseau 1990; King 1993).

Observers of Kenyah culture have recorded the medicinal use of a few plant and animal species, identified principally by local name (Elshout 1923; Nieuwenhuis 1929; Conley 1973; Whittier 1973). Only recently have studies of the interactions between people and forests in the Apo Kayan suggested extensive knowledge and use of the local flora and fauna as medicines. In two surveys of Kenyah ethnobotany conducted in Long Sungai Barang, Sangat-Roemantyo (1982) lists medicinal uses of 25 plant species, and Soedjito (1982) lists medicinal uses of 37 plant species. The present study was suggested by and builds upon the work of these researchers.

### 3.2. Materials and Methods

#### 3.2.1. Ethnobotanical surveys

Surveys of the flora and fauna used in local remedies and poisons were undertaken in three Kenyah villages in the Apo Kayan Plateau from March through June of 1989 and in August of 1990. These surveys were conducted in collaboration with R. Yusuf (in 1989), an ecologist, and H. Sangat-Roemantyo (in 1990), an ethnobotanist, from the Indonesian Institute of Sciences (LIPI). A preliminary trip was made in the fall of 1988 with H. Soedjito, a LIPI ecologist familiar with the area and the Kenyah, to discuss the study with village leaders and to evaluate potential study sites.

The most extensive survey was conducted in the Uma' Tukung Kenyah village at Long Sungai Barang, the most remote site (one day's walk) from the public landing strip at Long Ampung and from the regional administrative centre at Long Nawang (see Fig. 2.1, Chapter 2). More limited surveys were undertaken in the Lepo Tau Kenyah village at Lidung Payau and in the Uma' Jalan Kenyah village at Long Ampung. In 1988 and 1989, access to these sites from Samarinda was achieved by commercial flight (Merpati Nusantara) to Long Ampung and overland on foot to Lidung Payau and Long Sungai Barang. In 1990 a small Mission Aviation Fellowship (MAF) plane was chartered to land in Long Sungai Barang. A field laboratory was established for the 1989 field season in an abandoned house in Long Sungai Barang.

In each village, locally recognized traditional healers (*bali dayung*, literally "spirit singers") and other individuals with exceptional knowledge of local remedies (referred to here as "herbalists") were identified by the village chiefs and elders; interviews and collecting expeditions were made with these individuals as well as with

other individuals who assisted by retrieving specimens from tall trees or carrying out other tasks related to specimen collection. A daily wage to compensate time lost to personal and village tasks was established by the village councils.

Interviews were conducted primarily during collecting expeditions as unstructured, open-ended discussions guided by, but not rigidly confined to, a standard checklist (App. 3.1; see also Chin 1981; Croom 1983; Lipp 1989). Casual opportunities to discuss the various remedies and collections, as well as pre- and post-conversion beliefs concerning the origin and treatment of disease arose frequently. The qualitative research benefits of a flexible methodology are discussed for ethnobotany by Lipp (1989) and for human ecology by Vayda (1983). Interviews usually were conducted with pairs or small groups of consultants, in which at least one individual could translate from the local language, Kenyah, to Indonesian.

In most cases, materials were discussed, photographed, and collected as they were encountered during field trips. Most such excursions lasted several hours, but a few field trips lasted several days. Occasionally a consultant independently collected a plant not encountered during a field trip.

### 3.2.2. Treatment of collections

Plant specimens were collected in triplicate whenever possible according to established methods for the tropics and tropical flora (van Steenis 1950; Womersley 1981; Soderstrom and Young 1983; Balgooy 1987). Single specimens were collected for species considered by consultants to be rare. Some widely cultivated species were not collected. Specimens collected in 1989 were pressed and dried over a

wood fire in Long Sungai Barang. Specimens collected in 1990 were preserved either in commercially produced gin (approximately 40% ethanol) or in locally distilled rice alcohol (approximately 70% ethanol), and were subsequently pressed and dried at the Herbarium Bogoriense (BO) in Bogor, Indonesia. Inflorescences of Zingiberaceae and Musaceae collected in 1990 were preserved in alcohol. Voucher specimens are deposited at the University of Ottawa, Ottawa, Canada. Duplicates are deposited at BO and at the Arnold Arboretum (AA) of Harvard University, Cambridge, U.S.A.

Taxonomic identification, where no recent or complete published flora exists, is extremely challenging. Specimens were initially identified at BO: the Meliaceae by A.J.G.H. Kostermans; the bamboo (Poaceae) by E.A. Widjaja; the Arecaceae by J.P. Mogeia, and most remaining specimens by members of the technical staff. Most of the Zingiberaceae were identified by R.M. Smith at the Royal Botanic Garden (RBG), Edinburgh. Identification of many specimens was verified against collections at AA with assistance from P.F. Stevens and J.S. Burley. Specimens for which there remains some uncertainty are indicated in this report by a question mark. Collections that could not be identified to the species level have been placed within particular genera based on comparison of vegetative characteristics with herbarium specimens at BO and AA. None of these has been eliminated from this report since their identity and utility to the Kenyah are not in question.

Identifications of medicinally-used fauna were made without collections, with the exception of insect specimens verified by S. Miller at the Bishop Museum (BM), Honolulu, USA. Mammals were identified by Kenyah consultants using picture keys in Payne, Francis, and Phillipps (1985).

### 3.2.3. Definition of remedies, indications, and categories

For the purpose of this study, a remedy is defined as a unique species-use combination (*sensu* Johns et al. 1994) related to healing and maintaining or improving health. Poisons, stimulants, and some ritual uses that are not precisely medicinal from the Kenyah point of view were also described by consultants and recorded during the present survey. These latter uses have both cultural and phytochemical relevance to this discussion of Kenyah medicine and to those concerning biological activity in subsequent chapters.

An indication is a locally defined (etic) ailment or set of symptoms. Major use categories are externally defined (emic) groupings of indications based on physiological systems affected, such as the gastrointestinal system. Secondary categories are defined by the recipient of the treatment (e.g., pediatric) or by a distinctive relationship to other remedies (e.g., synergists are materials thought to enhance the efficacy of remedies).

### 3.2.4. Assignment of remedy importance value ( $IV_{\text{remedy}}$ )

Most methods for quantifying consensus of local knowledge recently described in the ethnobotanical literature assume that respondents are interviewed independently and treat their reports as independent observations. The application of these methods to test falsifiable hypotheses concerning human selection and use of plants has been demonstrated by Trotter and Logan (1986), Johns, Kokwaro, and Kimanani (1990); Phillips and Gentry (1993a, 1993b), and Johns et al. (1994). In this survey of Kenyah medicines, interview situations rarely occurred with a single respondent and frequently developed more naturally from larger gatherings

(for example, a group of women on the way to and from the rice field, a party of men looking for a particular source of wood or fish poison, or a gathering of several people to examine and discuss the plant collections as they were pressed and dried). It was clear that information about the survey was shared privately among respondents. These circumstances likely encouraged single reports of little-known remedies and discouraged multiple reports of popular remedies.

In this research context, a simple index was developed to quantify the degree of confirmation of knowledge of remedies among respondents within and between the communities surveyed. This index, the remedy importance value ( $IV_{\text{remedy}}$ ), does not require independent observations but reflects the distribution and consistency of knowledge within and between the communities surveyed. This method creates the categorical variable ( $IV_{\text{remedy}}$ ), defined in Table 3.1, part I, which is simple to assess in the field, allows flexibility in the survey situation, and enables quantitative evaluation of data obtained from groups. In this and subsequent chapters, the remedy importance value index is used to calculate other importance value indices for specific indications and species (Table 3.1, part II) as well as for larger taxonomic groups and other plant attributes. For example, the indication importance value for malaria ( $IV_{\text{mal}}$ ) is used in an examination of the antiplasmodial activity of Kenyah malaria remedies (Chapter 4). Importance values calculated for taxonomic, ecological, and other attributes of the Kenyah medicinal flora are examined in Chapter 5 in relation to biological activity.

### 3.2.5 Ethics of the research methods

The field programme was reviewed and approved by the Ethics Review Committee of the School of Graduate Studies and

Table 3.1. Calculation of remedy importance value ( $IV_{remedy}$ ) and other medicinal importance value indices

I. Remedy importance value ( $IV_{remedy}$ )<sup>a</sup>

Criterion	$IV_{remedy}$
Remedy reported once during the survey	1
Remedy reported twice in one community	2
Remedy reported at least three times in one community	3
Remedy reported at least three times and in more than one community <sup>b</sup>	4

II. Some medicinal importance value indices calculated from  $IV_{remedy}$

Index	Formula
$IV_{indication}^c$	$= \frac{\text{Sum of } IV_{remedy} \text{ values for indication}}{\text{number of remedies for indication}}$
$IV_{category}^d$	$= \frac{\text{Sum of } IV_{remedy} \text{ values for category}}{\text{number of remedies for category}}$
$IV_{species}$	$= \text{Sum of } IV_{remedy} \text{ values for species}$
$IV_{family}$	$= \frac{\text{Sum of } IV_{species} \text{ values for family}}{\text{number of medicinally used species in family}}$

<sup>a</sup> A remedy is a unique species-use combination related to maintaining or improving health.

<sup>b</sup> All remedies reported in more than one community were reported at least twice in at least one of the communities.

<sup>c</sup> Indications are locally defined (etic) ailments or sets of symptoms.

<sup>d</sup> Medicinal use categories are externally defined (emic) groupings of indications.

Research, the University of Ottawa. The communities and individuals involved in the study were informed of the academic and conservation objectives and potential outcomes, and will guide decisions on further use of the results. The identity of consultants has been protected except where permission to reveal identity has been obtained, in accordance with accepted ethical practices (Lipp 1989; Cunningham 1993).

### 3.3 Results and Discussion

During this survey in 1989-1990, malaria, tuberculosis, and cold symptoms were the most common ailments of patients visiting the clinic in the regional administrative capital at Long Nawang. Healers and herbalists in the villages surveyed believed malaria and skin infections to be the most serious illnesses requiring treatment.

Between July 1989 and September 1990, there were four deaths among the residents of Long Sungai Barang. The circumstances reported by the village chief were as follows: a young man, killed accidentally by a falling tree-branch; a middle-aged man, of malaria; a middle-aged woman, of tuberculosis; and an old woman, of age-related ailments. The most recent epidemic occurred in 1988, when six young children died of diphtheria introduced by a young man returning from a visit to the coast.

At the time of this study, the Apo Kayan villages had limited access to modern medical care or facilities. Since 1910 there has been a government-appointed physician based at a clinic in the regional administrative capital at Long Nawang. More recently dispensaries have been established at Long Ampung and Long Sungai Barang, staffed intermittently

by young men from the region trained as public health nurses (*mantri kesehatan*). These practitioners reported great difficulties in obtaining medicines and supplies. Some medicines, primarily Chinese remedies, have been available from traders. Seriously ill patients are flown by missionary plane to Samarinda or Tarakan on the east coast, but airfare for accompanying family members and costs of treatment are beyond the means of most Apo Kayan residents.

### 3.3.1. Kenyah *materia medica*

Healers and herbalists in three Kenyah villages reported 438 unique species-use combinations, or remedies, for 209 locally distinguished taxa. These local taxa represent 199 plant species and 5 animal species. The plants comprise 189 species of angiosperms distributed among 69 families (following Cronquist 1981), and 10 species of pteridophytes distributed among 6 families. No medicinal uses of fungi or lichens were reported. The animal species include 2 mammals, a crustacean, an insect, and a gastropod.

Although comprehensive for the Uma' Tukung Kenyah village at Long Sungai Barang, the list of species and uses documented here is not exhaustive. There remain local taxa described by healers and herbalists that were not encountered or collected during the survey. Materials known to and used by ritual healers are likely under-represented owing to the desire of these specialists to preserve the secrecy of their knowledge and art.

Survey results for the Lepo Tau Kenyah at Lidung Payau and the Uma' Jalan Kenyah at Long Ampung likely under-represent the known medicinal flora in these villages since they were derived from a smaller sample of healers and herbalists than those from the Uma' Tukung Kenyah at Long Sungai Barang.

Moreover, there are nearly 20 other Kenyah villages in the Apo Kayan (based on a census published by Whittier 1973) that were not surveyed, including the large Lepo Tau village at Long Nawang, as well as numerous Kenyah villages downstream on the Kayan and Mahakam rivers in East Kalimantan, and on the Baram River in Sarawak.

Kenyah remedies documented during the present study are listed by family, scientific name, and Kenyah name below. Kenyah names are listed alphabetically, with species equivalents, in Appendix 3.2. Spelling of Kenyah names is guided by the system used by Whittier (1973) and Whittier (1981).

This list begins with the flora, ends with the fauna, and follows the format outlined below:

#### **FAMILY**

##### *Scientific name*

*Kenyah name* - English translation if known (village: LSB=Long Sungai Barang; LP = Lidung Payau; LA = Long Ampung). Plant life form, notable taxonomic characters. Availability, habitat. (Voucher number(s) in the series Leaman-89).

**Major remedy category or categories** (village): use(s) (consultant reference; remedy importance value ( $IV_{remedy}$ ); gender of consultants). Number of uses (UN); species importance value ( $IV_{species}$ ). Other uses of the plant described or demonstrated by consultants.

Major remedy categories include the following:

ANT       antidote  
CAR-PUL   cardio-pulmonary  
DER       dermatological  
DEN       dental, oral

EYE eye  
 GI gastrointestinal  
 GYN gynecological  
 GEN general  
 MET metabolic  
 NEU/ORT neurological/orthopedic  
 POI poison  
 PED pediatric  
 RIT ritual  
 SYS systemic  
 SYN synergist  
 URI urinary  
 VET veterinary

Consultant reference numbers correspond to the following age, gender, and village:

- 1 Male, 60+ years old, village elder, LSB
- 2 Male, 60+ years old, LSB
- 3 Female, 50+ years old, LSB
- 4 Female, 50+ years old, LSB
- 5 Female, 50+ years old, LSB
- 6 Female, 50+ years old, LSB, originally from Long Bakung
- 7 Male, 60+ years old, LSB
- 8 Male, 60+ years old, LSB
- 9 Male, 30 years old, LSB
- 10 Male, 50+ years old, LSB
- 11 Male, 70+ years old, traditional healer (*dayung*), LSB
- 12 Male, 50+ years old, LSB
- 13 Female, 60+ years old, LSB
- 14 Male, 40+ years old, LSB
- 15 Male, 30+ years old, LSB
- 16 Female, 40+ years old, LSB
- 17 Male, 25 years old, LSB
- 18 Male, 30 years old, LSB
- 19 Male, 30 years old, LSB

- 20 Female, 40 years old, LSB
- 21 Female, 50+ years old, traditional healer (*dayung*), LP
- 22 Male, 60+ years old, traditional healer (*dayung*), LP
- 23 Female, 50 years old, LSB
- 24 Male, 60+ years old, LA
- 25 Female, 60+ years old, LA
- 26 Male, 40 years old, LA
- 27 Female, 30 years old, LA

Remedy importance value ( $IV_{\text{remedy}}$ ) and species importance value ( $IV_{\text{species}}$ ) are defined in Table 3.1.

### KENYAH MEDICINAL FLORA

#### ACANTHACEAE

*Justicia gendarussa* Burm.f.

Kayu be'kua (LSB)

Understory tree. Flower white. Common, mature secondary forest, near river or stream banks. (89-119)

RIT (LSB): leaves were soaked in a bamboo container with water and leaves of *Dendrocnide stimulans* (Urticaceae, 89-11, 260); the water was used in a ceremony in which the male elders prayed to omen animals for good hunting and harvest; the cold infusion was then divided among all families for harvest rituals in the rice fields (3,4;  $IV_{\text{remedy}}=1$ ; f).

UN=1;  $IV_{\text{species}}=1$ .

*Peristrophe bivalvis* (L.) Merr.

Udu tung lia - ginger leaf herb

Herb, 75 cm tall. Flower purple. Common in mature secondary forest. (89-223)

DER (LA): leaves are boiled until the water turns red, the decoction is used to wash infected wounds (*koreng-koreng*)

(24;  $IV_{\text{remedy}}=1$ ; m). UN=1;  $IV_{\text{species}}=1$

## AMARANTHACEAE

*Cyathula prostrata* (L.) Bl.

*Udu kedapet* - love charm herb (LSB)

Herb, .5 m tall, flower purple. Common in open, disturbed sites. (89-66)

**EYE/VET** (LSB): sap from the leaves, mixed with leaves of *Adenostemma lavenia* (Asteraceae, 89-67) is applied as a drop to treat eye infections of chickens (*rabun* - white eye, red eye) (8; IV<sub>remedy</sub>=2; mf). **SYS**: a decoction of the root is drunk daily for three days to treat chills (3; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=3

## ANNONACEAE

*Annona muricata* L.

*Dian beleda'*/*dian tapen* - Dutch durian; boat durian (LSB)  
Tree. Cultivated, in home gardens. (89-65)

**SYS** (LSB): crushed leaves mixed with gasoline are applied as a rubifacient to the skin to treat malaria (3,4; IV<sub>remedy</sub>=1; f). **GI** (LSB): the mixture above is applied as a poultice to the stomach to treat cholera (*kalira*), particularly if pharmaceuticals are not effective (3,4; IV<sub>remedy</sub>=1; f); crushed leaves mixed with Javanese tobacco and *kebin* (a red paste prepared from the leaves of *Trigonopleura malayana*, Euphorbiaceae, 89-139) are applied as a rubifacient to treat stomachache (3,4; IV<sub>remedy</sub>=1; f) and diarrhea (3,4; IV<sub>remedy</sub>=1; f). UN=4; IV<sub>species</sub>=4

*Melodorum* aff. *kentii* Hook.f. & Thoms.

*Kelembunyo bai'* - forest kelembunyo

Understory tree. Primary forest. (89-184, sterile)

GI (LSB): fresh root is peeled and chewed to ease stomachache; the root tastes of wintergreen (19; IV<sub>remedy</sub>=1; m). UN=1; IV<sub>species</sub>=1

*Polyalthia* (?) sp.

*Udu kalong* aka - necklace vine herb

Herbaceous liane. Mature secondary forest, near stream banks. (89-240, sterile)

DER (LA): crushed leaves are steeped in cooled, boiled water; the infusion is used to soak skin burns for one hour (24,25; IV<sub>remedy</sub>=1; mf). UN=1; IV<sub>species</sub>=1

#### APIACEAE (UMBELLIFERAE)

*Hydrocotyle javanica* Thunb.

*Tuba urong* - earlobe poison (LSB)

*Udu daun telinga* (LSB, LA)

*Tuba tuleng* (LP)

Creeping herb. Flower yellow. Common, open, disturbed sites. (89-105)

POI (LSB, LP, LA): fresh plants are beaten over a small stream, the sap rinsed into the water to kill fish; three rice-baskets full are sufficient for a small stream (3,4,28,29; IV<sub>remedy</sub>=4; mf). SYS (LSB): unspecified preparation of the leaves is used to treat fever (7; IV<sub>remedy</sub>=1; m). SYS/PED (LA): an infusion of the leaves mixed with three other ingredients is drunk to treat *pelian* (measles, pox) in small children, according to the following dosage: *H. javanica* - one leaf for an infant, three leaves for a one-month-old; *Desmodium triflorum* (Fabaceae, 89-222) - one or more plants; *Kadsura scandens* (Schisandraceae, 89-233) - one leaf for a newborn, three leaves for a small child; *Litsea cubeba* (Lauraceae, 89-16) - one fruit for an infant, three fruits for a small child, one handful for an adult (26,27,24; IV<sub>remedy</sub>=2; mf). UN=3; IV<sub>species</sub>=7

#### APOCYNACEAE

*Alstonia scholaris* (L.) R.Br.

*Njau lutung* - dried njau

Understory tree. Infrequent, primary forest, mature secondary forest. (89-188)

SYS (LSB): the sap is mixed into hot water and the suspension drunk to treat malaria (3; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

Other uses: the light wood is used to make the body of the *sampe'*, a stringed mandolin-like instrument.

#### AQUIFOLIACEAE

*Ilex* sp.

*Lengidan*

Understory tree. Common in mature secondary forest. (89-83, 291)

DER (LSB): scraped bark is applied as a rubifacient to relieve the sting and itch of insect bites (3,4,7; IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

#### ARACEAE

*Aglaonema* sp.

*Daun Bakung* - Bakung leaf

Herb. Common, mature secondary forest, hilly, wet areas. (89-288, sterile)

DER (LSB): the rhizome is crushed, wrapped in the leaves, baked in coals, and applied as a poultice to swollen sores caused by the stinging hairs of insects (6; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

**Other uses:** the leaves are used to wrap and store the starter for fermenting rice, prepared from powdered rice and the rhizome of *Alpinia galanga* (Zingiberaceae, 89-61).  
**Field note:** the source of the knowledge is the former village of Bakung.

*Alocasia longiloba* Miq.

*Udu bia' pibang* - twin-stalked arrow-leaf herb (LSB)

*Bia' kalong* - necklace arrow-leaf (LA)

Herb. Infrequent, mature secondary forest. (89-103, 237)

**DER/VET:** (LSB) leaf stalk and root are baked in coals until reduced to charcoal, cooled, and applied as a poultice to dogs' wounds (3,4; IV<sub>remedy</sub>=1; f); (LA) base of the leaf stalk is wrapped in a leaf and baked until soft, then applied as a poultice to sores caused by insect stings (24,25); (IV<sub>remedy</sub>=1; mf). **NEU/ORT:** (LSB) the entire plant, wrapped in a leaf, is baked until soft, then applied as a poultice to relieve soreness and pain in the feet (3,4; IV<sub>remedy</sub>=1; f). UN=3; IV<sub>species</sub>=3

*Colocasia esculenta* (L.) Schott

*La'ung* - arrow-leaf (LSB)

*Keladi* (LA)

Herb, to .5 m tall. Common, moist, disturbed sites. (89-94, sterile)

**DER:** (LSB) leaf stalk is heated over fire and rubbed on sores resulting from the sting and itch of an insect larva (*ulet yen*), which affects the skin between the toes (11,2; IV<sub>remedy</sub>=1; m); crushed young leaves are applied to new wounds to stop bleeding (3 and others); (LA) sap from a cut stalk is applied as an ointment to fresh wounds, but some wounds get worse instead of healing following this treatment (26,27); (IV<sub>remedy</sub>=4; mf). UN=2; IV<sub>species</sub>=5

*Homalomena humilis* (Jack) Hook.f.

*Lung adek* - aromatic arrow-leaf

Herb, 30 cm tall. Mature secondary forest. (89-150)

GI (LP): rhizome and stalk are charred in coals, powdered, and eaten in one-tablespoon doses to treat stomachache (33;

IV<sub>remedy</sub>=1; f). SYS/PED: a decoction of the rhizome and stalk is drunk to treat measles, pox (*pelian*) (33;

IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=2

*Homalomena rubra* Hassk. (var. 1)

*Lung bala* - red arrow-leaf

Herb. Common, in mature secondary forest and primary forest. Spadex is red. (89-43, 181, 260)

GI: (LSB) the tuberous root is baked to black coal; one teaspoon is stirred into a half-glass of boiled water, and the suspension drunk to treat diarrhea accompanied by white foam (*gnederui* - possibly giardias); or a decoction prepared from a dried root is drunk to treat diarrhea (3,4,5,6;

IV<sub>remedy</sub>=3; f). SYS/PED: (LA) a decoction of the root is drunk (one-half glass for adult, two teaspoons for a child), or is applied as a rub, to treat *kora-kora* (enlargement of the spleen, resulting from malaria); the root can be dried and stored for a long time without losing strength (24,25;

IV<sub>remedy</sub>=1; mf). RIT: (LP, LSB) the rhizome is burned with nine other ingredients in a ritual to cure illness caused by a curse (21,3; IV<sub>remedy</sub>=4; mf). UN=3; IV<sub>species</sub>=8

*Homalomena rubra* Hassk. (var. 2)

*Lung bileng* - green arrow-leaf

Herb. Common in mature secondary forest and primary forest. Spadex is green. (89-251, 259)

RIT/PED: (LSB, LA, LP) the root and leaves were used to make the user invisible to spirits. When a mother was to be separated from her child (by going to the rice field, for example), she divided a whole dried plant of *H. rubra*, leaving the root with the baby, usually tucked into the

*bening* (a carrier worn on the caregiver's back), and taking the leaves with her tucked into the waist of her *taa'* (a skirt worn by Kenyah women). A small child who was to be carried somewhere in the dark, especially in the rain, was held briefly over the smoke of a burning leaf. Menstruating or pregnant women placed a piece of root under one foot while bathing in or working near the river (3,4,24,25; IV<sub>remedy</sub>=4; mf). DER: (LSB) the root is crushed, moistened with water, wrapped thickly in banana leaves, baked in hot coals until half-cooked, and applied as a poultice to swollen wounds and sores; the poultice is reheated and reapplied until swelling is reduced (3,4); this treatment is interchangeable with *Hedychium cylindricum* Ridley (Zingiberaceae, 89-29, 270) (7); (IV<sub>remedy</sub>=2; mf). UN=2; IV<sub>species</sub>=6

*Pothos ovatifolius* Engl.

Aka *malung* - Alung's vine

Herbaceous climber. Primary forest, mature secondary forest. (89-149)

SYS (LP): leaves are heated over fire and applied as a poultice to reduce pain and swelling resulting from enlarged spleen (21; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Rhaphidophora montana* Schott

Aka *Bakung* - Bakung vine

Herbaceous liane. Mature secondary forest, near stream banks. (89-235)

DER (LA): the base of the stem is wrapped in leaves, baked in coals, wrapped in a black cloth, and applied as a poultice to aid in the extraction of stinging hairs of insects (*ulet bulu*) (24,25; IV<sub>remedy</sub>=1; mf). UN=1; IV<sub>species</sub>=1

## ARALIACEAE

*Schefflera lineamentorum* (cf., *oblongifolia* Merr.)

Jangkang iyap - chicken toes (LSB)

Puang (LA)

Shrub, shade-loving. Primary forest, mature secondary forest. (89-182, 228)

SYS (LSB, LA): (LSB) a decoction of young leaves is drunk to treat fever associated with malaria (6; IV<sub>remedy</sub>=1; f); (LA) leaves are crushed, boiled, and the decoction applied as a wash to treat fevers of long duration (24; IV<sub>remedy</sub>=4; m). UN=2; IV<sub>species</sub>=5

## ARECACEAE (PALMAE)

*Cocos nucifera* L.

Kelapa - coconut

Tree. Infrequent, cultivated in home gardens. (Field note 249)

GYN (LSB): the milky endosperm is drunk by pregnant women to force childbirth (3; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

Other uses: the endosperm is edible, but not used often in local cooking.

*Daemonorops hallierianus* Becc.

Uwai seringan - rattan seringan (LSB)

Climbing palm (rattan). Infrequent, primary forest, mature secondary forest. (89-115, 283)

GI (LSB): the fresh or dried stalk is beaten, dipped in unboiled water, and the juice wrung out and drunk or used as an external rub to treat food poisoning (3,4; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

Other uses: preferred among all rattans for weaving mats.

*Daemonorops periacanthus* Miq.

*Uwai semule'* (LSB)

Rattan (climbing palm). Infrequent, primary forest, mature secondary forest. (89-285)

NEU (LSB): endosperm of the seed is sometimes used instead of *Pinanga coronata* (Arecaceae, 89-220) as an ingredient of the masticatory called *sirih*, a mixture that also includes a preparation of leaves of *Trigonopleura malayana* (Euphorbiaceae, 89-139), fresh leaves of *Piper betle* (Piperaceae, 89-114), and a paste prepared from snail shells (3; IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

Other uses: the ripe fruit is edible. Strips cut from the stems are used to make baskets and to tie wooden poles together in various structures.

*Pinanga coronata* Bl.

Gaat

Tree. Infrequent, cultivated in home gardens. (89-220)

NEU: (LSB, LA, LP) endosperm of the seed is a major ingredient of the masticatory called *sirih*, a mixture that also includes a preparation of leaves of *Trigonopleura malayana* (Euphorbiaceae, 89-139), fresh leaves of *Piper betle* (Piperaceae, 89-114), and a paste prepared from snail shells (3,4; IV<sub>remedy</sub>=4; mf). CAR-PUL: (LSB) endosperm of the fruit is eaten raw to lower blood pressure; sometimes causes indigestion (23; IV<sub>remedy</sub>=1; f). GI: (LSB) endosperm of the seed is eaten raw to purge worms; sometimes causes indigestion (23; IV<sub>remedy</sub>=1; f). MET: (LSB) green bark is crushed and steeped in cooled boiled water, and the cold infusion used three times daily to bathe joints and limbs swollen from beriberi (23,3; IV<sub>remedy</sub>=2; f). GYN: (LSB) the treatment described above for beriberi is avoided as a treatment for swelling in pregnant women, for whom its application to the abdomen and lower back can cause miscarriage (3; IV<sub>remedy</sub>=1; f). UN=5; IV<sub>species</sub>=9

## ASCLEPIADACEAE

*Hoya coronaria* Bl.

Aka umeng - lone vine

Herbaceous climber. Mature secondary forest. (89-200, 197? sterile)

DER/VET (LSB): a decoction of lightly crushed leaves is applied as an ointment, or leaves heated over fire are applied as a poultice to treat ringworm (*kurep*)

(IV<sub>remedy</sub>=2), vitiligo (*panau*) (IV<sub>remedy</sub>=2), and dog mange (*kep*) (2,11,3; IV<sub>remedy</sub>=2; mf). UN=3; IV<sub>species</sub>=6

## ASPLENIACEAE

*Elaphoglossum* sp.

Udu jela'an - white-tongue herb

Creeping/climbing fern. Common, in primary forest and mature secondary forest. (89-45)

DEN (LSB): the mouth is rinsed with a decoction of young leaves to treat toothache by killing worms (*ulet*) under the teeth (IV<sub>remedy</sub>=1), and to treat infections of the gums (3,4; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=2

## ASTERACEAE (COMPOSITAE)

*Adenostemma lavenia* Kuntze o.k.

Udu tai - dung weed (LSB, LA)

Herb, 30 cm tall, flower white. Common in open, disturbed sites. (89-67, 234)

EYE/VET: (LSB) sap of crushed leaves mixed with leaves of *Cyathula prostrata* (Amaranthaceae, 89-66) is applied as a drop to treat eye infections of chickens (*rabun* - white eye, red eye) (8), or *A. lavenia* can be used alone to treat eye

infections in chickens (3; ; IV<sub>remedy</sub>=2); leaves are wrapped in a banana leaf, baked in coals, and the sap extracted, cooled, and applied to the human eye as a drop to treat clouded vision (7); (IV<sub>remedy</sub>=1; mf). CAR-PUL: in LSB a hot infusion of crushed leaves is drunk to treat cough (3); in LA a cold infusion of leaves is drunk to treat cough (24,25); (IV<sub>remedy</sub>=4; mf). DER: boiled leaves are rubbed on the skin to relieve itch (IV<sub>remedy</sub>=1) and treat infected sores (3; IV<sub>remedy</sub>=1; f). UN=5; IV<sub>species</sub>=9

*Ageratum conyzoides* L.

*Udu tai pute'* - white dung herb (LSB)

*Udu pute' bua* (LA)

Annual herb, to 0.75 m tall. Flower from white to lavender. Common in open, disturbed sites. (89-2)

SYS: (LSB) a decoction of young leaves and stems is used as a wash (1,2), or an infusion of young leaves is drunk in a normal dose of one glass, three times daily (3) to reduce fever (IV<sub>remedy</sub>=3; mf). GI: in LSB an infusion of leaves is drunk to treat stomachache as a replacement for *Etlingera* sp. 1 (Zingiberaceae, 89-1, 265) (7; IV<sub>remedy</sub>=1; m). DER: (LA) crushed fresh leaves are applied to new wounds as a poultice to hasten healing (27,24; IV<sub>remedy</sub>=2; mf). UN=3; IV<sub>species</sub>=6

*Blumea balsamifera* (L.) DC.

*Embeng pasa pen*

Herb. Flower yellow. Flowering stalks to 2.5 m tall.

Common, in open, disturbed sites. (89-51)

GEN (LSB): an infusion of leaves is prepared as an herbal steam and bath to relieve illness and weakness (3,4), and is drunk before sleeping as a tonic for strength (7)

(IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

Other uses: the soft leaves of seedlings are used as toilet tissue when travelling or working away from running water.

*Blumea pubigera* (L.) Merr. (var. 1) (syn: *Conyza pubigera*)  
*Udu sekiput lulut* - shin-bone closing herb (LSB, LA)  
Herb, to 2 m tall. Common in open, disturbed sites. (89-141, 230)

DER: (LSB) a poultice of crushed young leaves applied directly to new wounds; (LA) a poultice of leaves is applied to new or old wounds to aid healing and dry weeping infections (24) (IV<sub>remedy</sub>=4); (LSB) poultice above is heated over fire and rubbed as an ointment on scabbies (*puu'*) to aid healing (3,5,6; IV<sub>remedy</sub>=2; mf). SYS: a poultice of young leaves is applied to swollen liver or spleen (*kora-kora*) (3,4; IV<sub>remedy</sub>=1; f). UN=3; IV<sub>species</sub>=7

*Blumea pubigera* (L.) Merr. (var. 2)

*Embeng aka* - aster vine (LSB)

Herbaceous climber. Infrequent, young secondary forest. (89-262)

DER: (LSB) a poultice of crushed young leaves applied directly to new wounds; (LA) a poultice of leaves is applied to new or old wounds to aid healing and dry weeping infections (24) (IV<sub>remedy</sub>=4); (LSB) poultice above is heated over fire and rubbed as an ointment on scabbies (*puu'*) to aid healing (3,5,6; IV<sub>remedy</sub>=2; mf). UN=2; IV<sub>species</sub>=6

*Chrysanthemum* sp. (cf., *morifolium* DC.)

*Bunga alok* - foreign flower (marigold) (LA)

Herb. Flower gold/yellow. Common, cultivated in home gardens. (Field note 254)

GI/SYS (LA): crushed leaves are mixed with hair oil (*minyak tancho*) and applied as a rubifacient to treat stomachache (IV<sub>remedy</sub>=1); crushed leaves are mixed with *kepu* (a snail-shell paste), and applied as a rubifacient to treat a type of stomachache associated with black-and-blue lumps on the skin, known locally as *kora-kora* (24,26; IV<sub>remedy</sub>=1; m). UN=2; IV<sub>species</sub>=2

*Elephantopus scaber* L.

*Embeng kesa'*

Herb. Infrequent, open, disturbed sites. (Field note 256)  
DER (LSB): an infusion of the entire plant is used to wash out sores (3,4; IV<sub>remedy</sub>=1; f). SYS: the sap (approx. 150 ml) pressed from two large handfuls of plants is drunk three times daily to reduce fever; if the fever has not broken after several days of treatment, it is probably a symptom of malaria (3,4; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=2

*Emilia sonchifolia* (L.) DC.

*Udu lurun*

Herb, to 75 cm. Flower purple. Common, open, disturbed sites. (89-201)

URI (LSB): boiled leaves are eaten as a vegetable for two meals in succession to clarify yellow urine (13,20; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Erigeron linifolius* Willd.

*Udu berau*

Herb, 1 m tall. Common in open, disturbed sites. (89-231, sterile)

DER (LA): crushed stem and leaves are applied as a poultice to draw infection from old wounds (IV<sub>remedy</sub>=1) and to clean fresh wounds (24; IV<sub>remedy</sub>=1; m). UN=2; IV<sub>species</sub>=2

#### **BALSAMINACEAE**

*Impatiens balsamina* L.

*Semangkak* - wrapped hand (LSB, LP)

Herb, 30 cm tall. Common, cultivated in home gardens. (89-217)

DER: (LP,LSB) crushed leaves and stem are applied as a poultice to clean new wounds; the dressing is left for several days without being changed (21,3; IV<sub>remedy</sub>=4; f).

**CAR-PUL:** (LP) a decoction of the root and base of stalk is drunk to treat cough and asthma (IV<sub>remedy</sub>=1); the decoction is bright red, not bitter (21; IV<sub>remedy</sub>=1; f). UN=3;

IV<sub>species</sub>=6

**Other uses:** children in LP, LSB rub the root on their fingernails and palms to turn them red. Handling the root can remove layers of skin from the palms (3).

#### **BIGNONIACEAE**

*Pandorea pandorana* v. Steenis (syn: *Bignonia pandorana*)

Aka letien - maggot vine

Woody climber. Infrequent, primary forest and mature secondary forest (89-138, sterile)

**DER (LSB):** crushed leaves are wrapped in banana (or other thick) leaves, baked in ash a half hour, and applied as a poultice to reduce itch, pain, and swelling (usually on the sole of the foot), which the consultants believed to result from contact with a larva known locally as ulet Tien (possibly athletes' foot) (3,5,6; IV<sub>remedy</sub>=1; f). UN=1;

IV<sub>species</sub>=1

#### **BOMBACACEAE**

*Eriodendron anfractuosum* DC. (syn: *Ceiba pentantra* (L.)

Gaertn.)

Burak - kapok

Slender tree. Common, cultivated in home gardens. (89-183, sterile)

**SYS:** (LP, LSB) crushed fresh leaves are mixed with rice water to form a paste, wrapped in a cloth, and applied to the forehead as a poultice to reduce fever (possibly malaria) (IV<sub>remedy</sub>=2); and (LSB) treat colds (21;

IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=5

**Other uses:** the pods contain a silk-like fibre used for padding.

#### **BROMELIACEAE**

*Ananas comosus* (L.) Merr.

*Kayu ujan* - rain tree

Shrub (pineapple). Cultivated in plantations. (Field note 243)

**GI/PED:** (LP) unripe fruit is grated, the pulp and juice mixed with honey, and drunk to purge worms, especially in children; dose is one glass of juice with three tablespoons of honey per day, until worms are gone from stools (21; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

**Other uses:** the stalks of old plants are boiled and eaten as a vegetable. Fibre from the leaves is twisted by hand into a strong thread.

#### **BURSERACEAE**

*Garuga* sp.

*Kayu juping*

Overstory tree. Mature secondary forest. (89-236)

**DER (LA):** the bark is warmed over fire until the sap oozes; the sap is then applied as an ointment to sores caused by stinging hairs of insects. The ointment dries out infection and reduces swelling (24,25; IV<sub>remedy</sub>=1; mf). UN=1;

IV<sub>species</sub>=1

**Other uses:** the fruit is edible.

## CARICACEAE

*Carica papaya* L.

Manjan - papaya

Tree. Cultivated in home gardens. (89-185)

GI: (LP) two drops of latex from the immature fruit is mixed into a glass of boiled water, and the suspension drunk to purge worms; the treatment usually is effective after two or three treatments (21,3; IV<sub>remedy</sub>=1; f). SYS: (LSB) a decoction of leaves is drunk to reduce fever associated with malaria (3; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=2

Other uses: the fruit is eaten when ripe.

## CARYOPHYLLACEAE

*Drymaria cordata* Willd.

Udu beluk (LSB)

Herb, .25 m tall. Flower white. Common in open, disturbed sites. (89-86)

CAR-PUL (LSB): an infusion prepared from a handful of plants, crushed, is drunk to treat chest pain (*sakit dada*, *sakit tusuk*); dosage is one-half glass (11; IV<sub>remedy</sub>=1; m). UN=1; IV<sub>species</sub>=1

## CLUSIACEAE (GUTTIFERAE)

*Calophyllum biflorum* M.L. Henderson & Wyatt-Smith

Kayu betao' (LSB, LP)

Overstory tree. Infrequent, primary forest, mature secondary forest. (89-144, 273)

POI: (LSB, LP) fresh bark is crushed on a rack over a stream, the sap washed into the water to poison fish downstream (4,7,28,29; IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>species</sub>=4

*Calophyllum spectabile* Willd.

*Kayu tuwe'*

Overstory tree. Primary forest and mature secondary forest.  
(89-140, sterile)

POI (LSB): bark is beaten on a rack over a stream, the sap  
rinsed into the water to poison fish downstream (3,5,6;  
IV<sub>remedy</sub>=1; f) UN=1; IV<sub>species</sub>=1

*Cratoxylum sumatranum* (Jack) Bl.

*Duling*

Small tree. Common in mature secondary forest. (89-14)

DEN: (LSB) the mouth is rinsed with a strong decoction of  
the root to loosen and aid in the extraction of damaged or  
infected teeth (1), or the root is scraped and placed  
directly in the infected part of the tooth for the same  
purpose (6) (IV<sub>remedy</sub>=3; mf). DER: fresh leaves are heated  
over fire, crushed, and rubbed on skin to relieve the itch  
of insect bites and skin rash (*kudis-kudis*) (3,4; IV<sub>remedy</sub>=1;  
f). UN=2; IV<sub>species</sub>=4

*Garcinia* sp.

*Kayu te'pakun*

Overstory tree. Primary forest. (89-164)

DER/VET (LSB): dried resin is crushed and applied to dog  
wounds to hasten healing (3,4; IV<sub>remedy</sub>=1; f). UN=1;  
IV<sub>species</sub>=1

Other uses: the wood is used for fuel; long-burning.

#### COMMELINACEAE

*Aneilema herbaceum* (Roxb.) Wall.

*Udu nyalau*

Herb, to 1 m tall. Fruit a wine-coloured berry. Common,  
young secondary forest. (89-132)

DER (LSB): young leaves and stem are crushed and applied as a dressing for burns (3; IV<sub>remedy</sub>=1; f). RIT: used as a protective charm against spirits; no longer used (3; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=2

#### COMPOSITAE (SEE ASTERACEAE)

#### CONNARACEAE

*Rourea mimosoides* (Vahl) Planch

Udu Taman Aji - Aji's father's herb

Shrub. Common in primary forest and mature secondary forest. (89-13)

DER: (LSB) crushed fresh leaves and stem are applied as a poultice to new wounds to aid healing (1,2; IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

#### CONVOLVULACEAE

*Merremia borneensis* Merr.

Aka kedatung tura - trip vine (LSB)

Aka pulut - sap vine (LA)

Climbing liane, flower yellow. Common in young secondary forest. (89-68, 225)

DER: (LSB, LA) young leaves, crushed to release the sap, are applied to new wounds as a poultice to prevent infection; sap from twigs can be added to the poultice; the dressing can be left on a small wound for three days without changing (8,24; IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>species</sub>=4

*Merremia umbellata* (L.) Hallier f.

Aka Belan - Belan's vine (LSB)

Herbaceous climber. Flower white. Infrequent, young secondary forest. (89-136)

DER (LSB): an infusion of young leaves is used to wash out sores and ulcers (*tuko*) (IV<sub>remedy</sub>=1), and infected wounds (6; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=2

#### CRASSULACEAE

*Kalanchoe pinnata* (Lam.) Pers.

Taban sakit ulu - headache medicine

Succulent herb. An escaped cultivar, infrequently found in abandoned home gardens. (89-74)

NEU (LSB): crushed leaves, dampened with cold water, are wrapped in cloth and applied to the forehead to relieve headache; rarely used now in preference to headache tablets (8,3; IV<sub>remedy</sub>=3; mf). UN=1; IV<sub>species</sub>=3

#### CUCURBITACEAE

*Cucumis* sp. (cf., *sativa* L.)

Labu (LSB, LP)

Various cultivated herbs. (Field note 301)

RIT (LP, LSB): the seeds of two species cultivated for food are burned with eight other ingredients in a ritual to cure illness caused by a curse (21,3; IV<sub>remedy</sub>=4; mf).

Other uses: the fruits are an important food immediately before the rice harvest.

*Trichosanthes bracteata* Voigt

Aka kuwik (LSB, LA)

Herbaceous creeper. Flower green, inconspicuous. Common, young secondary forest. (89-107)

DER: (LSB, LA) a small piece of leaf is warmed over fire, then applied as a poultice to open an infected sore or boil; the stem is heated and pushed into the opening of a sore or boil to draw out the infection (3,4,24,25) (IV<sub>remedy</sub>=2); (LA) leaves and stem are crushed and applied as a poultice to treat sores caused by stinging insects (24,25); (IV<sub>remedy</sub>=1; mf). UN=2; IV<sub>species</sub>=5  
Other uses: the fruit is crushed, fermented, and eaten as a seasoning (terasi) (3); however, if the vegetative parts are eaten by mistake, the result is a severe stomachache and vomiting (3,4).

#### CYPERACEAE:

*Cyperus kyllingia* Endl.

Udu tika (LSB, LP)

Herb, .3 m tall. Common, open, disturbed sites. (89-113)

CAR-PUL (LSB, LP): a decoction or infusion of the crushed plant is drunk to treat cough (mike'); dose, one glass daily (3,4,21; IV<sub>remedy</sub>=4; f). UN=1; IV<sub>species</sub>=4

*Scleria sumatrensis* Retz.

Udu si'ik (LSB)

Herb, 1.5 m tall. Common, open, disturbed sites. (89-129)  
GI (LSB): young leaves at tip of the stem (puco') are eaten raw, or cooked with other vegetables and eaten to purge worms (6,3; IV<sub>remedy</sub>=1; f). DER: the root is applied (preparation not given) as an ointment to sooth irritations caused by stinging hairs of insects (6,3; IV<sub>remedy</sub>=1; f).  
UN=2; IV<sub>species</sub>=2

## DILLENIACEAE

*Tetracera scandens* Merr.

Aka pere' - sanding vine

Woody climber. Common, young secondary forest. (89-131)

EYE (LSB): sap extracted from the stem by blowing through a length of stem cut at both ends is applied to the eye as drops to sooth irritation and clear debris (IV<sub>remedy</sub>=1), or to clear clouded vision (7; IV<sub>remedy</sub>=1; m). UN=2;

IV<sub>species</sub>=2

Other uses: the rough leaves are used to sand and smooth wood.

## EBENACEAE

*Diospyros borneensis* Hiern

Kayu kelelingan - oily water wood (LSB, LP)

Overstory tree. Infrequent, primary forest, near river or stream banks. (89-121)

POI: (LSB, LP) fresh fruits are crushed inside an open bamboo tube set in a stream; the pulp washed downstream produces an oily slick on the water and poisons fish, turning the flesh yellow; 25 fruits are sufficient for a medium-sized stream (14,28,29; IV<sub>remedy</sub>=4; mf). UN=1;

IV<sub>species</sub>=4

## EUPHORBIACEAE

*Breynia* sp. (cf., *rhamnoides* (Retz.) Muell.-Arg.)

Aka lundok demah - clear sleep vine

Woody climber. Flower yellow, fruit red. Young secondary forest. (89-202)

SYS (LSB): a decoction of the chopped root is drunk three times on the first day, and a decoction of leaves is applied

as a wash in a mixture (with *Dalbergia pinnata*, Fabaceae, 89-203, and *Myrmeconuclea strigosa*, Rubiaceae, 89-204) on the fourth day of *po bulung*, a treatment of a condition with the symptoms of a humming sound in the ears, vomiting, and dizziness (13,20; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Croton tiglium* L.

*Tuba abeng* - rotting poison (LSB)

*Tuba kule'* - tiger-spot poison (LSB, LP, LA)

Small tree. Infrequent in young secondary forest. Saplings transplanted to home gardens. (89-18)

POI: in LSB, LP, and LA fresh or dried fruits are crushed on racks over a stream and rinsed into the water to stun fish downstream (1,2,22,26). One gunny-sac full is said to stun fish in a half-hour in small streams. Stings eyes and other orifices, especially open sores. (IV<sub>remedy</sub>=4; mf)

DER: the oil from crushed seeds is applied to slivers of wood and spines that have penetrated the skin to aid in extraction (7; IV<sub>remedy</sub>=1; m). DEN: a small root is inserted into tooth cavities to treat toothache by killing worms (*ulet*); the taste is piquant (7; IV<sub>remedy</sub>=1); m).

UN=3; IV<sub>species</sub>=6

*Glochidion arborescens* Bl.

*Suling julut* (1) - follower flute

Large tree. Infrequent, in mature secondary forest. (89-38)

MET (LSB): leaves are mixed with leaves of *Neonauclea calycina* (Rubiaceae, 89-42), crushed with uncooked rice grains (*Oryza sativa*, Poaceae) (3 leaves of each species to one handful of rice), and mixed with cooled, boiled water; the paste is applied to the skin to reduce the swelling associated with beriberi (3,4; IV<sub>remedy</sub>=2; mf). UN=1;

IV<sub>species</sub>=2

*Glochidion* sp.

*Suling julut* (2) - follower flute

Large tree. Young leaves red. Common in young secondary forest. (89-75, 38?)

**SYS/PED** (LSB): leaves are crushed with uncooked rice grains, leaves of *Kadsura scandens* (Schisandraceae, 89-71), and a little water to make a paste, which is applied as an ointment to relieve the itch of measles, pox (*pelian*), especially for young children (8; IV<sub>remedy</sub>=2; mf). **MET**: a paste prepared from leaves crushed with uncooked rice grains and a little water is applied to swollen feet, face, eyes, associated with beriberi (8; IV<sub>remedy</sub>=1; m). UN=2; IV<sub>species</sub>=3

*Homalanthus populneus* (Geisel.) Pax

*Kayu pela'*

Small tree. Common in young secondary forest. (89-33).

**DER**: (LSB, LP) leaves are heated until limp, then rubbed vigorously on skin while hot to treat vitiligo (*litak*) (3,4,30; IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>remedy</sub>=4

*Macaranga gigantea* Muell.-Arg.

*Jela bung-bung* - spotted tongue (LSB)

Small tree. Common, young secondary forest. (89-118)

**DEN** (LSB): latex from the rachis and trunk is applied as an ointment to the tongue and lips to treat thrush (white tongue); astringent (3,4; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Macaranga* sp.

*Payeng kayu* - seasoning wood (LP)

Overstory tree. Infrequent, primary forest, mature secondary forest. Transplanted to home gardens. (89-147)

**POI/VET** (LP): fresh bark is beaten over a stream, the sap rinsed into the water to poison fish downstream (22; IV<sub>remedy</sub>=1); leaves are heated and applied as a poultice to

hair or fur to eradicate ticks and lice (kutu) in human hair or dog fur (22; IV<sub>remedy</sub>=1; m). UN=2; IV<sub>species</sub>=2  
**Other uses:** fruit is crushed, the pulp boiled and fermented for one week, then baked in bamboo tubes and eaten as a seasoning (terasi).

*Manihot esculenta* Crantz

Ubi rambat - cassava

Ubi abo

Shrub. Common, cultivated in home gardens. (Field note 250)

**GI (LSB):** crushed leaves, mixed with gasoline, are applied to the stomach as a poultice to purge worms (3 and others; IV<sub>remedy</sub>=3; f). **GYN:** leaves are mixed with small stones and leaves of *Fagraea racemosa* (Loganiaceae, 89-7); the mixture is charred in fire, wrapped in fresh banana leaf and cloth, and applied as a hot poultice to the abdomen to aid expulsion of the placenta after childbirth; the placenta is usually expelled within one hour (3 and others; IV<sub>remedy</sub>=3; f). UN=2; IV<sub>species</sub>=6

**Other uses:** the thick root is a staple food between rice harvests; the young leaves are boiled and eaten as a vegetable.

*Phyllanthus niruri* L.

Udu beta' - bean herb

Small herb, to 15 cm tall. Infrequent, in wet, disturbed sites. (89-28)

**GI/MET (LSB):** the entire plant is steeped in twice-boiled water, and the infusion drunk without substitution for three days to treat dysentery (IV<sub>remedy</sub>=2) and diabetes (*kencing manis* - sweet urine) (3,4; IV<sub>remedy</sub>=2; mf). **SYS/PED:** an infusion of leaves and stems is drunk to reduce fever, especially in young children (3; IV<sub>remedy</sub>=1; f). UN=3; IV<sub>species</sub>=5

*Trigonopleura malayana* Hook.f.

*Kayu kelelei lan* - true kelelei tree

Overstory tree. Infrequent, primary forest and mature secondary forest (white soils). (89-139, 274)

DER/VET (LSB): young leaves are boiled in water until they are limp, the sap is expressed and reboiled to produce a viscous red liquid (*kembin*), which is dried to a paste (*kebin*) and rubbed on skin to treat scabbies and other rashes (IV<sub>remedy</sub>=1), and to treat dog mange (6; IV<sub>remedy</sub>=1; f). NEU: the *kembin* prepared from leaf sap (as above) is an ingredient of the masticatory called *sirih*, a mixture that also includes the fruit of *Pinaanga coronata* (Arecaceae, 89-220), fresh leaves of *Piper betle* (Piperaceae, 89-114), and a paste prepared from snail shells; the *kembin* is bitter, and stains the gums red (3,4,6; IV<sub>remedy</sub>=4; mf). UN=3; IV<sub>species</sub>=6

#### FABACEAE (LEGUMINOSAE)

*Albizia chinensis* (Osbeck) Merr.

*Enep* (LSB, LP)

Overstory tree. Flower white. Frequency unknown. Primary forest, mature secondary forest. (89-108)

POI (LSB, LP): fresh bark is beaten over a stream and the sap rinsed into the water to kill fish downstream (3,4,28,29; IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>species</sub>=4

*Cassia alata* L.

*Udu kep* - ringworm herb (LSB, LA, LP)

Shrub, flower yellow. Common in young secondary forest. (89-70)

DER/VET: (LSB, LA) leaves are heated over fire until limp, then rubbed on skin infected with scabies (IV<sub>remedy</sub>=4), ringworm (*kurep*) (IV<sub>remedy</sub>=4), and vitiligo (*litak*) (IV<sub>remedy</sub>=4); the treatment is administered every evening

for one week (8,7,24,25); (LP) three drops of gasoline are added to each handful of boiled leaves and the mixture is rubbed on skin as the preferred treatment for ringworm and scabies (30); (LSB, LP) boiled leaves are applied as a rub or poultice to treat dog mange, but the treatment is strong enough to kill a dog if the sores are large and open (8, 30); IV<sub>remedy</sub>=4; mf). UN=4; IV<sub>species</sub>=16

*Dalbergia pinnata* (Lour.) Prain

Aka bo' Ului (1) - old man Ului's vine

Woody climber. Young secondary forest. (89-203, sterile)

DER (LSB): crushed young leaves are applied as a poultice to new wounds (IV<sub>remedy</sub>=1); crushed leaves wrapped in a banana leaf are baked in coals and applied as a poultice to boils and infected sores (tuko') (20; IV<sub>remedy</sub>=1; f). SYS: a decoction of young leaves is drunk three times on the second day, and applied as a wash in a mixture (with *Breynia* cf., *rhamnoides*, Euphorbiaceae, 89-202, and *Myrmeconuclea strigosa*, Rubiaceae, 89-204) on the fourth day of *po bulung*, a treatment of a condition with the symptoms of a humming sound in the ears, vomiting, and dizziness (13,20; IV<sub>remedy</sub>=1; f). UN=3; IV<sub>species</sub>=3

*Dalbergia velutina* Benth.

Aka bo' Ului (2) - old man Ului's vine

Climber. Common, young secondary forest, open, disturbed sites. (89-142, sterile)

DER (LSB): crushed young leaves are applied as a poultice to new wounds (5; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Derris elliptica* (Wallich) Benth.

Tuba aka - poison vine (LSB, LP, LA)

Woody climbing liane. Infrequent, mature secondary forest, transplanted to home gardens. (89-91)

POI: (LSB, LP, LA) fresh bark is beaten over a stream, the sap rinsed into the water to kill the fish downstream; a

wrist-sized bundle is sufficient to poison a small stream (2,3,11,21,23,26,28,29; IV<sub>remedy</sub>=4; mf); a few suicides have occurred when a decoction of the bark (usually boiled in a bamboo tube) is drunk (3; IV<sub>remedy</sub>=1; f). RIT: (LP, LSB) a small sliver of the bark is burned with nine other items in a ritual to remove a curse (21,3; IV<sub>remedy</sub>=4; mf). UN=3; IV<sub>species</sub>=9

*Desmodium* sp. (cf., *triflorum* (L.) DC.)

*Udu pelian bule'* (LA)

Herb. Flower purple. Common in open, disturbed sites. (89-222)

SYS/PED (LA): the entire plant is crushed as part of a mixed infusion given to newborns and young children to treat *pelian* (pox, measles) according to the following dosage: *D. triflorum* - one or more plants; *Hydrocotyle javanica* (Apiaceae, 89-105) - one leaf for an infant, three leaves for a one-month-old; *Kadsura scandens* (Schisandraceae, 89-233) - one leaf for a newborn, 3 leaves for a small child; *Litsea cubeba* (Lauraceae, 89-16) - one fruit for an infant, three fruits for a small child, one handful for an adult (24; IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

*Parkia speciosa* Roxb.

*Kayu beta* (LSB, LA)

Overstory tree. Common, primary forest; transplanted to home gardens. (89-133)

DER: (LSB) the bark is scraped to reveal a red inner layer, which is applied as a dressing to burns; several hours later, the bark is removed and an infusion of the pounded white wood is used to clean the burned area of skin (3,7; IV<sub>remedy</sub>=2; mf). ANT: (LSB, LA) leaves, beans, and bark are eaten raw to counter the effects of the blow-dart poison (*ipo, salok*; the antidote must be taken no later than five minutes after the dart pierces the skin (7, 24; IV<sub>remedy</sub>=2; m). UN=2; IV<sub>species</sub>=4

Other uses: the beans are eaten as a vegetable; diuretic.

*Pongamia pinnata* (L.) Merr.

Tuba jek - quick poison

Shrub, less than 1 m tall. Infrequent, mature secondary forest. (89-124)

POI (LSB): roots are beaten on a rack over a stream (a wrist-sized bundle for a small stream), the sap rinsed into the water to poison fish downstream; fast-acting, considered the strongest of the fish poisons (7 and others; IV<sub>remedy</sub>=3; mf). The shrub is cultivated from root cuttings, but is difficult to grow and grows slowly. Suicides have occurred by drinking an infusion of the root prepared by sealing a short length of root with water in a bamboo tube and warming the infusion briefly over a fire; the drinker dies while sleeping. A man from LSB once intended to commit suicide by this means to escape a three-year illness from dysentery, but fell asleep while warming the infusion, and let it boil; he drank the decoction, slept, and woke cured of the dysentery. The root is considered so poisonous, however, that the decoction is never taken with the intention of treating dysentery (7; IV<sub>remedy</sub>=1; m). UN=2; IV<sub>species</sub>=4

*Saraca declinata* (Jack) Miq.

Kayu buah ala'

Tree. Common, mature secondary forest, near stream banks. (89-196)

GI (LSB): a decoction of bark or young leaves is drunk to treat stomachache accompanied by diarrhea (one handful of bark in a similar volume of water, drunk three or four times daily) (3,6; IV<sub>remedy</sub>=2; f). UN=1; IV<sub>species</sub>=2

*Spatholobus ferrugineus* Benth.

Aka keleasei (LSB, LA)

Climbing liane. Common in young secondary forest and open, disturbed sites. (89-22)

**DER:** (LSB, LA) sap from tender young stems is rubbed on bites and stings to relieve itch (1,2,24,25; IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>species</sub>=4

#### **FLACOURTIACEAE**

*Casearia borneensis* Merr.

Sata, durie - spine

Understory tree with red bark. Common in primary forest and mature secondary forest. Saplings transplanted to home gardens. (89-34, 284)

**GI (LSB):** a decoction of wood slivers from thin stems is drunk to relieve stomachache and diarrhea - the decoction is red (3,4; IV<sub>remedy</sub>=2; f); the fruit is eaten to treat stomachache - the taste is astringent (8; IV<sub>remedy</sub>=1; m).

**GEN:** the decoction prepared for stomachache is also drunk to relieve fatigue (3,4; IV<sub>remedy</sub>=2; mf). **DEN:** leaves and bark are boiled in water until the decoction turns red - the mouth is rinsed repeatedly to treat toothache so as to retain the tooth (3,4,8; IV<sub>remedy</sub>=2; mf). UN=4; IV<sub>species</sub>=7

#### **GESNERIACEAE**

*Aeschynanthus elongata* C.B. Clarke

Aka pebejek - sprain vine

Herbaceous climber. Flower red. Mature secondary forest. Borneo endemic (89-198)

**NEU/ORT (LSB):** crushed leaves are wrapped in banana leaves, baked in coals, and applied as a poultice to sprained joints (13,20,3; IV<sub>remedy</sub>=2; f). UN=1; IV<sub>species</sub>=2

*Aeschynanthus obconica* C.B. Clarke

Aka lepet - twisting vine

Herbaceous climber. Flower red. Infrequent, in primary forest. (89-145)

NEU/ORT (LSB): young leaves baked in coals are wrapped in a cloth and applied as a poultice to swollen, weeping joints (*Tinen bulu*) (3; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Cyrtandra mammillata* Hallier f.

*Udu salapunei* - fairy bluebird nest herb (LSB)

Herb, to 30 cm tall. Flower red. Infrequent, secondary forest. (89-137)

SYS/PED (LSB): an infusion of crushed young leaves is used as a wash to reduce fever resulting from childhood ailments such as pox and measles (*pelian*) (5; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

Note on etymology: the glossy green leaves resemble the feathers of the fairy bluebird (*Irena puella*).

#### GLEICHENIACEAE

*Dicranopteris linearis* (Burm.f.) Underw.

*Namam lan* - true branching fern

Terrestrial fern, woody, forming dense shrub. Common in open, disturbed sites. (89-12)

EYE: (LSB) sap from the fresh stalk of young fiddleheads is squeezed into the eye to sooth pain after injury (1,2; IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

#### GRAMINEAE (SEE POACEAE)

**GUTTIFERAE (SEE CLUSIACEAE)**

**LABIATAE (SEE LAMIACEAE)**

**LAMIACEAE (LABIATAE)**

*Anisomeles* sp.

*Udu aka anye'*

Herb, 30 cm tall. Flower purple. Common in open, disturbed sites. (89-229)

DER (LA): the entire plant is crushed and applied as a poultice to new wounds (24; IV<sub>remedy</sub>=1; m). UN=1;

IV<sub>species</sub>=1

*Dysophylla auricularia* Bl. (syn: *Pogostemon auricularia* Bl.)

*Panyap lenjau* - tiger steam (LSB)

Herb, 1 m tall, flower purple. Infrequent, moist, disturbed sites (89-127)

SYS: (LSB) the patient is steamed over a decoction of leaves to cause a continuous fever to break (3,6;

IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Hyptis capitata* Jacq.

*Udu ampan lumbeng* (1) - widower's stick herb

Herb, 1 m tall. Flower white. Common, open, disturbed sites. (89-208)

SYS (LSB): an infusion of the young leaves at the stem tips (*beluluk*) is drunk to treat chills (20; IV<sub>remedy</sub>=1; f).

UN=1; IV<sub>species</sub>=1

*Hyptis rhomboidea* Mart & Gal.

*Udu ampan lumbeng* (2) - widower's stick herb

Herb. Aromatic. Common in open, disturbed sites. (89-8)

DER: (LSB) the whole plant is crushed while fresh and applied as a poultice to disinfect wounds (1,2; IV<sub>remedy</sub>=3; mf). UN=1; IV<sub>species</sub>=3

*Orthosiphon caudatus*

Udu bulu pak nyao - cats' whisker herb

Shrub, 1 m tall. Flower white, stamens purple. Cultivated in home gardens. (89-58)

NEU (LSB): leaves at shoot tips are sliced, dried in the sun, and stored until needed to prepare an aromatic infusion drunk to relieve backache; the fresh leaves are not used because they have a strong smell (3,4; IV<sub>remedy</sub>=1; f).

UN=1; IV<sub>species</sub>=1

*Plectranthus scutellaroides* (L.) R.Br.

Udu langau - mosquito herb (LSB)

Udu ngeau - cat herb (LA)

Herb, to 1 m tall. Not aromatic. Flower purple. Common in open, disturbed sites. (89-6, 128)

DER: (LSB) leaves and stems are heated over a fire, crushed, and rubbed on insect bites and skin rash (*kudis-kudis*) to relieve itch (1,2; IV<sub>remedy</sub>=2; m) and to treat scabies (*puu'*) (7; IV<sub>remedy</sub>=1; m); (LA) leaves and stems are crushed, wrapped in cloth, and applied as a poultice to a new wound before it is exposed to water (24; IV<sub>remedy</sub>=2; m), and to an old wound to treat infection (3; IV<sub>remedy</sub>=2; f).

UN=3; IV<sub>species</sub>=5

**LAURACEAE**

*Cinnamomum* sp. 1

Lemulang (LSB)

Understory tree or shrub. Root smells of anise.

Infrequent, primary forest, mature secondary forest. (89-211, sterile)

GI: (LSB) a decoction of the peeled root is drunk to treat stomachache (4; IV<sub>remedy</sub>=1; f). RIT: (LSB) the stem and root of a sapling was roasted over fire to weaken spirits; no longer used (3; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=2

*Cinnamomum* sp. 2

*Kayu ba'o lung*

Understory tree. Common, mature secondary forest (white soils). (89-290)

GI (LSB): an infusion of wood scraped from the root is drunk to treat stomachache accompanied by diarrhea and vomiting (3; IV<sub>remedy</sub>=3; f). UN=1; IV<sub>species</sub>=3

*Litsea cubeba* (Lour.) Pers.

*Beleng la'*

Small tree. Fruit aromatic. Infrequent, in young secondary forest. Saplings transplanted to home gardens. (89-16)  
SYS/PED: in LSB, LP, and LA, fresh or stored dried fruits are pulverized in water and the suspension is then heated and drunk to reduce fever (1,2,21,27). In LA, a mixture of this suspension with one drop of a natural oil (Leaman 89-X) is the preferred treatment for fever (dose: 10 fruits for a young child, 30 fruits for a 10-year-old, 50 fruits for an adult). If fruit is not available, the bark is used in the same manner (3,4,7). To reduce fever in nursing babies, the mother drinks a strong decoction of fruit or bark, or a decoction of fruit or leaves is massaged into the crown of the child's head (3,4) (IV<sub>remedy</sub>=4; mf). (LSB) the stalk is eaten, or a decoction of the fresh or dried fruit is drunk to treat a childhood ailment known as *ambun*, possibly smallpox or measles. If the child is very young and nursing, the mother drinks the decoction (13 and others). (LA) dried fruit is crushed as part of a mixed infusion given to newborns and young children to treat *pelian* (pox, measles) according to the following dosage: *L. cubeba* - one fruit for an infant, three fruits for a small child, one

handful for an adult; *Desmodium triflorum* (Fabaceae, 89-222) - one or more plants; *Hydrocotyle javanica* (Apiaceae, 89-105) - one leaf for an infant, three leaves for a one-month-old; *Kadsura scandens* (Schisandraceae, 89-233) - one leaf for a newborn, 3 leaves for a small child. The infusion is given in small doses (half a teaspoon daily for a newborn, one teaspoon daily for a small child, three teaspoons for an adult (24); (IV<sub>remedy</sub>=4; f). GEN: in LSB, a decoction of fruit or bark is drunk to treat undefined ailments resulting in weakness and lethargy (7; IV<sub>remedy</sub>=1; m). RIT: dried fruit is one of the nine ingredients of a mixture burned as incense in curing rituals in LSB and LP (21,3; IV<sub>remedy</sub>=4; mf). GI: (LA) fruits are crushed with salt, mixed into rice porridge, and eaten to improve the appetite during illness with fever (26,27; IV<sub>remedy</sub>=1; mf). UN=4; IV<sub>species</sub>=14

**Other uses:** the fruit is crushed, soaked in water, and added in small amounts to food as a seasoning.

*Litsea noronhae* Bl.

*Buah mali* - difficult fruit (LSB)

Overstory tree. Mature secondary forest. (89-99)

GI (LSB): a decoction of the bark or of roasted or fried seeds is drunk in large quantities to treat cholera; the seeds are stored for this purpose (3,4,15; IV<sub>remedy</sub>=3; mf); a decoction of the bark or roasted seeds is drunk to treat stomachache, gastroenteritis (3; IV<sub>remedy</sub>=1; f). NEU: the fruit pulp or a paste prepared from crushed, roasted seeds is applied as a rubifacient to relieve muscle cramps, pinched nerves (3,4; IV<sub>remedy</sub>=1; f). DER: a paste prepared from crushed seeds and water is applied to infected sores to draw out the infection (15; IV<sub>remedy</sub>=1; m). UN=4;

IV<sub>species</sub>=6

**Other uses:** the fruit is eaten.

*Litséa* aff. *robusta* Bl.

Mali

Tree. Possibly transplanted to home gardens. (89-224)

NEU/ORT (LA): baked seeds are powdered, mixed with water to make a paste, and applied as a rubifacient to ease tense muscles (24; IV<sub>remedy</sub>=1; m). Seed paste prepared as above is applied as a plaster to reduce swelling of broken bones, especially of broken ribs (24; IV<sub>remedy</sub>=1; m). UN=2; IV<sub>species</sub>=2

#### LEEACEAE

*Leea* sp. (cf., *indica* (Burm.f.) Merr.)

Kayu nyelubang - hollow tree

Understory tree. Mature secondary forest. (89-180)

DER (LSB): fresh young leaves, crushed, are applied as a poultice to bleeding wounds (3,4; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

#### LEGUMINOSAE (SEE FABACEAE)

#### LILIACEAE

*Crinum asiaticum* L.

Udu pebejek - sprain weed (LSB)

Herb, to 1.5 m tall. Flower yellow. Infrequent, young secondary forest, wet sites. (89-97)

NEU/ORT: leaves heated over fire are bound around a sprained joint or broken bone to reduce swelling (3,4; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Curculigo* sp.

*Lempa' pisa'*

Herb, to 1 m tall. Flower yellow, on short leafless scape from base of stalk. Infrequent, in mature secondary forest, shaded wet sites. (89-46, 266) DER: (LSB) rhizome is crushed, wrapped in leaves, baked in coals, and applied as a poultice to treat infected sores (especially sores on the feet resulting from contact with the stinging hairs of insects - *Tinen Bulu*) (3,4,7); (LP) the crushed, baked rhizome is applied as a poultice to wounds (21); (IV<sub>remedy</sub>=5; mf). UN=2; IV<sub>species</sub>=5

*Dianella nemorosa* Lam. (Syn: *D. ensifolia* L. Redoute  
*Bete'* - good (LSB)

Herb, to 1.5 m tall. Infrequent, open, disturbed sites. (89-110)

RIT (LSB): the plant was carried off into the forest by the village elders (all male), where it was tied to a tree during a ceremony in which spirits were asked for blessings; no longer used (3,4; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

#### LOGANIACEAE

*Buddleja asiatica* Lour.

*Tuba selabung bekan* - fallow poison noose (LSB-7)

*Tuba palang bekan* - fallow penis-pin poison (LSB-3)

*Tekaleng bekan* - fallow carrying pole (LSB-7, LP-22)

Shrub. Flower white. Infrequent, open, disturbed sites, young secondary forest. (89-134)

POI: (LSB, LP) fresh, young leaves and stems are crushed, then beaten over a small stream, the sap is rinsed into the water to kill fish downstream; one armload per small stream (7,28,29; IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>species</sub>=4

**Other uses:** stems used to make nooses (salabung) for trapping deer. The plant is a favoured food of Sambar deer (payau), *Cervus unicolor*.

*Fagraea racemosa* Jack (ex Wall.)

Kayu batu - stone wood

Overstory tree. Common in mature secondary forest. (89-7)  
**SYS:** (LSB) leaves are heated over fire and applied as a poultice to treat hardness (enlargement) of the spleen (kora-kora) resulting from malaria (1,2; IV<sub>remedy</sub>=2;mf).  
**NEU/ORT:** leaves are heated over fire and applied as a poultice to relieve swelling resulting from sprains and broken bones (1,2; IV<sub>remedy</sub>=1; m) and to relieve arthritic/rheumatic swelling (*Tinen bulu*) (3,4; IV<sub>remedy</sub>=1; f).  
**MET:** a thick paste of crushed leaves mixed with crushed rice grains in hot water is massaged into the skin to reduce swelling from beriberi (*biri-biri*) (7; IV<sub>remedy</sub>=1; m).  
**GYN:** in LSB leaves are mixed with small stones and leaves of cultivated cassava (*Manihot esculenta*, Euphorbiaceae, field note 250); the mixture is charred in fire, wrapped in fresh banana leaf and cloth, and applied as a hot poultice to the abdomen to aid expulsion of the placenta after childbirth; the placenta is usually expelled within one hour (3 and others; IV<sub>remedy</sub>=3; f).  
**DER:** (LA) leaves heated over fire are applied as a poultice to reduce swelling caused by water getting into a wound and causing infection (24,25; IV<sub>remedy</sub>=1; mf). UN=6; IV<sub>species</sub>=9

#### LORANTHACEAE

*Loranthus constrictus* Danser (syn: *Dendrophthoe constricta*)

Buah acheng (1) - flower-pecker fruit (LSB)

Woody parasite. Common, primary forest, mature secondary forest. (89-125). Host: *Parkia speciosa* (Fabaceae, 89-133); also found on *Citrus* spp. (Rutaceae).

GI (LSB): a decoction of dried leaves and stem, mixed in equal amounts with *L. fuscus* (Loranthaceae, 89-126), is drunk to treat stomachache (IV<sub>remedy</sub>=2) and diarrhea (IV<sub>remedy</sub>=2); the decoction is very astringent if prepared from fresh material (7; mf). GEN: the decoction prepared as above is drunk once weekly to preserve youth (7; IV<sub>remedy</sub>=1; m). UN=3; IV<sub>species</sub>=5  
Etymology: the ripe fruits are eaten by a flowerpecker known locally as *acheng*, possibly *Prionochilus xanthopygius*.

*Loranthus fuscus* Bl. (syn: *Scurrula fusca*)

Buah *acheng* (2) - flowerpecker fruit (LSB)

Woody parasite. Common, primary forest, mature secondary forest. (89-126). Host: *Citrus* spp. (Rutaceae).

GI (LSB): a decoction of dried leaves and stems, mixed in equal amounts with *L. constrictus* (Loranthaceae, 89-125), is drunk to treat stomachache (IV<sub>remedy</sub>=2) and diarrhea (IV<sub>remedy</sub>=2); the decoction is very astringent if prepared from fresh material (7; mf). GEN: the decoction prepared as above is drunk once weekly to preserve youth (7; IV<sub>remedy</sub>=1; m). RIT: if the plant is found on bamboo, it is thought to bring good luck, and can be sold for a large sum of money (7; IV<sub>remedy</sub>=1; m). UN=4; IV<sub>species</sub>=6  
Etymology: the ripe fruits are eaten by a flowerpecker known locally as *acheng*, possibly *Prionochilus xanthopygius*.

#### LYCOPODIACEAE

*Lycopodium cernuum* L.

Udu *tange* - weeping herb (LSB - f)

Penganen *langau* - mosquito snake (LSB - m)

Herb, to 1.5 m. Common, open, disturbed sites. (89-80)

RIT/PED (LSB): a weeping child is touched four times on the head with a branch to stop the tears (3,4; IV<sub>remedy</sub>=1; f).

UN=1; IV<sub>species</sub>=1

Other uses: indicator of dry, infertile soil (1,7).

*Lycopodium* sp.

*Udu penganen* - snake herb (LSB)

Herb, 1.5 m tall. Common, mature secondary forest. (89-117, 267)

DER (LSB): crushed leaves are packed as a poultice into fresh wounds (3,4; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

Other uses: indicator of fertile soils.

#### MALVACEAE

*Sida rhombifolia* L.

*Penaggeng*

Shrub. Flowers yellow. Cultivated, in home gardens. (89-17)

GI: (LSB) young leaves are crushed, mixed with the yolk of a hen's egg, and eaten to treat stomachache and relieve vomiting (1,2; IV<sub>remedy</sub>=2; m), or to relieve *tenei mudep*, a hard feeling in the stomach (7; IV<sub>remedy</sub>=1; m). UN=2; IV<sub>species</sub>=3

*Urena lobata* L.

*Udu njau lupang*

Shrub. Flower pink. Common in open, disturbed sites. Cultivated in home gardens. (89-24)

DER: (LSB) the flower is heated over fire and applied to sores (*bisul*) to open and draw out the infection (3; IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

## MELASTOMATACEAE

*Astronia macrophylla* Bl. Bijdr.

*Jelemutin empak'* - primary forest jelemutin

Understory tree. Flower yellow/cream. Primary forest (89-146)

GI/SYS (LSB): a strong decoction of young leaves and stems is drunk to treat stomachache (IV<sub>remedy</sub>=1) accompanied by diarrhea (IV<sub>remedy</sub>=1) and fever (IV<sub>remedy</sub>=1); the decoction is astringent (3; f). UN=2; IV<sub>species</sub>=3

*Medinilla crassifolia* (Bl.) Bl.

*Kelepulo'* - tens (of fruit)

Climbing liane. Fruit an orange berry. Common in primary forest and mature secondary forest. (89-19)

DER: (LSB) crushed young leaves are applied to new wounds as a poultice to arrest bleeding (3,4; IV<sub>remedy</sub>=3; mf).

UN=1; IV<sub>species</sub>=3

Other uses: the fruit are used as fish bait, and are sometimes eaten by children (7).

*Melastoma malabathricum* L.

*Jelemutin (jemutin)*

Tall shrub. Flower pink. Common in open, disturbed sites and young secondary forest. (89-20)

NEU: (LSB) swollen and weeping arthritic joints (*Tinen bulu*) are soaked in a strong decoction of crushed leaves (1; IV<sub>remedy</sub>=2; mf). DER: (LSB) weeping sores caused by the stinging hairs of an insect, also called *Tinen bulu*, are soaked in a strong decoction of leaves to aid extraction of the hairs (7; IV<sub>remedy</sub>=1); the same preparation is used to disinfect other types of weeping wounds (IV<sub>remedy</sub>=1) (3; mf). GI: (LP) a decoction of leaves is drunk to treat stomachache (21; IV<sub>remedy</sub>=1; f). CAR-PUL: (LSB) in the past, a cold infusion of leaves prepared in a length of bamboo was drunk to treat tuberculosis by causing the

patient to vomit a great deal of blood, after which good health returned quickly (3,4; IV<sub>remedy</sub>=1; f). UN=5; IV<sub>species</sub>=6

#### MELIACEAE

*Aglaia dookoo* Griff. (syn: *Lansium domesticum* Corr. Serr.)  
*Lengeset* (LSB, LP)

Overstory tree. Common in mature secondary forest and primary forest. (89-30)

SYS: (LSB, LP) a strong decoction of inner bark (a handful of bark boiled in water for one hour) is drunk in two-tablespoon doses three times daily (on a full stomach) for four days to treat malaria; the fever should abate after three days. The decoction is freshly prepared each day, but dried bark is preferred to fresh; the drink is bitter. A decoction of crushed seeds is also used in this manner, but is more bitter and not preferred (3,4,21; IV<sub>remedy</sub>=4; mf).

UN=1; IV<sub>species</sub>=3

Other uses: the fruits are sought and eaten by children. In the Kroayan region north of the Apo Kayan, leaves are placed with confined chickens suffering from sleeping sickness to perk them up.

*Aglaia* sp.

*Kayu apiek* (LP)

*Kayu luit* (LSB)

Overstory tree. Infrequent, primary forest. (89-187)

POI (LSB, LP): fresh bark is beaten over a stream and the sap rinsed into the water to poison fish downstream (22,3;

IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>species</sub>=4

Other uses: the wood is used to build dugout canoes.

## MORACEAE

*Ficus* sp. (cf., *uncinulata* King Becc.)

Abung (LSB)

Tree, white bark. Infrequent, in young secondary forest. Borneo endemic. (89-73)

GI (LSB): the fruit is eaten fresh with salt to treat diarrhea (8), but the treatment sometimes exacerbates the ailment (3); (IV<sub>remedy</sub>=1; mf). DER: crushed young leaves are applied as a poultice to new wounds to stop bleeding (3 and others; IV<sub>remedy</sub>=2; f). UN=2; IV<sub>species</sub>=3

## MUSACEAE

*Musa borneensis* Becc.

Sawan, punyang (barana)

Giant herb. Flower pendulent. Infrequent, in young secondary forest. (89-53, 276)

GYN (LSB): a decoction of the heart of young flowers is drunk to hasten and increase the flow of breast milk after childbirth (3,4; IV<sub>remedy</sub>=1; f). DER: sap from the stalk is applied to skin irritations from stinging insects (ulet - caterpillars); the sap stains skin and clothing orange (3,4; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=2

Other uses: the immature fruit is cooked for eating; the mature fruit has too many seeds (3,4).

*Musa* spp.

Petee - banana (LSB)

Giant herbs, many wild varieties. Common, young secondary forest, transplanted to and cultivated in home gardens. (Field note 244)

ANT/DER (LSB): the leaf sheath (pak) is heated over fire to bring out the sap, and is bound as a poultice to draw out the poison and relieve the pain of snake bite (IV<sub>remedy</sub>=2)

or centipede (*lipan*) sting (IV<sub>remedy</sub>=2); does not reduce the swelling; the treatment is called *lemedem* (11; m). SYS/PED: the leaves of the variety called *petee lata'* (big banana) are heated over fire until they darken, then rubbed on the skin of babies suffering from *pelian* (measles, pox) to reduce fever and to diagnose the illness; if drawing the smooth side of the leaf produces a rasping sensation, the illness *pelian* is confirmed, and other treatments for the ailment are then given (7,3; IV<sub>remedy</sub>=2; mf). GI: used to treat illness that produce blood in vomit (7; IV<sub>remedy</sub>=1; m). UN=4; IV<sub>species</sub>=7

**Other uses (LSB):** The fruit of most varieties is eaten. Leaves of most varieties are used to wrap food, medicines for baking or roasting, and poultices applied to the skin. Drinking cups, plates, and spoons are fashioned from the pliable leaves. A large leaf serves as an umbrella in a downpour; a temporary roof on a forest hut is made of overlapping leaves.

#### MYRSINACEAE

*Embelia ribes* Burm.f.

Aka *sekileng* (LSB, LP)

Creeping liane. Common in mature secondary forest. (89-82)  
POI: (LSB) fresh bark, beaten until soft, is rubbed on the feet, ankles, lower legs to repel leeches; a fresh supply is carried on long overland journeys (3,4; IV<sub>remedy</sub>=3). (LSB, LP) The leaves and bark are beaten and the sap rinsed into a river or stream to poison fish (3,4,28,29); in LP, considered the strongest of the fish poisons (28,29). A small stream requires five thigh-thick bundles of bark; the sap makes the water soapy, the fish become agitated before dying (7); (IV<sub>remedy</sub>=4; mf). UN=2; IV<sub>species</sub>=7

**Other uses:** the fruit is eaten. During the Japanese occupation, when food was scarce, the leaves were cooked

with stalks of *Etilingera eliator* (Zingiberaceae, 89-40), and eaten (7).

*Labisia pumila* Benth. & Hook.f.

*Udu mudung bio'* - big mountain herb (LSB)

Herb, .5 m tall. Flower white, fruit red, on spathe-like inflorescence. Infrequent, in primary forest and mature secondary forest. (89-78)

RIT (LSB): leaf and rhizome were burned as protection from malevolent spirits during storms; no longer used (3,4;

IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

*Maesa ramentacea* (Roxb.) A. DC.

*Aka pelandu* - mousedeer vine

Woody climbing liane. Fruit is a white berry. Distribution and habitat unknown. (89-210)

SYS/GEN (LSB): a decoction of clean leaves is drunk to treat mild fever (IV<sub>remedy</sub>=1) and weakness (IV<sub>remedy</sub>=1) (13; f). UN=2; IV<sub>species</sub>=2

#### MYRTACEAE

*Cleistocalyx operculatus* (Roxb.) Merr. & Perry

*Uba tepu* - sugar root (LSB)

*Tampu* - (LA)

Understory tree. Common, young secondary forest, mature secondary forest, primary forest. (89-191)

GI (LA): a filtered infusion of leaves or bark is drunk to treat stomachache (26; IV<sub>remedy</sub>=1; m). UN=1; IV<sub>species</sub>=1

**Other uses:** (LSB) the fruit is eaten, the wood is used for housebuilding.

*Psidium guajava* L.

*Simo*

Small tree. Common in young secondary forest. (89-32)

GI (LSB): a decoction prepared by boiling a large handful of clean leaves for two hours, or until the decoction is black, is drunk in doses of one-half glass three times daily to treat diarrhea; the taste is astringent (3,4). The diarrhea stops more quickly if the leaves are eaten raw with salt - about seven leaf-tip clusters for an adult or three leaves for a child (7); IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

*Syzygium* sp. (cf., *confertum* (Korth.) Merr. & Perry)

*Kayu besuk*

Tree. Flower white. Common in mature secondary forest, near river and stream banks. (89-10, 226)

GI: (LSB) a decoction prepared from young leaves is drunk to treat stomachache; a normal dose is one glass each day for two days. The decoction is astringent (*sepelet*) (1,2; IV<sub>remedy</sub>=2). (LA) a decoction of leaves is drunk to treat diarrhea (24; IV<sub>remedy</sub>=1; mf) UN=1; IV<sub>species</sub>=3

#### ONAGRACEAE

*Ludwigia hyssopifolia* (G. Don.f.) Exell

*Semangkak bali* - spirits' red dye (LSB)

Herb, .3 m tall. Common (?). Young secondary forest, wet sites. (89-111)

DER (LSB): a decoction of leaves and stem is used to wash out infected wounds and sores (3,4; IV<sub>remedy</sub>=3; f). UN=1; IV<sub>species</sub>=3

#### PALMAE (SEE ARECACEAE)

## PASSIFLORACEAE

*Passiflora foetida* L.

*Pidang tanjung* - cape raspberry

Herbaceous climbing liane. Common in open, disturbed sites.  
(89-216)

SYS/PED (LSB): young stems are eaten raw, or boiled and the decoction drunk to treat *ambun*, a childhood disease (possibly smallpox or measles). If the child is very young and nursing, the mother drinks the decoction (13,20; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

## PEDALIACEAE

*Sesamum indicum* L.

*Lesayat*

Herb. Flower white. Common, cultivated in rice fields.  
(89-278)

RIT (LSB, LP): seeds are burned in a ritual cure of ailments caused by curses (21,3; IV<sub>remedy</sub>=4; f). UN=1; IV<sub>species</sub>=4

Other uses: the seeds are used to season food.

## PIPERACEAE

*Piper arborescens* Miq.

*Balang ulet* - (proud) caterpillar (LSB)

*Aka balet* - yellow vine (LSB)

*Aka unga* (LA)

Climbing liane. Root pith yellow. Inflorescence green, inconspicuous. Common in primary forest and mature secondary forest. (89-39, 56, 227)

DER: (LSB) leaves of *balang ulet* are crushed and applied as an ointment to relieve irritation resulting from contact

with the caterpillar known locally as *ulet jaten* (3,4; IV<sub>remedy</sub>=2; mf). GI: a strong, bitter-tasting infusion prepared from the pulverized yellow root of *aka balet* is drunk to treat stomachache (IV<sub>remedy</sub>=1) and diarrhea (8; IV<sub>remedy</sub>=1; m). SYS: an infusion of the root is drunk to treat malaria (8; IV<sub>remedy</sub>=2; m). GYN: (LA) a cold poultice of crushed leaves of *aka unga*, wrapped in a cloth, is applied to the abdomen to relieve soreness and reduce swelling after childbirth (24; IV<sub>remedy</sub>=1; m). UN=5; IV<sub>species</sub>=7

*Piper betle* L.

*Udu sepak* - sucking herb (LSB, LA)

Herbaceous climber. Cultivated in home gardens. (89-114)

SYS/PED: (LSB) a decoction of leaves is drunk to reduce fever (3; IV<sub>remedy</sub>=2; f); a decoction of leaves is drunk by children to reduce fever associated with malaria (3; IV<sub>remedy</sub>=2; f). NEU: (LSB, LP, LA) Leaves are among the ingredients of *sirih*, a mixture chewed as a stimulant and appetite depressant; the leaf is rolled around a paste made from snail shells (*kemper*), the fruit of *Pinanga coronata* (Arecaceae, 89-220), and a preparation of leaves of *Trigonopleura malayana* (Euphorbiaceae, 89-139) (3,4; IV<sub>remedy</sub>=4; mf). DEN: (LSB) the mixture described above blackens the teeth, reddens the gums, and strengthens the teeth (3,4; IV<sub>remedy</sub>=2; f); (LA) a decoction of leaves is rinsed in the mouth to treat toothache (24; IV<sub>remedy</sub>=2; m). CAR-PUL: (LSB) leaves are inserted in the nostril to stop nose bleed; an infusion of crushed leaves is used to wash the face and nose (four leaves per glass of water) (3,4; IV<sub>remedy</sub>=1; f). DER: (LSB) crushed leaves are applied as a poultice to infected sores or boils (3,4; IV<sub>remedy</sub>=1; f). GI: (LA) crushed leaves are mixed with a cosmetic hair oil (*minyak tancho*) and applied as a rubifacient to the stomach to treat stomachache not associated with diarrhea (26,27; IV<sub>remedy</sub>=1; mf). UN=8; IV<sub>species</sub>=15

*Piper peltatum* L. (syn: *Pothomorphe peltata*)

*Balang*

Small herb. Common, in open, disturbed sites. (89-52)

**GI/PED** (LSB): boiled leaves and stems are eaten to treat stomachache (IV<sub>remedy</sub>=2) and worms in children (3,4; IV<sub>remedy</sub>=2; mf). **GEN**: boiled leaves and stems are eaten with rice porridge for strength during any sort of illness (3,4; IV<sub>remedy</sub>=2; mf). **DEN**: boiled leaves and stems are eaten to clean the mouth (3,4; IV<sub>remedy</sub>=1; f). UN=4; IV<sub>species</sub>=7

*Piper* sp.

*Aka unga kalong* - necklace vine (LP)

Herbaceous climber. Primary forest, mature secondary forest. (89-148, sterile)

**GI** (LP): rhizome and leaves are boiled in a well-covered pot, which is not opened until it has been removed from the fire and cooled; one-half glass of the decoction is drunk three times daily to treat stomachache (IV<sub>remedy</sub>=1), gall stones (IV<sub>remedy</sub>=1), diarrhea (IV<sub>remedy</sub>=1), heartburn (IV<sub>remedy</sub>=1) (21; f). **GYN**: a decoction prepared as above is drunk to relieve soreness after childbirth (21; IV<sub>remedy</sub>=1; f). UN=5; IV<sub>species</sub>=5

#### **POACEAE (GRAMINEAE)**

*Coix lacryma-jobi* L.

*Jele'latung* (LSB)

*Pakat jalei* (LP)

Herb, to 2.5 m tall. Infrequent, in open sites in shallow, running water (LSB). (89-89)

**EYE**: (LSB) the stalk is roasted over fire, the sap from the tender inner pith squeezed into the eye to treat infections; dosage, 5 drops (11,2; IV<sub>remedy</sub>=1; m). **GI**: a decoction

prepared in a bamboo tube from a handful of roots is drunk to treat churning stomachache (IV<sub>remedy</sub>=1) and purge worms (IV<sub>remedy</sub>=1) (LSB; 2,11; m), and to treat vomiting (IV<sub>remedy</sub>=1) and heartburn (IV<sub>remedy</sub>=1) (LP; 21; f). UN=5; IV<sub>species</sub>=5

Field note: the seeds are collected from wild plants and cultivated by consultants in LP.

*Leersia hexandra* Swartz

*Kupei* (LSB, LP)

Herb, to 1 m tall. Common, open, disturbed sites. (89-122)  
CAR-PUL: (LSB) leaves and stem are steeped in hot water until the infusion is bright green; the infusion is drunk to treat irritating cough (6,3); (LP) an infusion of leaves and stem is mixed with salt and sugar, then drunk to sooth cough (21); (IV<sub>remedy</sub>=4; f). UN=1; IV<sub>species</sub>=4

*Lophatherum gracile* Brongn.

*Udu kedapet* (2) - stick-tight herb

Herb, .3 m tall. Common, open, disturbed sites. (89-120)  
SYS (LSB): a decoction of the rhizome is drunk to break a fever (IV<sub>remedy</sub>=1) accompanied by chills (IV<sub>remedy</sub>=1) (3,4; f). UN=2; IV<sub>species</sub>=2

*Miscanthus floridulus* (Labill.)

*Iyeng*

Shrub-like habit, 2 m tall. Common in open, disturbed sites. (89-215)

SYS/PED (LSB): the stalk is eaten raw, or boiled and the decoction drunk to treat a childhood illness known as *ambun*, possibly smallpox or measles. If the child is very young and is nursing, the decoction is drunk by the mother (13 and others; IV<sub>remedy</sub>=3; f). GEN: the stalk is eaten, or a decoction of the stalk drunk to treat weakness, general malaise (3 and others; IV<sub>remedy</sub>=3; f). UN=2; IV<sub>species</sub>=6

*Oryza sativa* L.

Baa' - rice

(Field note 300). The Kenyah grow at least 25 varieties of rice in swidden cultivation.

Rice grain accompanies many different types of treatments. It is also used medicinally in some mixtures in which it appears to be the primary ingredient. GI/SYN: (LSB) leftover cooked rice is reduced to charcoal in hot coals, powdered, mixed with orange (*Citrus* spp.) juice to produce a paste, which is eaten to treat stomachache accompanied by vomiting (IV<sub>remedy</sub>=1) and diarrhea (IV<sub>remedy</sub>=1) (17; m). This is the preferred treatment for stomachache in LSB; the dosage is two handfuls of rice to one-half glass of orange juice (3 and others; IV<sub>remedy</sub>=3; mf); the treatment given above for stomachache is also used to treat cholera (3 and others; IV<sub>remedy</sub>=3; f). (LA) rice porridge is mixed with crushed fruit of *Litsea cubeba* (Lauraceae, 89-16) and eaten to stimulate the appetite during illness with fever (IV<sub>remedy</sub>=1) (26,27; mf). MET: (LA) a fermented paste of powdered rice grains and the rhizome of *Alpinia galanga* (Zingiberaceae, 89-61) is thinned with water and applied as a rubifacient to swollen areas to treat beriberi (26,27; IV<sub>remedy</sub>=1; mf). UN=6; IV<sub>species</sub>=10  
Other uses: rice is the most important staple food, not only for the Kenyah, but also for village dogs, chickens, and domesticated pigs, to whom the leftover rice is fed. A fermented form, called *borak*, is prepared for festive occasions, to feed work parties during planting, harvest, and housebuilding. Cooked rice is fermented to prepare a beer (*tuak*) and a distilled alcohol (*arak*).

*Paspalum conjugatum* Bergius

Udu alok - foreign herb (LSB)

Herb, to 30 cm tall. Common, open, disturbed sites. (89-101)

DER (LSB): young blades are chewed and applied as a poultice to fresh wounds (3,4; IV<sub>remedy</sub>=3; f). UN=1; IV<sub>remedy</sub>=3

*Saccharum officinarum* L.

Tepu (sugar cane)

Woody herb. Common, cultivated in home gardens. (89-298)

DER (LSB): bits of stalk are chewed to remove sap, then baked in coals, and applied as a poultice to tissues swollen with infection from a wound in another part of the body (pe'liei) (3; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

Other uses: the sap used as a sweetener. The canes are chewed and sucked by children as a sweet.

*Schizostachyum latifolium* Gamble

Bulo lan - true bamboo

Shrub. Common, primary forest, mature secondary forest, young secondary forest, open, disturbed sites. (89-206, sterile)

DER/VET (LSB): leaves are heated over fire until dry, mixed with ash, and packed into dogs' wounds infested with maggots (13; IV<sub>remedy</sub>=2; f). UN=1; IV<sub>species</sub>=2

Other uses: young stalks are boiled or baked and eaten as a vegetable. Large woody stalks are used as containers for cooking and food storage.

Undetermined sp.

Udu bawing

Herb. Cultivated in open areas near longhouses. (89-253)

NEU/ORT (LA): an infusion of the leaves is massaged into the skin to ease soreness, especially following a fall (24; IV<sub>remedy</sub>=1; m). UN=1; IV<sub>species</sub>=1

## POLYGONACEAE

*Polygonum barbatum* L.

Tuba beriking - crazy poison (LSB, LP)

Tiking (LA)

Herb, 3 cm tall. Flowers white. Infrequent, wet disturbed sites. (89-116)

POI: (LSB, LP, LA) fresh plants are crushed, beaten on a rack over a stream, and the sap rinsed into the water to poison the fish downstream; stings sharply in the eyes of divers (3,4,28,29; IV<sub>remedy</sub>=4; mf). DER/VET: (LSB) an infusion of the crushed plant is applied as a wash to treat dogs' mange (3,4; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=5

## POLYPODIACEAE

*Blechnum orientale* L.

Paku telao - barking deer fern

Terrestrial fern, woody, fronds to 2 m long. Common in open, disturbed sites. (89-87)

DER (LSB): the fiddlehead is crushed, heated over fire, and applied to the rim of a weeping sore to draw out the infection (3,4,11; IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

*Drynaria sparsisora* Moore

Tuban - epiphyte

Bracket fern, epiphyte. Common in primary forest and mature secondary forest. (89-9)

GI: (LSB) a decoction prepared from sliced, thick roots is drunk as an anthelmintic. The decoction is not bitter.

(1,2; IV<sub>remedy</sub>=2; m). NEU/ORT: the thick root is pulverized, baked in coals, and applied as a poultice to relieve swelling (3; IV<sub>remedy</sub>=2; mf). UN=2; IV<sub>species</sub>=4

*Nephrolepis biserrata* Schott

*Paku julut* - follower fern

Herbaceous, fronds to 1.5 m tall. Common in open, disturbed sites. (89-25)

**GYN:** boiled young fronds are eaten as a postpartum tonic to clean and increase the breast milk and to increase the mother's appetite (3,4; IV<sub>remedy</sub>=3; mf). **DEN:** boiled young fronds are eaten to freshen foul breath (3,4; IV<sub>remedy</sub>=1; f). **GEN:** boiled young fronds eaten as a tonic for non-specific ailments (3; IV<sub>remedy</sub>=1; f). UN=3; IV<sub>species</sub>=5

#### **PROTEACEAE**

*Heliciopsis artocropoides* Elm.

*Kayu tengat* - taboo tree (LSB)

Tree. Common in primary forest and mature secondary forest. (89-77)

**RIT/PED (LSB):** small pieces of the dried wood were slipped into a child's carrier (*bening*) on its naming day, a tradition now replaced by baptism (3,4; IV<sub>remedy</sub>=2; mf).

**DER:** young leaves are heated over fire until limp, and the sap applied as an ointment to relieve the itch of insect bites (*puu'*) (3,4; IV<sub>remedy</sub>=1; f); the leaves prepared in this manner were used to clean the skin, a use now replaced by soap (3,4; IV<sub>remedy</sub>=1; f). UN=3; IV<sub>species</sub>=4

#### **RAFFLESIACEAE**

*Rhizanthus* sp.

*Buah aka pun* - fruit of the treeshrew vine (LSB - bud)

*Punyang tanah* - earth punyang (LSB - flower)

(89-245) Parasite on *Tetrastigma pedunculare* (Vitaceae, 89-161). Infrequent, mature secondary forest.

GI (LSB): the immature bud is charred, powdered, mixed with water, and the suspension drunk to treat stomachache and dysentery; the buds are collected whenever encountered, dried, and stored until needed; the mature flower is rarely seen (16; IV<sub>remedy</sub>=4; f). UN=2; IV<sub>species</sub>=4

Field note: the buds are said to be eaten by treeshrews and other small mammals. Flower is said to be black and white (2), and to occur in pairs, one about 30 cm in diameter, and the other somewhat smaller (2,3).

#### **RHAMNACEAE**

*Zizyphus borneensis* Merr.

Aka *silu sing* - cats' claw vine

Woody climber. Flower green/white. Infrequent, mature secondary forest. (89-186) Borneo endemic.

POI (LSB): fresh bark is beaten over a stream, the sap rinsed into the water to kill fish downstream (19;

IV<sub>remedy</sub>=1; m). UN=1; IV<sub>species</sub>=1

#### **ROSACEAE**

*Rubus moluccanus* L.

*Pidang pelaki* - hawk raspberry

Climbing liane. Flower white, fruit red. Common in young secondary forest, sunny openings. (89-3)

GI: (LSB) a decoction of young stems (tendrils) is drunk to treat stomachache (9; IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

## RUBIACEAE

*Hedyotis* sp. (cf., *sumatrana* Merr.)

*Udu taban sua'* - wound medicine herb (LSB)

*Aka sekiput lulut* - shin-bone closing vine (LSB)

Herbaceous climber. Infrequent, in open, disturbed sites.

(89-95)

DER (LSB): crushed leaves are heated over fire and applied as a poultice to new wounds (11; IV<sub>remedy</sub>=1; m). UN=1;

IV<sub>species</sub>=1

*Mussaenda laxiflora* Merr.

*Aka tepilik sulau* - tossed coin vine (LSB)

Climbing liane, flower orange, sepals green above, white beneath. Common in young secondary forest. (89-69)

RIT (LSB): the consultant related an instance in which a healer (*dayung*) from the distant village Mahak carried with him a piece of the root whenever he entered government law offices, as a charm (*na'an-na'an*) to avoid prosecution (8; IV<sub>remedy</sub>=1; m). GI: the leaves have an enhancing, or symbiotic effect in the treatment of stomachache when mixed with other stomachache treatments, but are not effective used alone (7; IV<sub>remedy</sub>=1; m). UN=2; IV<sub>species</sub>=2

Other uses: young leaves are mixed with other vegetables as a seasoning (3).

Note on etymology: fruit and white sepals resemble *leko' sulau*=coin made of snail shell, imported from Irian Jaya, often seen on *bening* (baby carriers). *Pilik (tepilik)* = to toss, as in skipping stones on water.

*Myrmeconuclea strigosa* (Korth.) Merr.

Kenyah name unknown

Shrub. Flower white. Common, young secondary forest, near stream banks. (89-204)

SYS (LSB): a decoction of chopped root and stem is drunk three times on the third day, and applied as a wash in a

mixture (with *Breynia* sp., Euphorbiaceae, 89-202, and *Dalbergia pinnata*, Fabaceae, 89-203) on the fourth day of *po bulung*, a treatment of a condition with the symptoms of a humming sound in the ears, vomiting, and dizziness (13,20; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Nauclea purpurascens* Korth.

*Tembalut bai* - river edge (LSB)

Overstory tree. Mature secondary forest, near river or stream banks. (89-100)

GI (LSB): a decoction of leaves or bark is drunk to treat diarrhea (IV<sub>remedy</sub>=1) and dysentery (IV<sub>remedy</sub>=1); the bark decoction is bitter and astringent (3,4,7; mf). DER: unspecified part used to treat infected sores (3,4; IV<sub>remedy</sub>=1; f). SYS: a decoction of leaves or bark is drunk to treat fever (3,4; IV<sub>remedy</sub>=1; f). UN=4; IV<sub>species</sub>=4

*Neonauclea calycina* (Bartl. ex DC.)

*Kayu sa'ong* - hat tree

Large tree. Primary forest, and mature secondary forest. (89-42)

MET (LSB): a paste prepared by crushing leaves with uncooked rice grains, leaves of *Glochidion arborescens* (Euphorbiaceae, 89-38), and a little water is applied to swelling associated with beriberi (3,4; IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

*Oldenlandia diffusa* Roxb. (syn: *Hedyotis diffusa* Willd.)

*Udu pelian* (2) - pox herb

Low, matting herb. Flowers white. Common, in open, disturbed sites near water. (89-50)

SYS/PED (LSB): a light decoction (once-boiled) of crushed clean shoots is drunk to treat *pelian* (measles, or a similar infection that produces red eruptions of the skin and affects children); the decoction is not bitter, and is given

directly to the ailing child or is drunk by a mother nursing an afflicted baby (3,4; IV<sub>remedy</sub>=2; mf). CAR-PUL: a decoction of clean shoots is drunk to quiet a cough (3,4; ts IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=3

*Oldenlandia verticillata* Korth. (syn: *Hedyotis verticillata* (L.) Merr.)

*Udu langau* - mosquito weed (LSB)

Herb, .3 m tall. Flower white. Infrequent, open, disturbed sites. (89-96)

DER: (LSB) leaves are heated over fire until slightly blue, then applied as a poultice to infected wounds (1,7; IV<sub>remedy</sub>=2; m). UN=1; IV<sub>species</sub>=2

*Spermacoce laevis* Lam. (syn: *Borreria laevis* Griseb.)

*Udu pelian* (1) - pox herb (LSB)

Herb, .3 m tall. Flower white. Common, open, disturbed sites. (89-106)

SYS/PED (LSB): an infusion of the leaves and stem is drunk or applied as a rubifacient to treat *pelian* (measles, pox) in children (3,4; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Spermacoce ocymoides* Burm.f. (syn: *Borreria ocymoides* (Burm.f.) DC.)

*Udu tai iyap* - chicken dung herb

Herb, creeping. Flower white. Common, open, disturbed sites. (89-199)

DER (LSB): washed, fresh leaves are crushed and applied as a poultice to new wounds (13,20; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

Note on etymology: said to occur only where there are chickens.

*Timonius* sp.

*Tung noh* - Noh's leaf

Large tree. Common in mature secondary forest. (89-37)

**DER** (LSB): mature leaves are heated over fire, crushed, and the sap rubbed on skin to treat infections (*puu'*) and relieve itch (3,4); mature leaves are also used in this manner without being heated (7). The rub feels hot. Commercially produced soap is now preferred to this preparation, which turns the skin green ( $IV_{\text{remedy}}=3$ ; mf).  
UN=1;  $IV_{\text{species}}=3$

*Uncaria cordata* (Lour.) Merr.

Aka *kelawit* - hook vine

Climbing liane, hook-shaped tendrils. Common, mature secondary forest. (89-47)

**MET** (LSB): the abundant watery sap is a source of water and vitamins for travellers; thick vines yield sufficient water for cooking (3,4,7;  $IV_{\text{remedy}}=2$ ; mf). UN=1;  $IV_{\text{species}}=2$

**Other uses:** the bark is beaten flat, shredded, blackened in mineral-rich mud (*tunyeng*), washed, dried, and used as tinder with flint and steel striker (7).

## RUTACEAE

*Citrus* spp. (cf., *aurantium* L.)

*Limau* - bitter orange

Tree. Common, cultivated in home gardens. (89-248)

**GI** (LSB): juice of the fruit is mixed with charred and powdered rice (*Oryza sativa*, Poaceae, field note 300) to make a paste, which is eaten to treat stomachache accompanied by vomiting ( $IV_{\text{remedy}}=1$ ) and diarrhea ( $IV_{\text{remedy}}=1$ ) (17). This is the preferred treatment for stomachache in LSB; the dosage is two handfuls of rice to one-half glass of orange juice (3,17;  $IV_{\text{remedy}}=3$ ; mf); the treatment given above for stomachache is also used to treat cholera (3 and others;  $IV_{\text{remedy}}=3$ ; f). **DER:** warmed juice of the fruit is used to wash out a heavily bleeding wound that has been treated with salt and the fruit of *Capsicum*

*frutescens* (Solanaceae, 89-205) (3 and others; IV<sub>remedy</sub>=3; f). RIT: fresh leaves are strewn on the floor around the body of person who has recently died, throughout the several days required to carve the coffin (*peti*) and hold the wake; the leaves mask the odor of the body (3 and others; IV<sub>remedy</sub>=3; f). UN=6; IV<sub>species</sub>=14  
Other uses: the fruit is edible.

#### SAPINDACEAE

*Nephelium* sp. (cf., *cuspidatum* Bl.

*Buah abung* (LSB)

Overstory tree. Infrequent in mature secondary forest, transplanted to village gardens. (89-88) Borneo endemic.

DEN (LSB): the mouth is rinsed with a strong, decoction prepared from one handful of crushed bark; one or two weeks later all the teeth fall out; astringent (11,2). The decoction can be applied carefully to individual teeth to aid extraction (7); (IV<sub>remedy</sub>=2; m). UN=1; IV<sub>species</sub>=2

*Nephelium criopetalum* (?)

*Buah tilo* - egg fruit (LSB)

Overstory tree. Infrequent, mature secondary forest. (89-109)

POI (LSB): bark is beaten over a stream, the resulting milky sap is rinsed into the water to kill fish downstream; rarely used because harvesting the bark kills the tree, which is protected for its fruit (3,4; IV<sub>remedy</sub>=1; f).

UN=1; IV<sub>species</sub>=1

Other uses: the fruit is eaten (3,4).

## SAPOTACEAE

*Palaquium calophyllum* (Tesyms.)

Kayu pute' - white wood

Puto' babui - white pig

Overstory tree. Infrequent, primary forest. (89-143, sterile)

POI (LSB): bark is crushed on a rack over a stream, the sap rinsed into the water to poison fish downstream (3,7;

IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

Other uses: planks cut from the wood are used to build house walls. The effect of the bark on fish was discovered in the early 1980s by someone cutting planks near a stream.

## SCHISANDRACEAE

*Kadsura scandens* Bl. (var. 1)

Aka tisip lanak - ulcer sucker (LSB, LA)

Woody climbing liane. Fruit a red aggregate berry. Root flesh orange, bitter. Common, in primary forest. (89-55, 232)

DER: (LSB) pulverized leaves and bark are wrapped in banana leaves, half-baked in coals, and applied as a poultice to weeping skin ulcers to draw out the pus (8; IV<sub>remedy</sub>=1; m).

GI: (LA) a decoction of inner bark is drunk to treat stomachache (IV<sub>remedy</sub>=1) and diarrhea (IV<sub>remedy</sub>=1) (24; m).

UN=3; IV<sub>species</sub>=3

*Kadsura scandens* Bl. (var. 2)

Aka pelian - pox vine (LSB)

Aka pelian apui - fire pox vine (LA)

Woody climbing liane. Fruit a red aggregate berry. Common in mature secondary forest. (89-71, 209, 233)

SYS/PED: (LSB) a paste prepared from crushed leaves mixed with pounded rice and cool water is applied as an ointment

to relieve itching associated with *pelian* - an early childhood disease (eg., measles, pox) that causes skin eruptions; leaves are often mixed with leaves of *Glochidion* sp. (Euphorbiaceae, 89-75) (8); leaves are steamed and rubbed on skin to relieve itch resulting from *pelian* (13); this treatment is rarely preferred to *Oldenlandia diffusa* (Rubiaceae, 89-50), which treats the ailment internally (3); (IV<sub>remedy</sub>=2; mf); in LA, crushed leaves are part of a mixed infusion given to newborns and young children to treat *pelian* (pox, measles) according to the following dosage: *K. scandens* - one leaf for a newborn, 3 leaves for a small child; *Desmodium triflorum* (Fabaceae, 89-222) - one or more plants; *Hydrocotyle javanica* (Apiaceae, 89-105) - one leaf for an infant, three leaves for a one-month-old; *Litsea cubeba* (Lauraceae, 89-16) - one fruit for an infant, three fruits for a small child, one handful for an adult. The infusion is given in small doses (half a teaspoon daily for a newborn, one teaspoon daily for a small child, three teaspoons for an adult (24,26,27); (IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>species</sub>=4

#### SCHIZAEACEAE

*Lygodium microphyllum* (Willd.) Alston

*Udu selaput*

Climbing fern. Common in young secondary forest and open, disturbed sites. (89-21)

SYS: (LSB) vapour from an infusion of fresh leaves is inhaled (1,2), or the body of the patient is steamed (3), to treat persistent, dry fever by inducing perspiration (IV<sub>remedy</sub>=3; mf). UN=1; IV<sub>species</sub>=3

## SCYPHOSTEGIACEAE

*Scyphostegia borneensis* Stapf

Kayu a'tio (LSB, LP)

Tree. Common, mature secondary forest. (89-98)

DER/VET: (LSB, LP) boiled leaves are rubbed into dogs' fur to treat mange (*kep*) (3,4,22; IV<sub>remedy</sub>=4; mf). UN=1;

IV<sub>species</sub>=4

## SIMARUBACEAE

*Eurycoma longifolia* Jack

Atiu Kenyah (LSB)

Understory tree. Common, primary forest. (89-93, sterile)

GI (LSB): an infusion of crushed root shavings is drunk to treat stomachache; dose is one-half glass, bitter (2;

IV<sub>remedy</sub>=1; m). SYS: an infusion of crushed root shavings is drunk to treat fever; dose is one-half glass, bitter (2;

IV<sub>remedy</sub>=1; m). POI/VET: leaves are heated over fire and rubbed into a dog's fur to kill lice (*kutu*) (14; IV<sub>remedy</sub>=1; m). UN=3; IV<sub>species</sub>=3

**Other uses:** the root is collected and sold to traders.

Banjarese men drink a decoction of the root as an aphrodisiac, and believe that the effect is heightened if the root has been pulled from the soil from between the legs in a single pull; the Kenyah find this belief humorous, but apparently harvest the root for trade in this manner to elevate the price. Bracelets made from the root are worn by Banjarese people for protection while travelling (2). A decoction of the root was applied as a rubifacient to treat backache by the Japanese troops occupying the Apo Kayan during the second world war; Chinese traders purchase the root for export to Japan (7).

## SMILACACEAE

*Smilax odoratissima* Bl.

Ata' - push away

Herbaceous climber. Common, young secondary forest. (89-130)

DER (LSB): leaves are warmed over fire, crushed and applied as a dressing on burns (6; IV<sub>remedy</sub>=1; f). RIT: the plant was used in ceremonies intended to repel or expel malevolent spirits or bad luck; no longer used (6; IV<sub>remedy</sub>=1; f).

UN=2; IV<sub>species</sub>=2

*Smilax barbata* Wall.

Padi (LSB, LP)

Climber. Infrequent, primary forest. (89-92, sterile)

POI (LSB, LP): fresh rhizome is heated over fire, beaten over a stream, the sap rinsed into the water to kill fish downstream; two large gunny sacks sufficient for a small stream; produces a soapy lather (11,2,28,29; IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>species</sub>=4

## SOLANACEAE

*Capsicum frutescens* L.

Lia alok - foreign spice

Shrub. Flower white. Cultivated in home gardens. (89-205)

DER (LSB): a small cutting from a heated young leaf is applied as a poultice to a sore to draw out the infection (20; IV<sub>remedy</sub>=1); the fresh fruit, with seeds removed, is mixed with salt and rubbed into a heavily bleeding wound to stop the bleeding (3 and others; IV<sub>remedy</sub>=3; f). RIT: a small piece of root is buried above a coin, later retrieved and held between the teeth while drinking arak (distilled rice alcohol) to prevent drunkenness (17; IV<sub>remedy</sub>=1; m).

UN=3; IV<sub>species</sub>=5

**Other uses:** the fruit is used liberally as a spice with many foods.

*Nicotiana tabacum* L.

*Tembakau (jako')* Kenyah - Kenyah tobacco

Shrub. Flowers white, pink. Common, cultivated in home gardens. (89-221)

**POI (LSB):** leaves are heated over fire and rubbed on feet and lower legs to repel leeches (many; IV<sub>remedy</sub>=4; mf).

**NEU:** sun-dried leaves are cured over kitchen fires, sliced into strips, rolled in whole dried leaves, and smoked as a stimulant; no gathering occurs without the host offering a basket of strips and leaves for rolling (many; IV<sub>remedy</sub>=4; mf). **GI:** (LA) a quid of chewed tobacco mixed with gasoline is applied as a rubifacient to treat stomachache associated with chills (26,27; IV<sub>remedy</sub>=1; mf). UN=3; IV<sub>remedy</sub>=9

*Solanum* sp. (cf., *melongena* L.)

*Kelungaung bulan* - moon eggplant

Creeping liane. Common, cultivated in home gardens. (89-207, 277)

**GI (LSB):** immature fruit is eaten raw to treat stomachache (IV<sub>remedy</sub>) and relieve vomiting (IV<sub>remedy</sub>=1) (20; f). UN=2; IV<sub>species</sub>=2

**Other uses:** the fruit is cooked and eaten as a vegetable.

*Solanum torvum* Sw.

*Ulem*

Shrub. Common, open, disturbed sites. (89-214)

**MET (LSB):** one root is chopped, dried, and steeped in about 350 ml of arak (distilled rice alcohol) for two weeks; the extract (about two finger-widths, in a glass) is drunk each night before retiring to stimulate weight gain. Usually taken by slender young women who want to become more voluptuous (16; IV<sub>remedy</sub>=2; f). UN=1; IV<sub>species</sub>=2

## TACCACEAE

*Tacca* sp. (cf., *crinata* Jack)

*Beting*

Herb, 50 cm tall. Mature secondary forest, near stream banks. (89-239, sterile)

DER (LA): several leaves are heated over fire and wrapped around a wound or joint swollen from contact with water (24,25; IV<sub>remedy</sub>=1; mf). UN=1; IV<sub>species</sub>=1

## THELYPTERIDACEAE

*Diplazium* sp.

*Paku danum*

Herbaceous terrestrial fern, to 1.5 m tall. Common in open, disturbed sites. (89-26)

SYS/PED (LSB): a decoction of the fronds is used to bathe persons, often children, suffering from *pelien'* (pallor); the treatment induces sweat and returns colour to the skin (3,4; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>remedy</sub>=1

*Thelypteris unita*

*Paku pahit* - bitter fern

Herbaceous terrestrial fern, to 1 m tall. Common in open, disturbed sites. (89-27)

GYN (LSB): young leaves are boiled and eaten as a postpartum tonic to increase strength and clean breast milk; the fronds taste bitter (3,4; IV<sub>remedy</sub>=3; mf). GEN: young leaves boiled and eaten as a tonic and strengthener (3,4; IV<sub>remedy</sub>=3; mf). UN=2; IV<sub>species</sub>=6

## THYMELAEACEAE

*Aquilaria beccariana* van Tiegh.

Kayu sekau (LSB, LP)

Overstory tree. Infrequent, primary forest, mature secondary forest. (89-112, sterile)

**SYS:** (LSB) a decoction of the fungus-infected heartwood is drunk to warm a person suffering from chills (3,4; IV<sub>remedy</sub>=1; f). **GI:** (LSB) the smoke from burning diseased heartwood is inhaled to treat a suddenly upset stomach (3,4; IV<sub>remedy</sub>=1; f). **POI:** (LSB) diseased heartwood is burned in a doorway to produce smoke that repels mosquitos (3,4; IV<sub>remedy</sub>=1; f). **RIT:** (LSB, LP) diseased heartwood is one of nine ingredients burned in a ritual to cure a person made ill by a curse (3,4,25; IV<sub>remedy</sub>=4; mf). UN=4; IV<sub>species</sub>=7  
**Other uses:** trade: (LSB, LA, LP) the fragrant, resin-filled diseased heartwood, known locally as *gaharu* (aloes wood) is sold and traded for the production of incense.

## UMBELLIFERAE (SEE APIACEAE)

## URTICACEAE

*Dendrocide stimulans* (L.f.) Chew (syn: *Urtica stimulans*)  
Pei

Small tree. Leaves covered in stinging hairs. Common in young secondary forest. (89-11, 261)

**DER:** (LSB) the root of a sapling is baked in coals, water added to make a paste, and applied as a poultice to disinfect weeping sores (3,4) or to dry the skin over a boil to facilitate lancing (7) (IV<sub>remedy</sub>=2; mf). **DEN:** a poultice prepared from the root (processing not described) is applied to the gum to treat toothache (3; IV<sub>remedy</sub>=1; f). **RIT:** a cold water infusion of the leaf, mixed with rice

grains and leaves of *Justicia gendarussa* (Acanthaceae (89-119), was prepared in a length of bamboo by the village ceremonial leader (*kepala adat*), distributed among the village families, and used in a traditional harvest-fertility ceremony called *telang limbah*, performed before the rice flowered to keep the ripening grains safe from predators and other disturbance; no longer used (3,4;  $IV_{remedy}=1$ ; f). UN=3;  $IV_{species}=4$

*Leucosyke alba* Zoll. & Mor. (syn: *L. capitellata* (Poir.) Wedd.)

*Kayu te pa'ei* (LSB)

Understory tree. Mature secondary forest, near river or stream banks. (89-102)

GEN (LSB): a decoction of the bark and leaves is drunk to treat tiredness (3,4;  $IV_{remedy}=1$ ; f). GI: a decoction of the bark and leaves is drunk to treat stomachache ( $IV_{remedy}=1$ ) and diarrhea (3,4;  $IV_{remedy}=1$ ; f). UN=3;  $IV_{species}=3$

#### VERBENACEAE

*Callicarpa longifolia* Lam.

*Bute' baa'* - husked rice (LSB)

Tree. Flower green, fruit white. Common, in mature and young secondary forest. (89-72)

GI (LSB): a decoction of the root, mixed with the root of an unknown plant, is drunk three times daily to treat diarrhea (8;  $IV_{remedy}=1$ ; m). DEN: a decoction of young leaves is gargled to treat toothache (3;  $IV_{remedy}=1$ ; f).

UN=2;  $IV_{species}=2$

Note on etymology: fruit looks like polished rice

*Clerodendrum* sp.

*Udu pendeng kayeng* - stop fever herb

Shrub or small tree. Mature secondary forest. (89-238, sterile)

**SYS/PED** (LA): a decoction of leaves is used as a cooling bath to treat children suffering from fever (24,25;

IV<sub>remedy</sub>=1; mf). UN=1; IV<sub>species</sub>=1

*Premna glandulosa* Merr. (var. 1)

*Udu lekahan* (1) - worm herb

Climber. Leaf aromatic when crushed. Infrequent, in young secondary forest and open, disturbed sites. (89-36)

**SYS:** (LSB) leaves are heated over fire and applied as a poultice to treat *kora-kora* - pain and hardness of the liver or spleen resulting from malaria (1,2); mixing with leaves of *P. glandulosa* (var. 2) (89-23) strengthens the effect

(7); (IV<sub>remedy</sub>=2; m). **GI/PED:** (LSB) a poultice of leaves heated over fire is applied to the stomach to treat worms (IV<sub>remedy</sub>=1) and constipation (IV<sub>remedy</sub>=1), frequently used to treat children (3; mf). UN=3; IV<sub>species</sub>=4

*Premna glandulosa* Merr. (var. 2)

*Udu lekahan* (2) - worm herb

Climber. Leaf aromatic when crushed. Infrequent, in young secondary forest and open, disturbed sites. (89-23)

**SYS:** (LSB) leaves are heated over fire and applied as a poultice to treat *kora-kora* - pain and hardness of the liver or spleen resulting from malaria (1,2); mixing with leaves of *Premna glandulosa* (var. 1) (89-36) strengthens the effect

(7); (IV<sub>remedy</sub>=2; m). **GI/PED:** (LSB) a poultice of leaves heated over fire is applied to the stomach to treat worms (IV<sub>remedy</sub>=1) and constipation (IV<sub>remedy</sub>=1), frequently used to treat children (3; mf). UN=3; IV<sub>species</sub>=4

## VITACEAE

*Ampelocissus imperialis* (Miq.) Bl.

Udu aka pute' ndak - white/not white vine (LSB)

Aka barep (LP)

Woody climbing liane. Leaves light green above, white-gold below. Common, in young secondary forest. (89-44)

DER (LSB, LP): young leaves are crushed and applied as a poultice to clean new wounds (3,4,22; IV<sub>remedy</sub>=4; mf).

UN=1; IV<sub>species</sub>=4

*Ampelocissus pilipes* Planch.

Udu sekiput lulut - shin-bone closing herb

Climbing liane. Infrequent, in mature secondary forest. (89-41)

DER (LSB): crushed young leaves, wrapped in banana leaves, are baked in coals until limp, unwrapped, and applied as a poultice to clean and close new wounds; the poultice is rinsed with cooled boiled water to irrigate the wound (3,4; IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

*Cissus simplex* Blanco

Aka keleput laso' (abbrev. kepulaso') - blowpipe vine for burns

Climbing liane. Infrequent in mature secondary forest. (89-31)

DER: in LSB crushed young leaves and tendrils are applied directly as a poultice to infected wounds (1,2,7); (LA) the crushed young leaves are heated over fire before being applied to wounds (26,27) (IV<sub>remedy</sub>=4); (LSB) the abundant watery sap is blown from a short length of freshly cut stem onto burns (3,4; IV<sub>remedy</sub>=1; mf). UN=2; IV<sub>species</sub>=5

## WINTERACEAE

*Drimys piperita* Hook.f.

*Kayu bisit* (LSB, LP)

*Bichit* (LA)

Understory tree. Flower white. Infrequent, primary forest.  
(89-90)

POI (LSB, LA, LP): fresh leaves are beaten over a stream, the sap rinsed into the water, kills the fish downstream and causes worms to rise to the surface; slightly stinging to the eyes of divers; strongest of all the fish poisons; a large armful of leaves is sufficient to poison fish in a small stream (2, 11, 28, 29, 26; IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>species</sub>=4

## ZINGIBERACEAE

*Alpinia galanga* (L.) Sw.

*Lia buke' borak* - fermented rice spice (LSB)

Herb, leaf stalks to 3 m tall. Flower white. Common, cultivated in home gardens. (89-61, 280)

GI: (LSB) an infusion of the grated rhizome is drunk or applied as a rubifacient, or the tender pith of the stalk is baked and eaten, to treat heartburn (*sakit usuk, sakit dada*) (3,4; IV<sub>remedy</sub>=1; f). A decoction of the crushed rhizome mixed with *kapu sepak* is drunk (one glass daily for six days) to treat throbbing stomach pain (*salah urat*) (7; IV<sub>remedy</sub>=3; mf). DER: (LSB, LA) the rhizome is heated over fire, crushed, and rubbed on skin daily for one week to relieve itch (IV<sub>remedy</sub>=1); and to treat vitiligo (*litak*) (3,4,21,24); the tender pith of the stalk and the rhizome are cooked and eaten daily for one week to treat vitiligo by killing parasites (*kutu*) (7); IV<sub>remedy</sub>=4; mf). MET: (LA) the slurry of crushed stalk and rhizome with pulverized rice and water that is fermented to prepare *arak*, a distilled

alcohol, is used while still fermenting as an ointment to reduce swelling associated with beriberi (26,27; IV<sub>remedy</sub>=1; mf). UN=5; IV<sub>species</sub>=10

**Other uses:** the crushed stalk and rhizome are mixed with pulverized rice and water to make a paste, which is allowed to ferment, then dried and stored as "starter" for the production of tuak - a rice beer, arak - a distilled rice alcohol, and borak - a sweet fermented rice.

*Alpinia mutica* Roxb.

*Kerapat bai* - forest kerapat (LSB)

*Seki pui bai* (LP)

Herb, 1 m tall. Flower white, fruit red. Common, mature secondary forest, near stream banks. (89-179, 272)

GI: (LSB, LP) tender pith of young stalk is boiled in a little water, the pith eaten and the decoction drunk to treat dysentery (3,4,21; IV<sub>remedy</sub>=4; f). UN=1; IV<sub>species</sub>=4

*Amomum ligulatum* R.M. Smith

*Ubut bele sa'ai* - shy flower

Herb, shrub-like on creeping rhizomes. Leaf stalks to 5 m tall. Flower yellow, inflorescence on short, leafless scape. Infrequent, in young secondary forest. (89-85, 268)

GI (LSB): the tender inner pith of the stalk is roasted over fire or boiled and eaten to treat stomachache (IV<sub>remedy</sub>=1) and diarrhea (IV<sub>remedy</sub>=1) (3,4; f). UN=2; IV<sub>species</sub>=2

*Costus speciosus* (Koenig) Smith

*Pe Luan* - grandparent Luan (LSB, LP)

Herb, 2m tall. Flower white. Common, young secondary forest. (89-104)

**NEU/ORT:** (LSB) the crushed rhizome is wrapped in leaves, baked in coals, wrapped in cloth and applied as a poultice to treat arthritis (*Tinen bulu*) (3,4; IV<sub>remedy</sub>=1; f). **CAR-PUL:** (LP) the stalk is heated over fire, the sap extracted

and swallowed as a syrup to soothe coughs (*mike'*) (21; IV<sub>remedy</sub>=1; f). GI: (LSB) a decoction of the rhizome is drunk to treat diarrhea (3,4; IV<sub>remedy</sub>=1; f). UN=3; IV<sub>remedy</sub>=3

*Curcuma longa* L.

*Lia mit pute'* - yellow and white spice

Herb, leaf stalk to 1 m tall. Flowers yellow. Common, cultivated in home gardens. (89-60, 281)

NEU/ORT (LSB): a cold infusion prepared from the grated rhizome is rubbed on the forehead to relieve headache (3,4; IV<sub>remedy</sub>=1; f). GEN: the infusion is applied as a body rub to relieve general malaise (3,4; IV<sub>remedy</sub>=1; f). CAR-PUL/PED: the infusion is drunk to treat nose bleed and coughs producing blood (locally associated with tuberculosis); adults may drink one-glass doses, children may be given one tablespoon; very bitter (3,4; IV<sub>remedy</sub>=1; f). UN=3; IV<sub>species</sub>=3

*Etingera eliator* (Jack) R.M. Smith (syn: *Nicolaia speciosa* Horan)

*Nyanding*

Perennial herb, shrub-like on creeping aromatic rhizomes. Leaf stalks to 4.5 m. Inflorescence pink, large and showy, on leafless scape, to 1.5 m. Common in open young secondary forest. (89-40)

EYE (LSB): sap from the crushed stalk is applied to the eye to relieve soreness and treat infection (3,4; IV<sub>remedy</sub>=1; f). DER/VET: the milky endosperm of mature fruits is applied as an ointment to relieve pain and itch from contact with the caterpillar known locally as *ulet jaten* (IV<sub>remedy</sub>=1), and to treat mange and wounds of dogs (IV<sub>remedy</sub>=1) (3,4; f); women apply the aromatic endosperm of mature fruits to finger and toe nails as a cleanser (IV<sub>remedy</sub>=1), and to the hair as a conditioner and scent (IV<sub>remedy</sub>=1) (3,4). ANT: the endosperm is applied to the

skin as an antidote to puncture wounds from blowgun darts tipped with *salok* (IV<sub>remedy</sub>=1) (7; m). GI: the endosperm is added as a sweetener to *kepu*, a preparation of snail shells eaten to treat worms (3,4; IV<sub>remedy</sub>=1; f). RIT: in the Bungan ritual, in which a supplicant asked the goddess Bungan for some favour, the stalk was split into ten parts; five parts were placed on each side of a gong-like container and smeared with the blood of a chicken; the blood was also smeared on the forearm of the supplicant (3; IV<sub>remedy</sub>=1; f). UN=8; IV<sub>species</sub>=8

**Other uses:** young shoots are boiled or steamed and eaten as a vegetable; the leaf is used as wrapping for food (3,4).

*Etilingera* sp. 1

*Lamei* - tears

Perennial herb, shrub-like on creeping aromatic rhizomes. Leaf-stalk to 4 m; flower on separate scape, to 1 m. Calyx red, labellum white-lipped; fruit a capsule with abundant milky endosperm. Common in young secondary forest. (89-1, 265)

GI: (LSB) young buds are boiled and eaten with meals to treat stomachache (IV<sub>remedy</sub>=1), heart burn (IV<sub>remedy</sub>=1), and to stimulate appetite (IV<sub>remedy</sub>=1) (1,2; mf). SYS: (LSB) A decoction of young buds is drunk to treat a condition having the symptoms pallor and jaundice, described by the consultant as *ya-a tudep* (very difficult) (7; IV<sub>remedy</sub>=1; m). DER: in LSB milky endosperm is rubbed on insect stings and bites to relieve itch (1; IV<sub>remedy</sub>=1; m). UN=5; IV<sub>species</sub>=5.

**Other uses:** (LSB) the endosperm is sucked from seeds as a sweet/sour refreshment (3,4); the leaf is used as a wrapping for food (3,4).

*Etilingera* sp. 2 (cf., *punicea* Roxb.)

Tite' lan - true ginger

Herb, leaf stalks to 3 m, shrub-like on creeping rhizomes. Flower yellow with red, stalkless from rhizome. Common, in young secondary forest (89-48, 264)

**MET** (LSB): the tender pith of the stalk is baked over fire and eaten with meals for its vitamin content (3,4;

IV<sub>remedy</sub>=1; f). **URI**: eating the baked pith has the diuretic effect of increasing the volume and sweetening the smell of urine (3,4; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=2

**Other uses**: the nectar is sipped from the flowers as a sweet refreshment (3,4).

*Etilingera* sp. 3

Ubut ladyei - sharp pith

Herb. Leaf stalks 2 m tall; inflorescence stalkless, from rhizome. Infrequent, in young secondary forest. (89-35, 271)

**URI** (LSB): leaf stalks are boiled or baked in coals, the tender inner pith eaten, or a decoction of sliced rhizome is drunk, to cleanse yellow urine (3,4; IV<sub>remedy</sub>=2; mf).

**GI/PED**: boiled pith is eaten, or a decoction of rhizome drunk to treat worms (3,4; IV<sub>remedy</sub>=1; f); boiled pith is eaten, or a decoction of rhizome drunk to treat jaundice (3,4; IV<sub>remedy</sub>=1; f). Large volumes of these preparations can be eaten or drunk safely and are therefore preferred for treating children (3,4). UN=3; IV<sub>remedy</sub>=4

*Etilingera* sp. 4

Lia mit tuning - yellow rubbing spice (LSB)

Herb, leaf stalks to 1 m tall. Cultivated in home gardens. (89-63, sterile)

**DER/PED** (LSB): the raw rhizome is rubbed as an ointment on the skin of children to relieve the itch of insect bites (*kudis-kudis*) (3,4; IV<sub>remedy</sub>=1; f); sap from the crushed rhizome is applied to wounds and sores caused by wood (7;

IV<sub>remedy</sub>=1; m). GI: an infusion of the grated rhizome, mixed with a little salt, is drunk to treat diarrhea (3,4; IV<sub>remedy</sub>=1; f) and stomachache; serious cases of stomachache are treated by mixing a raw egg with 1 tablespoon of the infusion, which is both drunk and applied as an ointment to the abdomen (3,4; IV<sub>remedy</sub>=2, mf). GYN: as a postpartum tonic for new mothers, sugar is added to the infusion described above after one week (3,4; IV<sub>remedy</sub>=1; f). NEU/ORT: sap from the crushed rhizome, mixed with egg and honey, is applied as a rubifacient to treat soreness and bruises from falls (7; IV<sub>remedy</sub>=1; m). UN=6; IV<sub>species</sub>=7  
Other uses: the grated rhizome is used to season food.

*Globba atrosanguinea* T. & B.

*Tubo bala* - red tended one

Herb. Flower red/orange. Infrequent, open, disturbed sites. (89-257)

DER (LSB): the rhizome is wrapped in leaves, baked in coals, and applied as a poultice to sores caused by stinging hairs of insects (*Tinen bulu*) (3,4; IV<sub>remedy</sub>=1; f). UN=1; IV<sub>species</sub>=1

*Globba* sp.

*Tubo saleng* - black stalk

Herb, .75 m tall. Flower white. Infrequent in open, disturbed sites. (89-135, 258)

GI (LSB): a decoction of the rhizome and stalk is drunk to treat stomachache (IV<sub>remedy</sub>) and purge worms (IV<sub>remedy</sub>=1) (3,6; f). UN=2; IV<sub>species</sub>=2

*Hedychium cylindricum* Ridley

*Tubo sakai* - welcome guest

Aerial/epiphyte. Common in mature secondary forest and primary forest. (89-29, 270)

EYE (LSB): the stalk is warmed over fire until limp, the sap squeezed directly into the eye to treat infections and

injuries (3,4; IV<sub>remedy</sub>=2; mf). DER: the rhizome is scraped clean, pulverized, wrapped in banana leaves and baked in coals until the leaves turn yellow; the packet is applied as a poultice to infected sores, insect bites and stings (IV<sub>remedy</sub>=2), and weeping wounds; the poultice is rinsed with warm water to leach poultice material into the wound (3,4,7; IV<sub>remedy</sub>=2; mf). SYS/PED: (LP) a decoction of the tender inner stalk is prepared in a length of bamboo and drunk twice daily for three days to treat malaria; preferred for children, not bitter (21; IV<sub>remedy</sub>=1; f). UN=4; IV<sub>species</sub>=7

*Hedychium* sp.

*Lia bung Lei* - Lei's spice

Herb, leaf stalk to 3 m tall. Flowers rarely. Infrequent in young secondary forest, possibly cultivated in home gardens. (89-62)

NEU/ORT (LSB): an infusion of grated rhizome is applied as a rubifacient to relieve aches and pains, bruises from a fall (3,4; IV<sub>remedy</sub>=2; mf). GEN/GI: the same infusion is applied as a rubifacient to relieve tiredness (3,4; IV<sub>remedy</sub>=2; mf), and is drunk to treat stomachache (3,4; IV<sub>remedy</sub>=2; mf). UN=3; IV<sub>species</sub>=6

*Hornstedtia havilandii* (K. Schum.) K. Schum.

*Tepo* (LSB, LP)

Perennial herb, shrub-like on creeping aromatic rhizomes. Leaf stalk 4+ m tall. Flower wine-red on short, leafless scape. Common in young secondary forest. (89-5, 279)

GI: (LSB) a decoction of chopped rhizomes is drunk 3 times daily as an anthelmintic, until worms are gone from stools (1,2); (LP) an infusion of crushed rhizomes, or the unprocessed rhizome sap is drunk as an anthelmintic; the treatment is continued at a dose of one-half glass daily until worms in stools are dead (21) (IV<sub>remedy</sub>=4; mf). GYN: (LSB) the soft pith of the stalk is crushed with a land

crab, and eaten uncooked to improve a woman's health after childbirth (7; IV<sub>remedy</sub>=2; mf); (LA) a decoction of the rhizome is drunk to increase strength and hasten healing after childbirth (27; IV<sub>remedy</sub>=2; mf). UN=4; IV<sub>species</sub>=8

*Hornstedtia* sp.

Titei' telajan (LSB, LA)

Herb, leaf stalks to 3 m tall. Cultivated in home gardens. (89-123)

NEU/ORT: (LSB, LP) the stalk is roasted, beaten until soft, and applied as a poultice or rubifacient to relax stiffness and ease soreness in joints and muscles (IV<sub>remedy</sub>=1) and to relieve pain from falls (6,3, 24,25; IV<sub>remedy</sub>=3; mf). UN=2; IV<sub>species</sub>=4

Field note: cultivars in LSB were obtained from LA (6).

*Kaempferia galanga* L.

Lia nyalau - nyalau spice

Kencur (Indon)

Herb, to 10 cm tall. Infrequent, cultivated in home gardens. (89-57)

SYS/PED (LSB): an infusion of the rhizome is drunk to treat fevers; adults may drink one half-glass three times daily, young children take one tablespoon or less three times daily (3,4); application of the infusion as a cooling rub is preferred for children (11); (IV<sub>remedy</sub>=2; mf). UN=1; IV<sub>species</sub>=2

*Zingiber longipedunculatum* Ridley

Ubut bele'sua' - pith of thorn flower (LSB)

Tekorak lalaut (LSB)

Herb, leaf stalks 3 m tall, shrub-like on creeping rhizomes. Flower white, inflorescence on leafless scape, to .5 m tall. Infrequent, in young secondary forest, wet sites. (89-49, 263)

**GI (LSB):** the stalk is roasted or boiled and the tender pith eaten to treat dysentery (*senderei*) (IV<sub>remedy</sub>=1), or a decoction of the pith is drunk to treat stomachache (IV<sub>remedy</sub>=1) and dysentery (IV<sub>remedy</sub>=1) (3,4; mf). **DER/VET:** the whole inflorescence is baked, the abundant nectar applied as an ointment to treat dog mange (14; IV<sub>remedy</sub>=2; mf). **MET:** the tender pith is baked and eaten for its vitamin content (7; IV<sub>remedy</sub>=1; m). UN=5; IV<sub>species</sub>=6 **Other uses:** the mature fruits are cooked and eaten with fish as a condiment (7).

*Zingiber cassumunar* Roxb. (syn: *Z. purpureum* Rosc.)

*Lia bukei salok*

Herb. Infrequent, cultivated in home gardens. (89-219, 282)

**GYN (LSB):** an infusion of the crushed rhizome is drunk in a half-glass dose by a pregnant woman to ease childbirth (IV<sub>remedy</sub>=2), and to ease pain during childbirth (IV<sub>remedy</sub>=2) (13,20 others; f). UN=2; IV<sub>species</sub>=4

*Zingiber officinale* Rosc.

*Lia sukeng* - repellent spice (LSB)

Herb, leaf stalks to 2 m tall. Common, in open, disturbed sites. (89-64, sterile)

**NEU (LSB):** an infusion of the rhizome is drunk or a strong infusion of the rhizome or stalk is applied as a body rub to treat general aches and pains (IV<sub>remedy</sub>=1), backache (IV<sub>remedy</sub>=1), and fever (IV<sub>remedy</sub>=1) (3,4,5; mf). **CAR/PUL:** infusion above applied as rub to treat chest pain (IV<sub>remedy</sub>=1) (3,4,5; mf); a decoction of the crushed rhizome, mixed with a raw egg and honey, is drunk to treat cough (3,4; IV<sub>remedy</sub>=1; f). **GEN:** a strong infusion prepared from the crushed rhizome or stalk is applied as a body rub to relieve tiredness (3,4; IV<sub>remedy</sub>=2; mf). UN=6; IV<sub>species</sub>=7

## UNDETERMINED

Undetermined sp.

*Lia ubat* - medicine spice

Herb, leaf stalks 1.5 m tall. Infertile, rarely flowers. Common, in young secondary forest, transplanted to home gardens. (89-59)

SYS (LSB): a spicy infusion of grated young shoots, rhizome (a thumb-size piece), or roots is drunk, a half-glass three times daily, to treat malaria (3,4; IV<sub>remedy</sub>=1; f); the same infusion is drunk to treat fevers other than malaria (3,4; IV<sub>remedy</sub>=1; f). UN=2; IV<sub>species</sub>=2

## FAUNA

### HYSTRICIDAE

*Thecurus crassispinis*

*Landa'* - thick-spined porcupine

Common, primary forest. (Field note/artifact no. 246)

GI (LSB, LA, LP): the gallstones (*batu setung*), widely known as bezoar stones, are sold (for approximately US \$20.00/g) to traders, and believed to be used by the Chinese to treat stomachache (14; IV<sub>remedy</sub>=4; mf). UN=1; IV<sub>species</sub>=4

### SCIURIDAE

*Ratufa affinis*

*Sanangan* - giant squirrel

Infrequent, primary forest. (Field note 247)

RIT (LP, LSB): the fur is burned with eight other ingredients in a ritual to cure illness caused by a curse

(IV<sub>remedy</sub>=4), and is placed with harvested rice and other crops in storage huts to prevent spoilage as a result of curses (21, 3; IV<sub>remedy</sub>=2; f). UN=2; IV<sub>species</sub>=6

## URSIDAE

*Helarctos malayanus*

Beruang - sunbear.

(Field note 252)

NEU (LA): the contents of the gall bladder (*empedu*) are either drunk (one drop in a glass of water) or applied as a rubifacient to ease tense muscles (*sakit tehangang*) or ease soreness after a fall (IV<sub>remedy</sub>=1); one drop of gall in a glass of hot water is given to revive someone unconscious after a fall (IV<sub>remedy</sub>=1) (24; m). GYN: one drop of gall in a glass of hot water is drunk by women as a postpartum tonic (24; IV<sub>remedy</sub>=1; m). DER: the gall is applied undiluted as an ointment to infected sores (24; IV<sub>remedy</sub>=1; m). UN=4; IV<sub>species</sub>=4

Other uses: (LSB, LP, LA) the gall bladder is sold to traders for export for medicinal use; value unknown. The teeth and claws are used locally in handicrafts (necklaces, baby carriers), and are also traded or sold. The meat is rarely eaten.

Field note. The sunbear is considered a pest for the damage it does to ripening rice crops.

## CRUSTACEA

Undetermined species

*kepiting* - land crab

(Field note 255)

GYN (LSB): one crab is crushed with the soft pith of the stalk of *Hornstedtia havilandii* (Zingiberaceae, 89-5); the

mixture is eaten raw to improve the mother's health following childbirth (7; IV<sub>remedy</sub>=1; m). UN=1; IV<sub>species</sub>=1

#### GASTROPODA

Undetermined species

*seh'* - snail

*siput Kenyah* (I) - Kenyah snail

(Field note 299)

NEU/DEN: (LSB, LA, LP) the shells are baked in leaves placed on hot coals for a half-hour, until they grow limp and turn white, and are then ground into a paste which is known as kepu. Kepu is spread in a thin layer onto a leaf of *Piper betel* (Piperaceae, 89-114), along with another paste (*kebin*) prepared from the leaves of *Trigonopleura malayana* (Euphorbiaceae, 89-139). A small piece of palm fruit, either *Daemonorops periacanthus* or *Pinanga coronata* (Arecaceae, 89-285, 220) is added, rolled up in the paste-covered leaf, and sucked as a stimulant. Saliva turns bright red, and is spit out every few moments. The preparation turns the teeth black with repeated use, and is said to keep the teeth and gums healthy (3 and others; IV<sub>remedy</sub>=4; mf). GI: (LA) kepu prepared as above is mixed with crushed leaves of *Chrysanthemum* sp. (Asteraceae, field note 254) and applied as a rubifacient to treat stomachache (24,26). Kepu is sweetened with endosperm of the fruit of *Etilingera eliator* (Zingiberaceae, 89-40) and eaten to purge worms (3,4); (IV<sub>remedy</sub>=2; mf). UN=3; IV<sub>species</sub>=10

#### 3.3.2. Important remedies, indications, and categories

Sixty-two remedies were reported on at least three occasions by different consultants and in more than one village; these have been assigned the highest remedy importance value

(IV<sub>remedy</sub> = 4) and are listed in Table 3.2. These remedies are derived from 44 plant species and 4 animal species. The largest numbers of widely known remedies are used to treat dermatological ailments (17 remedies), as fish poisons (13 treatments); and to treat complex systemic ailments such as malaria, fevers, and poxes (9 remedies). General categories for which no important remedies were reported include those affecting eyes, metabolism, and the urinary tract, and remedies used as antidotes.

In discussing the Apo Kayan flora and fauna and their medicinal uses, Kenyah healers and herbalists named or described 74 unique indications and 3 applications as poisons or toxins (Table 3.3). The degree of local consensus concerning the remedies used for each indication (IV<sub>indication</sub>) has been quantified as the mean of the remedy importance values (mean IV<sub>remedy</sub>) for each indication (Table 3.1, part II). A list of species by major category and indication is provided in Appendix 3.3.

Two major groups of Kenyah remedies are apparent in the circumstances of their use: ritual remedies with supernatural power used in direct interventions with the spirit world, and household remedies (*taban*) used for indications related to natural phenomena. Such a distinction between treatments for internal disorders caused by spirits and treatments for natural causes, such as skin wounds, cuts, and gashes, was noted by Hose (1926) and Tillema (1938) for the Kenyah and closely related groups in the Borneo highlands. Similar dichotomies have been described for other cultures. For example, in the pharmacopoeia of the indigenous peoples of Eastern Canada, Arnason, Hebda, and Johns (1981) noted a distinction between rational treatments for ailments with easily perceived, organic causes, such as wounds and fractures, and ritualistic treatments for diseases with more obscure

Table 3.2. Important Kenyah remedies (V<sub>remedy</sub> = 4)<sup>a</sup>

Scientific name	Kenyah name	Family	Indication <sup>b</sup>	Category <sup>c</sup>	Voucher <sup>a</sup>
<b>I. Plants</b>					
<i>Adenostemma lavenia</i> Kuntze o.k.	udu fai	Asteraceae	cough	CAR-PUL	67
<i>Aglaia dookoo</i> Griff.	lengeset	Meliaceae	malarial fever	SYS	30
<i>Aglaia</i> sp.	kayu aplek; kayu luit	Meliaceae	piscicide	POI	187
<i>Albizia chinensis</i> (Osbeck) Merr.	enep	Fabaceae	piscicide	POI	108
<i>Alpinia galanga</i> (L.) Sw.	lia buke' borak	Zingiberaceae	villigo	DER	61
<i>Alpinia mutica</i> Roxb.	kerapat bai; sekipul bai	Zingiberaceae	dysentery	GI	179
<i>Ampelocissus imperialis</i> (Miq.) Bl.	udu aka pute' ndak	Vitaceae	new wounds	DER	44
<i>Aquilaria beccariana</i> van Tiegh.	kayu sekau	Thymelaeaceae	ritual cure	RIT	112
<i>Blumea pubigera</i> (L.) Merr. (var. 1)	udu sekiput lulut	Asteraceae	new wounds	DER	141
<i>Blumea pubigera</i> (L.) Merr. (var. 2)	emibeng aka	Asteraceae	new wounds	DER	262
<i>Buddleja asiatica</i> Lour.	tuba selabung bekan	Loganiaceae	piscicide	POI	134
<i>Calophyllum biflorum</i>	kayu beta-o'	Clusiaceae	piscicide	POI	144
M.L. Henderson & Wyatt-Smith					
<i>Cassia alata</i> L.	udu kep	Fabaceae	dog rashes	DER/VET*	70
			rashes	DER	
			ringworm	DER	
			villigo	DER	
<i>Cissus simplex</i> Blanco	aka keleput laso'	Vitaceae	old wounds	DER	31
<i>Colocasia esculenta</i> (L.) Schott	le'ung; keladi	Araceae	new wounds	DER	94
<i>Croton tiglium</i> L.	tuba abeng; tuba kule'	Euphorbiaceae	piscicide	POI	18
<i>Cucumis</i> cf., sativa L.	labu	Cucurbitaceae	ritual cure	RIT	301
<i>Curatigo</i> sp.	lempa' pisa'	Liliaceae	old wounds	DER	46
<i>Cyperus kyllingia</i> Endl.	udu tika	Cyperaceae	cough	CAR-PUL	113
<i>Derris elliptica</i> (Wallich) Benth.	tuba aka	Fabaceae	piscicide	POI	91
			ritual cure	RIT	

Table 3.2. continued

Scientific name	Kenyah name	Family	Indication <sup>b</sup>	Category <sup>c</sup>	Voucher <sup>d</sup>
<i>Diospyros borneensis</i> Hiem.	kayu kelelingan	Ebenaceae	piscicide	POI	121
<i>Drimys piperita</i> Hook.f.	kayu bisit; bichit	Winteraceae	piscicide	POI	90
<i>Embellia ribes</i> Burm.f.	aka sekileng	Myrsinaceae	piscicide	POI	82
<i>Eriodendron anfractuosum</i> DC.	burak'	Bombacaceae	fever	SYS	183
<i>Homalanthus populneus</i> (Geisel.) Pax	kayu pela'	Euphorbiaceae	vittigo	DER	33
<i>Homalomena rubra</i> Hassk. (var. 1)	lung bala	Araceae	ritual cure	RIT	43
<i>Homalomena rubra</i> Hassk. (var. 2)	lung bileng	Araceae	amulet	RIT/PED*	251
<i>Hornstedtia havilandii</i> (K.Schum.) K.Schum.	tepo	Zingiberaceae	worms	GI	5
<i>Hornstedtia</i> sp.	titei' telejan	Zingiberaceae	postpartum weakness	GYN	
<i>Hydrocotyle javanica</i> Thunb.	tuba urong	Apiaceae	muscle soreness	NEU/ORT	123
<i>Impatiens balsamina</i> L.	semangkak	Balsaminaceae	piscicide	POI	105
<i>Kadsura scandens</i> Bl. (var. 2)	aka pelian	Schisandraceae	new wounds	DER	217
<i>Leersia hexandra</i> Swartz	kupei	Poaceae	childhood poxes	SYS/PED*	71
<i>Litsea cubeba</i> (Lour.) Pers.	beleng la	Lauraceae	cough	CAR-PUL	122
			childhood poxes	SYS/PED*	16
			fever	SYS/PED*	
			ritual cure	RIT	
<i>Merremia borneensis</i> Merr.	aka kedatung ture; aka pulut	Convolvulaceae	new wounds	DER	68
<i>Nicotiana tabacum</i> L.	tembakau; joko Kenyah	Solanaceae	stimulant	NEU/ORT	221
			insect/leech repellent	POI	
<i>Pinanga coronata</i> Bl.	gaat	Arecaceae	stimulant	NEU/ORT	220
<i>Piper betle</i> L.	udu sepak	Piperaceae	strengthen teeth	DEN	114
			stimulant	NEU/ORT	
<i>Polygonum barbatum</i> L.	tuba beriking; tiking	Polygonaceae	piscicide	POI	116
<i>Schefflera</i> cf., <i>oblongifolia</i> Merr.	jangkang yap; puang	Araliaceae	fever	SYS	182
<i>Scyphostegia borneensis</i> Stapf	kayu a-fio'	Scyphostegiaceae	dog rashes	DER/VET*	98
<i>Sesamum indicum</i> L.	lesayat	Pedaliaceae	ritual cure	RIT	278
<i>Smilax barbata</i> Wall.	padi	Smilacaceae	piscicide	POI	92

Table 3.2. continued

Scientific name	Kenyah name	Family	Indication <sup>b</sup>	Category <sup>c</sup>	Voucher <sup>d</sup>
<i>Spatholobus ferrugineus</i> Benth.	aka kelesel	Fabaceae	ulcers, sores	DER	22
<i>Trichosanthes bracteata</i> Voigt	aka kuwik	Cucurbitaceae	old wounds	DER	107
<i>Trigonopleura malayana</i> Hook.f.	Kayu kefele/lan	Euphorbiaceae	stimulant	NEU/ORT	139
II. Animals					
<i>Ratufa affinis</i>	sanangan	Sciuridae	ritual cure	RIT	247
<i>Thecurus crassispinis</i>	landa'	Hystriidae	stomachache	GI	246
Undetermined sp. (snail)	seh; siput Kenyah	Unknown	strengthen teeth	DEN	288
			stimulant	NEU/ORT	
III. Undetermined species (Leaman 89-X)					
			childhood poxes	SYS/PED*	
			fever	SYS/PED*	
			malarial fever	SYS/PED*	

<sup>a</sup> A remedy is a unique species-use combination related to healing and maintaining or improving health.

<sup>b</sup> Indications are locally defined (etic) ailments or sets of symptoms.

<sup>c</sup> Major use categories are externally defined (emic) groupings of indications related to physiological systems. \* indicates more general, overlapping categories that reflect the remedy recipient.

CAR-PUL=cardio-pulmonary

DEN=dental/oral

DER=dermatological

GI=gastrointestinal

GYN=gynecological

NEU/ORT=neurological/orthopedic

<sup>d</sup> Voucher numbers are in the series Leaman-89.

PED\*=pediatric

POI=pollin

RIT=ritual

SYS=systemic

VET=veterinary

Table 3.3. Kenyah remedy indications and their importance value (IV<sub>indication</sub>)

Kenyah indication <sup>a</sup>	English equivalent <sup>b</sup>	Major use category <sup>c</sup>	Number of remedies	IV <sub>indication</sub> <sup>d</sup>	± S.E. <sup>e</sup>
<b>Part I. Ritual remedies</b>					
<i>na'an-na'an</i>	charms, amulets	RIT	10	1.6	± 0.3
	ritual healing	RIT	8	3.6	± 0.3
	omens	RIT	4	1.0	± 0
	funeral air freshener	RIT	1	3.0	± 0
<b>Part II. Home remedies (<i>taban</i>)</b>					
<i>sakit bafe' tenel mudep, lempungan</i>	hard stomachache (gastroenteritis)	GI	42	1.5	± 0.1
<i>sua' majan</i>	old, infected wound	DER	31	1.7	± 0.4
<i>sua' mading, bisul</i>	bleeding wounds	DER	22	2.3	± 0.2
<i>sakit bafe' gneduri</i>	diarrhea/white foam	GI	22	1.3	± 0.1
<i>mayung</i>	fever	SYS	21	1.9	± 0.3
<i>linen bulu</i>	bites, stings	DER	18	1.4	± 0.2
<i>sakit bafe' lekahan</i>	worms in stools (intestinal worms)	GI	16	1.4	± 0.2
<i>pellien'</i>	pallor	SYS/PED*	14	2.3	± 0.3
<i>pellan (peluan, ambun)</i>	skin eruption, pediatric (measles, chicken pox)	SYS	13	2.2	± 0.3
<i>kulit pucat-pucat</i>	pallor, tiredness, weakness	GEN	12	1.8	± 0.2
<i>pu'u, kudis-kudis</i>	skin rash (scabies)	DER	12	1.5	± 0.3
<i>mayung kora</i>	periodic fever, chills (malaria)	SYS	10	1.7	± 0.4
	muscular soreness, pain	NEU	10	1.6	± 0.3
<i>sirih, joko</i>	stimulant	NEU	7	3.3	± 0.5
<i>mike'</i>	cough	CAR-PUL	7	2.3	± 0.6
<i>kep</i>	dog mange	DER/VET*	7	2.1	± 0.5
<i>sakit peliwut</i>	postpartum weakness	GYN	7	2.0	± 0.4

Table 3.3. continued

Kenyah indication <sup>a</sup>	English equivalent <sup>b</sup>	Major use category <sup>c</sup>	Number of remedies	IV <sub>indication</sub> <sup>d</sup>	+ S.E. <sup>e</sup>
<i>biri-biri</i> (I)	swollen limbs (beriberi)	MET	7	1.4	+ 0.2
<i>kora-kora</i>	enlarged liver or spleen (splenomegaly)	SYS	6	1.5	+ 0.2
<i>sakit gigi</i>	toothache	DEN	6	1.3	+ 0.2
<i>sakit bate' mua'</i>	vomiting	GI	6	1.0	+ 0
<i>pebeje', sakit tegang laso'</i>	sprains, bruises, swelling burns	NEU	5	1.4	+ 0.2
-	clouded vision (conjunctivitis)	DER	5	1.2	+ 0.2
<i>sakit salesma</i>	chills, flu	EYE	5	1.2	+ 0.2
<i>panau, litak</i>	white patches on skin (vitiligo)	SYS	5	1.0	+ 0
<i>kalira</i> (I)	diarrhea, vomiting (cholera)	DER	4	3.5	+ 0.4
<i>sakit bate' pekaliu</i>	blood in stools (dysentery)	GI	4	2.5	+ 0.4
<i>finen bulu</i>	swollen joints (arthritis, rheumatism)	GI	4	2.3	+ 0.5
<i>sua' asu</i>	dog wounds	NEU	4	1.3	+ 0.2
<i>ya tudep, po buleng</i>	pallor, ringing in ears, dizziness	DER/VET*	4	1.0	+ 0
<i>tuko, koreng</i>	ulcers, sores, boils	SYS	4	1.0	+ 0
-	ease childbirth	DER	4	1.0	+ 0
-	labour pain	GYN	3	1.3	+ 0.3
-	vitamins	GYN	3	1.3	+ 0.3
<i>sakit usu'</i>	heartburn	MET	3	1.3	+ 0.3
<i>sembelit</i> (I)	constipation	GI	3	1.0	+ 0
-	lack of appetite	GI	3	1.0	+ 0
-	strengthen teeth, gums	GI	3	1.0	+ 0
-	delivery of placenta	DEN	2	4.0	+ 0
<i>kurep, kep alo'</i>	circular patches on skin (ringworm)	GYN	2	3.0	+ 0
-	decayed tooth	DER	2	3.0	+ 0.7
<i>rabun</i>	white/red eye, poultry (conjunctivitis)	DEN	2	2.5	+ 0.3
<i>sakit ulu</i>	headache	EYEVET*	2	2.0	+ 0
<i>sakit mata</i> (I)	eye injury	NEU	2	2.0	+ 0.7
		EYE	2	1.5	+ 0.3

Table 3.3. continued

Kenyah indication <sup>a</sup>	English equivalent <sup>b</sup>	Major use category <sup>c</sup>	Number of remedies	IV <sup>d</sup> indication	+ S.E. <sup>e</sup>
<i>kencing kuning</i>	yellow urine (hepatitis)	URI	2	1.5	+ 0.3
<i>anti-sempit</i>	poison dart wound	ANT	2	1.5	+ 0.3
<i>tuning-tuning</i>	yellow skin, strong urine (jaundice)	GI	2	1.0	+ 0
<i>sakit dada, sakit usuk</i>	chest pain	CAR-PUL	2	1.0	+ 0
<i>t.b.c. (I)</i>	blood in sputum, cough (tuberculosis)	CAR-PUL	2	1.0	+ 0
-	foul breath	DEN	2	1.0	+ 0
-	maintain youth	GEN	2	1.0	+ 0
-	hair and skin cleanser	DER	2	1.0	+ 0
<i>kencing manis</i>	sweet urine (diabetes)	MET	1	2.0	+ 0
-	weight loss or thinness	MET	1	2.0	+ 0
<i>lemedem</i>	snakebite	ANT	1	2.0	+ 0
<i>sakit bate' batu</i>	gallstones	GI	1	1.0	+ 0
<i>sakit bate' milu makan, mbok makan</i>	stomachache, vomiting (food poisoning)	GI	1	1.0	+ 0
<i>sakit bate' mua' dhara</i>	blood in vomit	GI	1	1.0	+ 0
<i>sua, durie</i>	wood splinters, splines	DER	1	1.0	+ 0
<i>asma (I)</i>	shortness of breath (asthma)	CAR-PUL	1	1.0	+ 0
<i>dhara tinggi</i>	(high blood pressure)	CAR-PUL	1	1.0	+ 0
-	nosebleed	CAR-PUL	1	1.0	+ 0
<i>jela'an</i>	white tongue (thrush)	DEN	1	1.0	+ 0
-	mouth sores	DEN	1	1.0	+ 0
-	sweeten urine	URI	1	1.0	+ 0
<i>anti-milu (I)</i>	drunkenness	ANT	1	1.0	+ 0
-	cause miscarriage	GYN	1	1.0	+ 0
<i>sakit bate' menecu</i>	sudden stomachache (gastroenteritis)	GI	1	1.0	+ 0
<i>ulet yen, letien</i>	rash between toes (athletes' foot)	DER	1	1.0	+ 0

Table 3.3. continued

Kenyah indication <sup>a</sup>	English equivalent <sup>b</sup>	Major use category <sup>c</sup>	Number of remedies	IV <sub>indication</sub> <sup>d</sup>	+ S.E. <sup>e</sup>
<b>Part III. Poisons (<i>tuba</i>)</b>					
<i>tuba ikan</i>	piscicides	POI	18	3.2	± 0.3
<i>tuba temete'</i>	repel insects, leaches	POI	6	1.8	± 0.5
-	suicide	POI	2	1.0	± 0

<sup>a</sup> Indications are locally defined (etic) ailments or sets of symptoms. Indications having consistently described symptoms, but for which a Kenyah term was not recorded, are indicated by (-). Indonesian terms are indicated by (I).

<sup>b</sup> English equivalents are approximate, based on symptoms described and the interpretation of the author. English common names are enclosed in parentheses.

<sup>c</sup> Major use categories are externally defined (emic) groupings of indications related to physiological systems. \* Indicates more general, overlapping categories that reflect the remedy recipient.

ANT=antidote (n=4)      GI=gastrointestinal (n=64)      POI=poison (n=22)

CARPUL=cardio-pulmonary (n=12)      GYN=gynecological (n=14)      RIT=ritual (n=20)

DEN=dental/oral (n=12)      MET=metabolic (n=12)      SYN\*=synergist (n=2)

DER=dermatological (n=79)      NEU=neurological (n=25)      SYS=systemic (n=50)

EYE=optical (n=7)      ORT=orthopedic (n=3)      URI=urinary (n=3)

GEN=general (n=14)      PED\*=pediatric (n=29)      VET\*=veterinary (n=14)

n = number of remedies reported.

<sup>d</sup> IV<sub>indication</sub> = mean IV<sub>remedy</sub> (see Table 3.1).

<sup>e</sup> Standard error of the mean.

causes, such as psychosomatic illnesses. In western allopathic medicine, Moerman (1983:164) distinguished specific therapies that influence "the physical predicates of persons" from general therapies that influence "the mental predicates of persons", and suggested that this distinction typifies a bimodal quality of medical systems in general.

### *Ritual uses*

Healers and herbalists described 23 remedies used directly in interventions with the spirit world (Table 3.3, part I). These practices follow clearly from Kenyah beliefs concerning the influence of the spirit world (see Chapter 2); many are no longer used in post-conversion Kenyah society. The largest number of ritual remedies are charms and amulets used to protect particularly vulnerable individuals (for example, small children, women during menses and childbirth, and people traveling in the forest) from the actions of a variety of spirits, or to prevent their souls from wandering. Soul loss was considered the primary cause of child mortality among the Kenyah (Whittier 1973).

The use of the rhizomes of *lung bileng* (*Homalomena rubra*, Araceae) to protect infants from spirits was the most widely and consistently reported charm ( $IV_{\text{remedy}} = 4$ ), and one of the few ritual uses of plants reported by previous observers. In his study among the Lepo' Tau Kenyah of the symbolic significance of the *ba'* (a rattan carrier for infants and small children elaborately decorated with beadwork designs, tiger teeth, and other objects considered to have protective power) Whittier (1973) described the practice of placing a piece of *lung* rhizome in a snail shell suspended from the *ba'*. The soul of the child, considered dangerously volatile, was prevented from wandering far from

the child by its residence in the rhizome. During the present survey, herbalists in Long Sungai Barang explained that Kenyah mothers kept the aerial portion of the plant tucked into the waistband of the *taa* (a wrapped skirt) to provide an additional anchor for the wandering soul.

The most important ritual indication comprises nine remedies that are the ingredients of a single complex treatment used in healing ceremonies for ailments resistant to other treatments. The use of this treatment was observed during the present study in Long Sungai Barang, and is described in App. 3.4. In this instance, a severe headache (*sakit ulu*) could not be attributed to natural phenomena and did not improve with other treatment (aspirin tablets and rest). The headache was eventually attributed to supernatural causes. Two spirit mediums, as well as a lay brother from the village Catholic church, were called upon to perform a ceremony in which the nine-remedy treatment was used. The components of this mixture were confirmed independently by healers and herbalists in Long Sungai Barang and Lidung Payau. Hose (1926) described a similar bundle of charms (*siap aioh*) used to protect Kenyah households or entire villages, which were considered to have great and potentially dangerous power. The ritual use of numerical cures applied nine times was also observed in the *Ruda de Monte* cure for *espantajo* among the Maya (Arnason et al. 1980).

#### *Household remedies (taban)*

The Kenyah use many more remedies (380) to treat ailments or conditions caused by natural phenomena than has been evident in previous reports, which have focused greater attention on the exotic and peculiar nature of ritual treatments. These non-ritual remedies are called collectively *taban*, synonymous with the English term "medicine", and the

Indonesian term *obat* (Table 3.3, part II). For example, a remedy for fever (*mayeng*) is called *taban mayeng*; a local remedy for headache (*sakit ulu*) is called *taban sakit ulu*; and aspirin tablets are called *taban sakit ulu alo'* (the term *alo'* means "foreign").

Many indications treated by *taban* remedies have universal equivalents easily understood by an external observer. For example, human accident is considered the immediate cause of ailments such as falls and knife wounds, which occur frequently while clearing forests and cutting firewood. The largest numbers of *taban* remedies are for gastrointestinal infections, dermatological maladies, and complex systemic ailments causing fever. For example, consultants reported nine types of stomachache (*sakit bate'*) treated with 94 remedies (Table 3.3). A large number of treatments for a single ailment might signal the lack of a singularly effective treatment. Alternatively, ailments with a variety of agents may require a similarly varied range of therapeutic strategies. Intestinal disorders, wound and skin infections, and ailments with fever symptoms are common and debilitating health problems among forest-dwelling agriculturists (Armelagos and Dewey 1970; Polgar 1964; Dubos 1968), involving a large number of pathogens, parasites, and other agents.

The most important indications among *taban* remedies include prevention of tooth decay and gum disease (IV<sub>indication</sub> = 4), and treatments for *panau* or *litak*, a skin infection with symptoms that suggest vitiligo (IV<sub>indication</sub> = 3.5). One of the two species used to prevent tooth decay, *Piper betle* (Piperaceae), is cultivated and used by the Kenyah and by peoples throughout South East Asia in a stimulant masticatory (*sirih*, or *sireh*) that is also widely associated with magical healing properties and has numerous other effects, including blackening teeth, sweetening breath,

depressing appetite (Burkill 1935), and disinfecting the mouth (Perry and Metzger 1980). Phenolic constituents of *Piper* spp. may be effective in preventing tooth decay by biochemical or physical means (Lewis and Elvin-Lewis 1984). The other preventive remedy for tooth decay, *Pinanga coronata* (Arecaceae), is a little-known local substitute in *sirih* for the widely cultivated *Areca catechu* (betel nut), to which are attributed many medicinal and toxic effects (Burkill 1935; Perry and Metzger 1980).

The Kenyah use four remedies to treat vitiligo (*panau*): *Hoya coronaria* (Asclepiadaceae), *Homalanthus populneus* (Euphorbiaceae), *Alpinia galanga* (Zingiberaceae), and *Cassia alata* (Fabaceae). *Cassia alata*, the most important remedy (IV<sub>remedy</sub> = 4) according to the present survey, was also described by Elshout (1923), Nieuwenhuis (1929), Soedjito (1982), and Sangat-Roemantyo (1982). It is widely used in tropical countries against skin diseases. Activity against dermatophytic fungi has been reported by Ibrahim and Osman (1995).

For 17 indications there is a single remedy each (Table 3.3), nearly all of which were reported only once or twice during the present survey (IV<sub>remedy</sub> < 3). Among these are conditions that might be more common in urban settings, such as high blood pressure, diabetes, and asthma (Polgar 1964; Dubos 1968). Also included in this group, however, is snakebite, a potentially fatal event in the Apo Kayan. The single remedy (*Musa* spp., Musaceae) was reported to relieve the pain rather than neutralize the poison. No local remedies were reported for some ailments that have appeared only recently in the Apo Kayan. For example, prayer was the only available treatment during a recent epidemic of diphtheria, likely introduced from the coastal town of Samarinda by someone traveling by airplane.

Some ailments are attributed to more ambiguous and culture-specific causes: *ya tudep*, *po buleng*, *sakit salesma*, and the childhood ailment *pelien'* have symptoms of general malaise that are difficult to equate with western concepts of disease. Concepts such as *masuk angin* and *panas mlebu* in Javanese culture (Geertz 1960), *susto*, *espantajo*, *mal viento*, and *mal ojo* in Latin American cultures (Rubel 1964), and the common cold in North America are similarly ambiguous. Treatments for *pelien'* are among the most numerous and important in Kenyah medicine (Table 3.3, part II).

Complex ailments, particularly those causing sudden sickness and death, were in the past attributed to supernatural causes and treated with both *taban* and healing ceremonies. A modern medical explanation and terminology for some such ailments has been adopted, such as those for cholera (*kalira*), tuberculosis (*t.b.c.*), and beriberi (*biri-biri*). A number of indications have no specific local name, or it was not recorded during this survey.

Kenyah terminology for some complex and important ailments affecting the Apo Kayan Kenyah suggests an understanding of disease pathology that is as perceptive as the western folk equivalent. For example, the Kenyah not only distinguish between malarial fever and other fevers, but the term for malarial fever, *mayeng kora* (literally "fever spleen") associates the two principal clinical symptoms for malaria - periodic fever and spleen enlargement (*kora-kora*). There is evidence to suggest that this understanding predates early contact between Borneo peoples and European physicians (Skeat 1900). Kenyah antimalarials and their antiplasmodial activity are considered in detail in Chapter 4.

Worms (*ulet*) were reported to be the agents of many ailments, ranging from the visible intestinal parasites

*lekahan* (*Ascaris* spp.) that cause various types of stomachache (*sakit bate'*) to invisible worm-like agents of skin, mouth, and gum infections. This association was reported previously by Conley (1973). Kenyah consultants associated insects not only with their bites and stings, an important irritant during forest clearing, but also with dermatological symptoms of complex systemic ailments such as measles (*ambun*) and childhood poxes (*pelian*). The painful swelling caused by urticacious hairs of caterpillars encountered in rice fields and the swollen joints of rheumatism and arthritis were given the same local name, *tinen bulu*.

Some remedies reflect an understanding of special nutritional circumstances, such as the use of tonics during gestation and postpartum. Prevention and control of goiter (*gondok*) and cretinism appear to have been associated with access to sea salt before contact with Europeans; sea salt was and remains among the most desirable articles of trade in the Apo Kayan, and there are numerous references to its value in early sources (Elshout 1923; Nieuwenhuis 1929; Tillema 1938). Some dietary prohibitions, such as restricted consumption of barking deer (*kijang*, *Muntiacus muntjac*) by aristocrats appear to have greater symbolic than dietary value. Other prohibitions may be related to undesirable physiological effects, such as the association of certain foods, condiments, and medicines with miscarriage.

Abortifacients and remedies to prevent pregnancy are notably lacking in the Kenyah pharmacopoeia. The great value of parenthood in Kenyah society combined with a relatively low birthrate (Tillema 1938; Mackie 1986) and high child mortality suggest that there is little need for such interventions.

### *Poisons (tuba)*

Kenyah consultants reported 26 uses of plants as poisons and repellants (*tuba*) (Table 3.3, part III; App. 3.3). Plants used as both medicines and poisons may be more biologically active than are plants used only as medicine or poison (Spjut and Perdue 1976). Piscicides are used throughout the world as an efficient means of obtaining food (Acevedo-Rodriguez 1990). The practice of poisoning or stupefying fish in small streams by beating in the sap of plants (especially of *Derris elliptica*, Fabaceae) was common among inland Borneo peoples (King 1993), although it has now been banned in most areas to protect fisheries and communities downstream.

#### 3.3.3. Healers, herbalists, and local knowledge

In the Kenyah villages surveyed, two groups of individuals were identified as having extraordinary knowledge about the healing qualities of local plants and animals. Of the 32 individuals interviewed in this survey, three were considered by their peers to be ritual healers (*dayung*) (Table 3.4). Two were male and one was female, all apparently members of the highest social class in Kenyah society (*paran*), and between 70 and 80 years old in 1989. These individuals had apprenticed with other Kenyah healers, but had no apprentices themselves. During the present survey, the most commonly used Kenyah term for ritual healer was *dayung*, also used by Whittier (1973) and Conley (1973) in their descriptions of Kenyah customary healing practices. The Malay term *dukun* was sometimes substituted, while the term *belian*, commonly used by the nomadic Punan and other inland ethnic groups (Sellato 1994), was used rarely by the Kenyah.

Table 3.4. Demographic profile of Kenyah healers and herbalists in three Apo Kayan villages

Status	Age class (years)	Gender	Long Sungai Barang	Lidung Payau	Long Ampung	All villages
<i>Dayung</i> (healer)	70+	male	1	1	0	2
		female	0	1	0	1
<b>Herbalist</b>						
<i>Pe</i> (elder)	40+	male	6	3	2	11
		female	7	2	2	11
<i>Taman</i> (father)	20-40	male	4	0	0	4
<i>Tinen</i> (mother)	20-40	female	1	1	0	2
Unmarried	<20	male	1	0	0	1
		female	0	0	0	0
<b>All healers/herbalists</b>			<b>20</b>	<b>8</b>	<b>4</b>	<b>32</b>

The principal source of information in this survey, however, was not ritual healers but 29 individuals known within their communities for their more general knowledge of common ailments and remedies. These individuals were given no special title. Most had obtained their knowledge from a parent or grandparent, who were said to have had much broader knowledge of remedies than was now recalled. Most of these herbalists were addressed by the gerontonym "Pe-", a prefix indicating advanced age and status within the family as elders (Whittier 1981). Several of the males were members of the inner circle of village elders (likely *paran* and heads of households) or were the wives of such individuals, while others had no other obvious status within the community.

The concentration of specialized medical knowledge in village elders has been documented elsewhere, for example, by Phillips and Gentry (1993b) among the non-indigenous mestizo people of Tambopata, Amazonian Peru. The 20 individuals identified as ritual healers and herbalists in Long Sungai Barang represent approximately 6% of the village population (343 in 1989). This is a small group of specialists compared with 26% of the Kayapo' who specialize in medicinal curing in the South American village Gorotire (Posey 1992).

#### *Gender and knowledge*

Differences in knowledge between male and female healers and herbalists are of interest since many ethnobotanical researchers have better access to one or the other for cultural reasons. Gender bias in research is thus difficult to avoid. In this study, healers and herbalists interviewed happened to be represented by approximately even numbers of men (18) and women (14), but more time was spent with women, who were more available for informal discussions.

A majority of remedies (54%) were known to both genders (Table 3.5). A larger proportion of remedies reported (36%) were known to females only than to males only (10%). The mean remedy importance value (mean  $IV_{\text{remedy}}$ ) is significantly greater for those remedies known to both genders, however, than for those known only to a single gender of healer/herbalist. Had the present survey been focused on a single gender of healer, or on a smaller number of individuals, the most widely known remedies likely would have been reported, but 10-36% of the remedies may have been omitted.

#### *Distribution and transfer of knowledge*

The most important remedies ( $IV_{\text{remedy}} = 4$ ) account for approximately 14% of all remedies used by the Kenyah (Fig. 3.1). The majority of remedies (60%) were described only once during the survey ( $IV_{\text{remedy}} = .1$ ). Relatively few remedies (7%) were described more than twice but in only one village ( $IV_{\text{remedy}} = 3$ ). Knowledge of remedies therefore appears to be somewhat bimodal: that which is held by individuals, based on individual experience and expertise, and remains essentially private; and that which is widely known in the region to individuals interested in healing.

Individuals appear to be sampling and testing materials from the local environment in search of effective treatments. The process of experimentation and discovery was described or demonstrated numerous times during the survey. Two examples are given here.

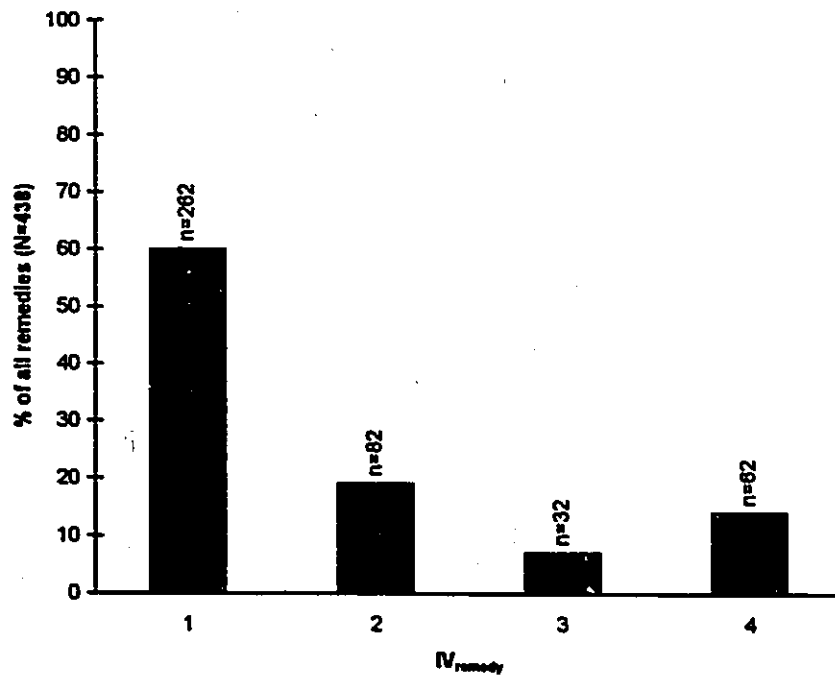
A remedy for intestinal worms (*lekahan*) was described by a herbalist in Lidung Payau in the presence of two herbalists from Long Sungai Barang, who were assisting with field collections for the present survey. This remedy involved

**Table 3.5. Distribution of knowledge of medicinal species between male and female healers and herbalists**

<b>Gender</b>	<b>Number of species</b>	<b>% of all species</b>	<b>Mean <math>IV_{species}^a \pm</math></b>	<b>S.E.<sup>b</sup></b>
Female	75	36	2.3 $\pm$	0.2
Male	20	10	1.8 $\pm$	0.2
Male and female	114	54	5.0 $\pm$	0.3
Total	209	100		

<sup>a</sup> Species importance value ( $IV_{species}$ ) can be greater than 4 since it is calculated as the sum of remedy importance values ( $IV_{remedy}$ ) for each species.

<sup>b</sup> Standard error of the mean.



**Figure 3.1. Frequency distribution of importance value in Kenyah remedies.  $IV_{remedy}=1$ : remedy reported once;  $IV_{remedy}=2$ : remedy reported twice;  $IV_{remedy}=3$ : remedy reported at least three times in one community;  $IV_{remedy}=4$ : remedy reported at least three times and in more than one community.**

ingesting grated unripe pineapple fruit, *kayu ujan* (*Ananas comosus*, Bromeliaceae), with honey. It was administered particularly to children, who resist the bitterness of other treatments. Pineapple is cultivated throughout the Apo Fayan and is eaten extremely ripe. This remedy was new to the Long Sungai Barang herbalists, who tested it on an ailing child upon arriving home. After several days of treatment, they decided it was ineffective and switched to another remedy.

In another instance, reported to have occurred in 1983, a young man from Long Sungai Barang was cutting planks for the walls of his house (*lamin*) from *puto' babui* (*Palaquium calophyllum*, Sapotaceae), a common, latex-producing primary forest tree favoured for building because it is easy to work but durable. Bark shaved from the wood fell into a forest stream, where children noticed stupefied fish rising to the surface downstream. This "new" poison has been tried by at least one other individual ( $IV_{\text{remedy}} = 2$ ), but both reported a preference for other piscicides that are considered more effective (App. 3.3).

### 3.4. Conclusions

The observations reported in this chapter provide evidence that Kenyah knowledge and use of the Apo Kayan flora and fauna in a system of medicine is extensive and dynamic. The large number of Kenyah remedies reported in this survey confirms a more extensive knowledge and application of local flora and fauna as medicines than has been documented previously. Anecdotal evidence of selection and elimination of remedies suggests that the Kenyah pharmacopoeia has been developed, and continues to develop, through empirical processes of discovery and experimentation. The biological

basis for Kenyah selection of medicinal remedies from the surrounding flora and fauna is examined in Chapter 5.

Large numbers of remedies for gastrointestinal, dermatological, and fever-inducing ailments indicate the relative significance of various risks to health in the Apo Kayan.

A quantitative tool (the remedy importance value index,  $IV_{\text{remedy}}$ ), developed for and applied to this survey, was used to identify locally important remedies based on consensus among Kenyah healers and herbalists. It is proposed that important remedies are most likely to be effective as treatments of the indications described. While it is not feasible to test this hypothesis for all remedies, particularly in the case of culturally defined ailments, it is possible to examine the relationship between  $IV_{\text{remedy}}$  and potential efficacy for particular ailments where suitable models and procedures exist. Such an examination of Kenyah remedies for malaria is presented in Chapter 4.

Medicinal knowledge in the Kenyah communities surveyed is distributed beyond the ritual healers (*dayung*), and includes the knowledge of non-specialist herbalists, many of whom are women. Important remedies are known equally to both genders. Most ritual healers and non-specialist herbalists are elders.

The Kenyah system of medicine distinguishes between two main types of causative agents. A relatively small but important group of remedies used in ritual treatments continues to reflect strong cultural themes concerning the influence of spirits on human health and well-being. A much larger group of remedies reflects an association of health with natural events or agents that coincides in many instances with a more universal understanding of health and illness.

The elaborate system of symbols, rituals, and restrictions that once provided the overriding context for Kenyah medicine is rapidly disappearing. Healing rituals are integral to the Kenyah world view and customary practices, and change in these beliefs and practices has resulted in general discouragement of the use of practical remedies. Concentration of knowledge of healing and remedies among village elders suggests a break in the tradition of apprenticeship. While the Kenyah are likely meeting many of their health needs effectively with traditional remedies, lack of effective local treatments for serious local ailments and recently introduced diseases reflects a need for and interest in combining modern treatments with local remedies to provide a more effective system of health care.

**CHAPTER 4**  
**KENYAH MALARIA REMEDIES:**  
**A QUANTITATIVE ASSESSMENT OF LOCAL CONSENSUS**  
**AS AN INDICATOR OF BIOLOGICAL EFFICACY**

**4.1. Introduction**

Early accounts of disease and healing among the Malay and other peoples of Southeast Asia suggest the antiquity of the association of periodic fever with splenomegaly and mosquitoes. In 1900, Skeat recorded a popular Malay creation myth in which a demon transforms himself into a band of mosquitoes to cause sickness (Skeat 1900). He reported that Malay healers commonly attribute to mosquito bites the onset of a disease called *demam kura*, or fever of the spleen, the symptoms of which include periodic fevers and enlargement of the liver and spleen. In the Fifth Century AD, the Indian physician Susruta associated periodic fevers with mosquito bites (Wells, Huxley, and Wells 1931). Susruta's observation predated by more than a millennium the association of malaria with mosquitoes by European scientists. Until 1900, most Europeans associated the disease *mal'aria* with foul air from swamps.

According to surveys conducted by the World Health Organization (WHO), malaria causes more sickness and death in the world than any other parasitic infection, especially in tropical developing countries (WHO 1986; Strickland 1991). Financial and logistical limitations of pharmaceutical control of the parasite and pesticidal control of the mosquito vectors have encouraged increasing genetic resistance in parasites, especially in *Plasmodium falciparum* and vectors. *Plasmodium falciparum*, the agent of cerebral malaria, causes more severe and fatal cases of

malaria and affects larger numbers of people than any other species of *Plasmodium*.

The incidence of *P. falciparum* infection is increasing in Southeast Asia (WHO 1992), and there is indirect evidence that the incidence of malaria is increasing in the Apo Kayan. A relatively low level of chronic malaria and few acute cases were observed in the Apo Kayan villages between 1896 and 1901 by the visiting Dutch physician Nieuwenhuis (1929), who attributed the low level of infection to the high altitude and natural immunity among the local residents. In the 1930s, the resident physician De Rooy considered malaria among the most prevalent ailments of the Apo Kayan population (Tillema 1938). In a WHO-supported malaria eradication programme in Sarawak in the 1950s, Colbourne, Huehne, and Lachance (1959) observed a higher rate of malaria infection in the interior highlands adjacent to the border with Kalimantan than in the lowland and coastal areas. During the survey conducted in 1989, the resident physician in Long Nawang considered malaria the most serious infection in the Apo Kayan villages, causing many cases of chronic illness and several deaths each year. Antimalarial drugs are not generally available in the Apo Kayan; thus the disease and its symptoms are treated almost exclusively with local remedies.

Resistance of *P. falciparum* and *P. vivax* to antimalarial drugs has been reported in Southeast Asia as in other regions of the world (WHO 1992). The search for novel compounds effective against *Plasmodium* strains resistant to widely used synthetic drugs has led to increased interest in new and existing information about malaria remedies from natural sources (Phillipson and Wright 1991; Angerhofer et al. 1992). Simultaneously, and as importantly, the need for accessible, inexpensive, and culturally relevant health care in much of the world is beginning to direct pharmacological

research toward the safe and effective use of traditional remedies (WHO 1986; De Smet 1991).

The gradual shift from nomadic to sedentary communities, increasing populations, and deforestation have been shown to contribute to an increase in the incidence of malaria (Anon. 1978; Hong 1987). Social and environmental change, combined with the resurgence of malaria in the region, suggest that effective treatments for malaria will only increase in their importance to the health of the Apo Kayan Kenyah.

#### 4.2. Materials and Methods

Kenyah malaria remedies were identified as part of the broader survey of Kenyah remedies (Chapter 3), in which 32 healers and herbalists were interviewed in three Kenyah villages (Long Sungai Barang, Lidung Payau, and Long Ampung) in the Apo Kayan (Fig. 2.1).

Taxonomic identities were verified by staff at the Herbarium Bogoriense, Bogor, Indonesia; the Arnold Arboretum of Harvard University, Cambridge, USA; and the Royal Botanic Garden, Edinburgh, UK (see Chapter 3). Vouchers were deposited at the Herbarium Bogoriense (Bogor, Indonesia), the University of Ottawa (Ottawa, Canada), and the Arnold Arboretum of Harvard University (Cambridge, USA).

The remedy importance value ( $IV_{\text{remedy}}$ ) index was developed for the present study to quantify the degree of confirmation among consultants within and between the communities surveyed (Chapter 3, Table 3.1). The importance value for malaria ( $IV_{\text{mal}}$ ) = 1 for remedies reported once during the survey;  $IV_{\text{mal}}$  = 2 for remedies reported twice in one community;  $IV_{\text{mal}}$  = 3 for remedies reported at least three times in one community; and  $IV_{\text{mal}}$  = 4 for remedies reported at least three times and in more than one community. This

method thus creates the categorical variable ( $IV_{mal}$ ) which is simple to assess in the field, allows flexibility in survey situations, and enables quantitative evaluation of data obtained from groups.

Antiplasmodial activity of species used by the Kenyah specifically to treat malaria was compared with the antiplasmodial activity of a variety of species used to treat other ailments or as piscicides. Selection of species for antiplasmodial activity testing was biased in favour of those for which significant biological activity was demonstrated in field trials against brine shrimp (*Artemia salina* Leach) and for which collection of bulk samples did not threaten local populations (see Chapter 5). Methods for the field trials were adapted from Meyer et al. (1982), and preliminary results were reported by Leaman, Yusuf, and Sangat-Roemantyo (1991).

Bulk tissue samples for extraction were collected in September 1992 in the Apo Kayan by H. Soedjito (Indonesian Institute of Sciences - LIPI); a few common species were collected in bulk at Bogor in May 1992 by J.T. Arnason and R. Yusuf. Tissue samples were collected in volumes of 1-2 litres and preserved on site in aqueous ethanol. Voucher data for these species are recorded in Table 4.1 (malaria remedies) and Appendix 4.1 (non-malaria remedies).

Samples were macerated in aqueous ethanol, allowed to stand at least 24 hours, and exhaustively extracted in additional aqueous ethanol. The filtrates were evaporated under reduced pressure and freeze-dried.

Selective antiplasmodial activity was evaluated in a tandem screen combining an antimalaria assay with an in vitro cytotoxicity assay following protocols described in detail by Angerhofer et al. (1992). Crude extracts were screened

at 10 and 20  $\mu\text{g ml}^{-1}$  for in vitro activity against *P. falciparum* cultured in human erythrocytes (Trager and Jensen 1976). This test employs the differential incorporation by *P. falciparum* of the radiolabelled nucleic acid precursor [ $^3\text{H}$ ]hypoxanthine to detect inhibition of the growth of plasmodia by test substances (Desjardins et al. 1979; O'Neill et al. 1985; Angerhofer et al. 1992). The two concentrations selected represent the range within which selective antiplasmodial (non-cytotoxic) activity generally can be detected in crude plant extracts. Incorporation of [ $^3\text{H}$ ]hypoxanthine was compared between test extracts and zero-drug controls to determine percent inhibition of *P. falciparum*. Approximate  $\text{IC}_{50}$  values (the concentration of test substance that inhibits [ $^3\text{H}$ ]hypoxanthine incorporation by 50%) were determined for the more active crude extract samples from serial dilutions in subsequent tests and compared with antimalarial compounds.

Samples were screened concurrently at 20  $\mu\text{g ml}^{-1}$  for general cytotoxicity against human epidermoid carcinoma (KB) cells (Skehan et al. 1990; Angerhofer et al. 1992). Cell growth in the presence of test extracts was compared with zero-day controls to determine percent of cells surviving the treatment. Approximate  $\text{IC}_{50}$  values were determined for the more active samples in subsequent tests.

#### **4.3. Results and Discussion**

##### **4.3.1. Kenyah malaria remedies**

In a comprehensive survey of Kenyah traditional medicines, consultants described 438 remedies derived from 199 species of plants and 5 animals; 17 of these remedies are, or were in the past, used by the Kenyah to treat malaria (Table 4.1). These remedies are drawn from diverse taxonomic

Table 4.1. Kenyah malaria remedies

Scientific name <sup>a</sup> (Family)	Voucher <sup>b</sup>	Kenyah name	Symptom treated	Part used	Preparation/ application	IV <sup>mal</sup> <sup>c</sup>
<i>Alstonia scholaris</i> (L.) R. Br. (Apocynaceae)	188	<i>njau lutung</i>	spleen fever	sap	infusion	1
<i>Annona muricata</i> L. (Annonaceae)	65	<i>dian beleda'</i>	spleen fever	leaves & petrol	rubifacient	2
<i>Blumea pubigera</i> (L.) Merr. (var. 1) (Asteraceae)	141	<i>udu sekiput lulut</i>	splenomegaly	leaves	poultice	1
<i>Carica papaya</i> L. (Caricaceae)	185	<i>manjan</i>	spleen fever	latex of immature fruit	suspension	1
<i>Eriodendron anfractosum</i> DC. (Bombacaceae)	183	<i>bura'</i>	spleen fever	leaves & rice water	poultice	1
<i>Chrysanthemum</i> sp. (Asteraceae)	252	<i>bunga alok</i>	splenomegaly	leaves & lime	rubifacient	1
<i>Fagraea racemosa</i> Jack (Loganiaceae)	7	<i>kayu batu</i>	splenomegaly	leaves	poultice	2
<i>Hedychium cylindricum</i> Ridley (Zingiberaceae)	29	<i>tubo sakal</i>	spleen fever (pediatric)	stalk	decoction	1
<i>Homalomena rubra</i> Hassk. (var. 1) (Araceae)	43	<i>lung bala</i>	splenomegaly	root	decoction rubifacient decoction	1
<i>Lansium domesticum</i> Corr. Serr. (Meliaceae)	30	<i>lengeset</i>	spleen fever	bark, seeds	decoction	4
<i>Piper arborecens</i> Miq. (Piperaceae)	39	<i>balang ulat</i>	spleen fever	root	infusion	2
<i>Piper belle</i> L. (Piperaceae)	114	<i>udu sepa'</i>	spleen fever (pediatric)	leaves	decoction	1
<i>Pothos ovatifolius</i> Engl. (Araceae)	149	<i>aka maiung</i>	splenomegaly	leaves	poultice	1
<i>Premna glandulosa</i> Merr. (Verbenaceae)	36	<i>udu lekahan</i>	splenomegaly	leaves	poultice	2

Table 4.1. continued

Scientific name <sup>a</sup> (Family)	Voucher <sup>b</sup>	Kenyah name	Symptom treated	Part used	Preparation/ application	IV <sub>mal</sub> <sup>c</sup>
<i>Schefflera</i> cf., <i>oblongifolia</i> Merr. (Araliaceae)	182	<i>Jankang iyap puang</i>	spleen fever	leaves	decoction	1
Unidentified sp. (Zingiberaceae)	59	<i>lia ubat</i>	spleen fever	roots, shoots, rhizome	infusion	1
Unidentified sp.	89-X		spleen fever (pediatric and adult)	oil	suspension rubifacient	4

<sup>a</sup>Taxonomic notes. *Eriodendron anfractosum* DC. was formerly *Ceiba pentandra* (L.) Gaertn.

*Lansium-Aglia* complex: according to Burkill (1966), the vernacular name *lansat* generally distinguished cultivated forms of *Lansium domesticum* from the wild forms, known as *duku*. Heyne (1927) identified the Kenyah *lengeset* as *L. domesticum*, whereas Kostermans (1966) classified specimens from the Apo Kayan as *Aglala dookoo* Griff., a species endemic to Borneo. Chal, Lee, and Ismawi (1989) gave *Aglala domestica* (Corr.) Pellegr. as the scientific name for the Iban *lansat*. In a recent revision of the Southeast Asian Meliaceae, Mabberley (1985) combined *A. dookoo* with *L. domesticum*, but acknowledged unresolved taxonomic confusion among wild, cultivated, naturalized, and island-endemic forms. *Piper arborescens* and *Premna glandulosa* are wild, climbing lianas. Kenyah consultants recognized at least two local varieties for each species.

<sup>b</sup>Voucher numbers are in the series Leaman 89-

<sup>c</sup>IV<sub>mal</sub> = remedy importance value for malaria. IV<sub>mal</sub> = 1 for remedies reported once during the survey; IV<sub>mal</sub> = 2 for remedies reported twice in one community; IV<sub>mal</sub> = 3 for remedies reported at least three times in one community; and IV<sub>mal</sub> = 4 for remedies reported in more than one community; no malaria remedies reported in Lidung Payau and Long Ampung were reported fewer than three times in Long Sungat Barang. The more limited scope of surveys in Lidung Payau and Long Ampung resulted in single reports for most remedies in these communities.

groups, comprising 14 families and 11 orders of flowering plants.

Other ethnobotanical surveys of Borneo peoples described treatments for various types of fever not directly associated with malaria (Chai 1978; Chai, Lee, and Ismawi 1989), but none described remedies specific for malaria. Malaria is not always distinguished from other causes of fever (Johns, Kokwaro, and Kimanani 1990; Etkin and Ross 1991), but in some systems of ethnomedicine, malaria, its symptoms, and treatments are identified meticulously (Brandão et al. 1992; Rasoanaivo et al. 1992).

The Kenyah recognize two distinct symptoms of malaria: spleen fever (*mayung kora* or *demam kora*) and spleen enlargement, or splenomegaly (*kora-kora*). Spleen fever was distinguished by its periodicity from other types of fever, for example, those associated with childhood pox diseases and gastrointestinal ailments. Kenyah consultants described 11 remedies to treat spleen fever and 6 remedies to treat splenomegaly. All of the remedies for *kora-kora* were reported to be administered externally as heated poultices, primarily of leaves. Most of the remedies for *demam kora* are taken internally as decoctions or infusions prepared from a variety of plant parts.

The remedies most important to the Kenyah ( $IV_{mal} = 4$ ) are the bark of *Lansium domesticum* (Meliaceae) and a natural oil extracted from an as yet unidentified species (Leaman 89-X). These remedies were known to most consultants in all three villages surveyed, but are little known beyond the Apo Kayan. They are among a small group of remedies prepared from stored materials, and sometimes traded in lieu of cash. *L. domesticum*, a tree native to the Indo-Malayan region, is widely cultivated for its edible fruit, the *langsats*. Use of the bark and seeds in North Borneo (now Sabah) to treat

malaria and fever was recorded by Burkill (1966). Chai, Lee, and Ismawi (1989) reported use of *langsat* leaves by the Iban in Sarawak to treat fever (Table 4.1, note a).

Several of the less important malaria remedies in Table 4.1 are widely known and used to treat malaria and related ailments. *Alstonia scholaris* (Apocynaceae) stem and root bark has been used since ancient times throughout Southeast Asia and Indo-China, where the tree is native, as a treatment for fever, malaria, and splenomegaly (Burkill 1966; Holdsworth 1975; Perry and Metzger 1980; Deka, Majumdar, and Dutta 1983; Pushpanandan and Atal 1984; Mahyar et al. 1991), and was reported as a remedy for malaria in Africa, where the species is cultivated (Adesina 1982). *Annona muricata* (Annonaceae) and *Carica papaya* (Caricaceae) are New World species cultivated in Southeast Asia for their fruit, the soursop and the papaya, respectively. Both are used in traditional remedies principally to treat gastrointestinal ailments (Perry and Metzger 1980; Burkill and Haniff 1930; Heyne 1927; Steenis-Kruseman 1953).

*Annona muricata* leaves are used in the Caribbean and in Africa to treat malaria and fever (Asprey and Thornton 1955; Adesina 1982; Gbeassor et al. 1990), but this remedy has not been reported previously for Southeast Asia. *Carica papaya* is widely used in Asia and the Americas to treat fevers, splenomegaly, and other liver disorders (Oakes and Morris 1958; Burkill 1966; Amico 1977; Perry and Metzger 1980; Singh, Sharma, and Khare 1980; Adesina 1982; MacFoy and Sama 1983; le Grand 1989; Brandão et al. 1992). *Fagraea racemosa* (Loganiaceae), like *L. domesticum*, has a more regional reputation; in the Malay peninsula leaf poultices are applied to the abdomen to treat malaria and other fevers (Burkill 1966). Several related species are used in Malaysia, Java, and Papua New Guinea to treat malaria,

fever, and splenomegaly (Burkill 1966; Holdsworth and Sakulas 1986).

The remaining 11 species apparently are not used elsewhere to treat malaria. Related uses as febrifuges, anti-inflammatories, and analgesics have been reported for *Eriodendron anfractosum* (formerly *Ceiba pentandra*, Bombacaceae), *Blumea pubigera* (Asteraceae), *Homalomena rubra* (Araceae), and *Piper arborescens* (Piperaceae) (Chai 1978; Chai, Lee, and Ismawi 1989). *Piper betle* leaves are used throughout Southeast Asia and Indo-China in a stimulant masticatory with the betel nut, *Areca catechu* (Arecaceae) (Eisen 1946; Burkill 1966; Perry and Metzger 1980).

Numerous members of the genus *Chrysanthemum* (Asteraceae) are used to treat fever, pain, inflammation, migraine, and a variety of liver and blood disorders (Hussey 1974; Perry and Metzger 1980; Anderson 1986), as are species of *Schefflera* (Adam et al. 1982; Kitajama and Tanaka 1989). No previous reports of ethnomedical use were found for the remaining species, *Hedychium cylindricum* (Zingiberaceae), *Premna glandulosa* (Verbenaceae), and *Pothos ovatifolius* (Araceae).

#### 4.3.2. Antiplasmodial and cytotoxic activity

The results of four screens using chloroquine-sensitive *Plasmodium falciparum* clone D6 and chloroquine-resistant clone W2 at 10 and 20  $\mu\text{g ml}^{-1}$  are presented in Tables 4.2a and 4.2b. Among the malaria remedy extracts, the two most important malaria remedies in the Kenyah pharmacopoeia, *L. domesticum* and unidentified species Leaman 89-X ( $\text{IV}_{\text{mal}} = 4$ ), effected the greatest reduction in *P. falciparum* proliferation at both test concentrations and for both *P. falciparum* clones. The antiplasmodial activity of these extracts was significantly greater than that observed for other extracts, as indicated by a multiple comparison of

Table 4.2a. Effect of Kenyah malaria and non-malaria remedy extracts on the viability of chloroquine-sensitive (clone D6) *Plasmodium falciparum* in vitro

Extract	Part	Number of samples <sup>a</sup>	<i>Plasmodium falciparum</i> (clone D6)	
			10 µg ml <sup>-1</sup>	20 µg ml <sup>-1</sup>
			% viability ± S.E. <sup>b,c</sup>	
<b>I. Malaria remedies</b>				
<i>Alstonia scholaris</i>	leaves	3	111.0 ± 2.9 a	91.6 ± 1.2 a-h*
	bark	3	114.9 ± 1.8 a	99.1 ± 2.0 a-e
<i>Annona muricata</i>	leaves	3	106.3 ± 2.3 ab	72.0 ± 2.1 b-k**
<i>Carica papaya</i>	leaves	3	104.6 ± 0.2 a-d	87.2 ± 0.8 a-l**
<i>Fagraea racemosa</i>	leaves and fruit	6	104.7 ± 2.2 a-d	99.5 ± 8.3 a-c
<i>Hedychium cylindricum</i>	stalk	9	107.7 ± 1.5 a	97.5 ± 7.1 a-g
<i>Lansium domesticum</i>	bark	6	87.8 ± 5.5 b-d	36.7 ± 11.8 c-k**
<i>Lansium domesticum</i> (cf., <i>Aglaia dookoo</i> )	bark	9	95.2 ± 4.4 a-d	60.9 ± 11.9 c-k*
<i>Piper arborescens</i>	root	9	105.0 ± 1.0 a-c	107.1 ± 2.9 ab
<i>Piper betle</i>	leaves	6	102.0 ± 10.0 a-d	95.8 ± 2.9 a-h
	stems	6	100.5 ± 2.0 a-d	97.2 ± 0.9 a-h*
<i>Premna glandulosa</i>	leaves	9	107.6 ± 1.6 a	117.9 ± 5.4 a

Table 4.2a. continued

Extract	Part	Number of samples <sup>a</sup>	<i>Plasmodium falciparum</i> (clone D6)			
			10 $\mu\text{g ml}^{-1}$	% viability $\pm$ S.E. <sup>b,c</sup>	20 $\mu\text{g ml}^{-1}$	
<i>Schefflera</i> sp.	leaves	9	104.4 $\pm$ 1.5	a-d	99.1 $\pm$ 4.2	b-f
Unidentified sp. (89-X)	natural oil	3	31.1 $\pm$ 0.9	e***	20.9 $\pm$ 4.0	c-k**
<b>II. Non-malaria remedy extracts</b>						
<i>Ageratum conyzoides</i>	leaf, stem	6	100.5 $\pm$ 1.2	a-d	93.6 $\pm$ 0.3	a-h
<i>Albizia chinensis</i>	bark	9	109.6 $\pm$ 2.3	a	94.7 $\pm$ 5.3	a-h
<i>Dianella nemorosa</i>	whole plant	3	113.6 $\pm$ 6.8	a	93.4 $\pm$ 0.3	a-h
<i>Diospyros borneensis</i>	leaves	9	107.7 $\pm$ 1.9	a	90.8 $\pm$ 4.9	a-h
<i>Etilingera eliator</i>	fruit	9	98.4 $\pm$ 3.9	a-d	63.0 $\pm$ 7.8	c-k**
	stalk	9	101.3 $\pm$ 0.9	a-d	70.0 $\pm$ 14.4	c-k
<i>Etilingera</i> sp. 1	stalk	9	100.0 $\pm$ 2.2	a-d	78.7 $\pm$ 7.5	b-j*
<i>Homalomena pendula</i>	rhizome	3	103.9 $\pm$ 1.6	a-d	91.8 $\pm$ 2.7	a-h
<i>Leucosyke alba</i>	leaves	9	104.0 $\pm$ 3.9	a-d	105.9 $\pm$ 6.7	ab
	bark	9	103.6 $\pm$ 2.2	a-d	99.3 $\pm$ 6.7	a-d
<i>Parkia speciosa</i>	bark	3	105.9 $\pm$ 8.5	ab	94.4 $\pm$ 4.9	a-h

Table 4.2a. continued

Extract	Part	Number of samples <sup>a</sup>	<i>Plasmodium falciparum</i> (clone D6)	
			10 $\mu\text{g ml}^{-1}$	20 $\mu\text{g ml}^{-1}$
			% viability $\pm$ S.E. <sup>b,c</sup>	
<i>Plectranthus scutellaroides</i>	leaves	3	103.0 $\pm$ 5.5	98.0 $\pm$ 3.8
<i>Pongamia pinnata</i>	stem	3	115.4 $\pm$ 3.7	100.5 $\pm$ 1.5
<i>Smilax barbata</i>	rhizome	9	97.3 $\pm$ 1.1	98.1 $\pm$ 2.1

<sup>a</sup>Sample numbers (N) indicate one of the following cases: 3 = 3 pseudo-replicates of a single biological sample; 6 = 3 pseudo-replicates of each of 2 biological samples (2 individuals of the same species); 9 = 3 pseudo-replicates of each of 3 biological samples.

<sup>b</sup>Viability of *P. falciparum* is expressed as percent of [<sup>3</sup>H]hypoxanthine uptake of zero-drug control, and was calculated as the mean of at least three replicates for each sample. S.E. = standard error of the mean. Crude extract samples were dissolved in DMSO and screened in *P. falciparum* cultures at 10 and 20  $\mu\text{g ml}^{-1}$ . DMSO had no effect on *P. falciparum* viability at screen concentrations (< 0.025  $\mu\text{g ml}^{-1}$ ).

<sup>c</sup>Hypothesis tests:

**Null hypothesis 1:** Significant differences in the effect of different extracts on the viability of *P. falciparum* were determined using a multiple comparison of the means (Tukey test, Zar 1984:186-190). Mean percent viability determinations followed by different letters were significantly different from each other (e.g. "a" was significantly different from "b" but not from "ab" at  $P < .05$ ). The null hypothesis is

$$H_0: V_1 = V_2 = V_3 \dots V_n$$

where  $V_{1-n}$  denotes the mean percent viability of *P. falciparum* in the presence of any one of  $n$  extracts.  $H_0$  was rejected and an alternate hypothesis, such as

$$H_A: V_1 \neq V_2 = V_3 \dots V_n$$

was accepted at  $P = .05$ .

(continued below Table 4.2b)

Table 4.2b. Effect of Kenyah malaria and non-malaria remedy extracts on the viability of chloroquine-resistant (clone W2) *Plasmodium falciparum* in vitro

Extract	Part	Number of samples <sup>a</sup>	<i>Plasmodium falciparum</i> (clone W2)	
			10 $\mu\text{g ml}^{-1}$	20 $\mu\text{g ml}^{-1}$
			% viability $\pm$ S.E. <sup>b,c</sup>	
<b>I. Malaria remedies</b>				
<i>Alstonia scholaris</i>	leaves	3	111.3 $\pm$ 1.0	81.4 $\pm$ 0.3 a-j***
	bark	3	124.4 $\pm$ 15.1	98.0 $\pm$ 5.0 a
<i>Annona muricata</i>	leaves	3	102.2 $\pm$ 1.8	55.6 $\pm$ 3.0 a-n**
<i>Carica papaya</i>	leaves	3	101.2 $\pm$ 0.7	60.4 $\pm$ 0.6 a-n***
<i>Fagraea racemosa</i>	leaves and fruit	6	98.4 $\pm$ 4.2	72.4 $\pm$ 5.0 a-j*
	stalk	9	98.4 $\pm$ 1.1	76.4 $\pm$ 9.3 a-j*
<i>Lansium domesticum</i>	bark	6	87.3 $\pm$ 3.5	19.1 $\pm$ 4.2 j-n***
<i>Lansium domesticum</i> (cf., <i>Aglaia dookoo</i> )	bark	9	83.9 $\pm$ 2.8	39.8 $\pm$ 12.8 c-n**
	root	9	97.0 $\pm$ 2.1	97.8 $\pm$ 4.8 ab
<i>Piper betle</i>	leaves	6	101.7 $\pm$ 7.1	79.7 $\pm$ 1.9 a-l***
	stems	6	92.7 $\pm$ 2.6	84.6 $\pm$ 1.9 a-e***
<i>Premna glandulosa</i>	leaves	9	95.8 $\pm$ 1.5	92.7 $\pm$ 7.7 ab

Table 4.2b. continued

Extract	Part	Number of samples <sup>a</sup>	<i>Plasmodium falciparum</i> (clone W2)	
			10 $\mu\text{g ml}^{-1}$	20 $\mu\text{g ml}^{-1}$
			% viability $\pm$ S.E. <sup>b,c</sup>	
<i>Schefflera</i> sp.	leaves	9	90.1 $\pm$ 3.3	83.5 $\pm$ 3.7
Unidentified sp. (89-X)	natural oil	3	64.0 $\pm$ 1.0	7.5 $\pm$ 0.3
<b>II. Non-malaria remedy extracts</b>				
<i>Ageratum conyzoides</i>	leaf, stem	6	98.1 $\pm$ 0.4	70.9 $\pm$ 6.9
<i>Albizia chinensis</i>	bark	9	90.7 $\pm$ 2.6	75.7 $\pm$ 3.0
<i>Dianella nemorosa</i>	whole plant	3	89.5 $\pm$ 16.7	67.4 $\pm$ 0.9
<i>Diospyros borneensis</i>	leaves	9	98.3 $\pm$ 1.9	66.2 $\pm$ 8.6
<i>Etilingera eliator</i>	fruit	9	92.8 $\pm$ 1.7	45.1 $\pm$ 6.2
	stalk	9	89.8 $\pm$ 1.7	50.8 $\pm$ 15.7
<i>Etilingera</i> sp. 1	stalk	9	90.0 $\pm$ 2.2	46.9 $\pm$ 5.6
<i>Homalomena pendula</i>	rhizome	3	108.8 $\pm$ 1.4	81.6 $\pm$ 0.9
<i>Leucosyke alba</i>	leaves	9	95.8 $\pm$ 2.3	82.8 $\pm$ 4.8
	bark	9	94.7 $\pm$ 1.5	96.1 $\pm$ 6.8
<i>Parkia speciosa</i>	bark	3	103.3 $\pm$ 2.8	83.2 $\pm$ 1.5

Table 4.2b. continued

Extract	Part	Number of samples <sup>a</sup>	<i>Plasmodium falciparum</i> (clone W2)	
			10 $\mu\text{g ml}^{-1}$	20 $\mu\text{g ml}^{-1}$
			% viability $\pm$ S.E. <sup>b,c</sup>	
<i>Plectranthus scutellaroides</i>	leaves	3	109.2 $\pm$ 1.6	75.7 $\pm$ 1.1
<i>Pongamia pinnata</i>	stem	3	108.4 $\pm$ 0.7	86.8 $\pm$ 0.4
<i>Smilax barbata</i>	rhizome	9	93.3 $\pm$ 1.6	86.8 $\pm$ 4.2

(Continued from Table 4.2a)

**Null hypothesis 2:** Significant reduction in viability of *P. falciparum* was determined using a paired *t*-test (Zar 1984:97-121) to examine the null hypothesis

$$H_0: U = U_0$$

where *U* denotes that the mean [<sup>3</sup>H]hypoxanthine uptake of *P. falciparum* in the presence of test extracts and *U*<sub>0</sub> denotes the mean [<sup>3</sup>H]hypoxanthine uptake of *P. falciparum* in the presence of zero-drug controls. The number of asterisks to the right of the percent viability data indicates probability of *t* for the null hypothesis, not the degree of inhibition of *P. falciparum*. *H*<sub>0</sub> was rejected and the alternate hypothesis

$$H_A: U < U_0$$

was accepted at the following levels of probability:  
 $*$  =  $P < .05$ ;  $**$  =  $P < .01$ ;  $***$  =  $P < .001$ .

**Null hypothesis 3:** Mean percent viability of *P. falciparum* in the presence of test (malaria remedy) extracts is not significantly lower than in control (non-malaria remedy) extracts. *H*<sub>0</sub> was rejected in a two-sample *t*-test (see explanation for null hypothesis 1 above) for D6 screen at 10  $\mu\text{g ml}^{-1}$ ; *H*<sub>0</sub> was accepted for W2 and for D6 screen at 20  $\mu\text{g ml}^{-1}$  ( $P = .05$ ).

percent viability (Table 4.2, note c, null hypothesis 2). For example, at a concentration of  $20 \mu\text{g ml}^{-1}$ , *L. domesticum* bark extracts were significantly more active against chloroquine-resistant clone W2 than 14 other extracts (those followed by letter ranges that do not overlap with j-n), but were not significantly more or less active than 13 other extracts (those followed by letter ranges that do overlap with j-n).

Weaker antiplasmodial activity was indicated in at least one of the four tests reported in Table 4.2 for all but two of the other malaria remedy extracts (significant reduction of viability compared with zero-drug controls is indicated in Table 4.2 by asterisks; note c, null hypothesis 1). Notably, there was little activity in leaf extracts of the more widely known, but locally less important malaria remedies *Alstonia scholaris*, *Carica papaya*, and *Piper betle*. There was no significant activity in the root bark of *A. scholaris*, which is used throughout Southeast and South Asia as a remedy for fever and malaria (e.g., Burkill 1966). *A. scholaris* root bark and leaves contain numerous indole alkaloids (Boonchuay and Court 1976; Atta-Ur-Rahman et al. 1985; Yamauchi et al. 1990a, 1990b). Earlier studies have also failed to find significant activity in bark extracts and constituents of *A. scholaris* against *P. falciparum* (Wright et al. 1993) or against the murine malaria parasite *P. berghei* (Mukerji, Gosh, and Siddons 1942; Ghandi and Vinayak 1990). Activity against *P. falciparum* has been reported for quinoline alkaloids from *A. coriacea* by Wright et al. (1993), and in bark extracts of *A. boonei* (at the extremely high concentration of  $22 \text{ mg ml}^{-1}$ , however) by Tantchou and Sherman (1985). Antiplasmodial activity has not been reported previously for extracts of *Carica papaya* or *Piper betle*.

Although *Annona muricata* leaf extracts significantly reduced the viability of *P. falciparum* at 20  $\mu\text{g ml}^{-1}$ , toxicity to human epidermoid carcinoma (KB) cells was observed at the same concentration (Table 4.3), indicating toxicity rather than selective antiplasmodial activity. Antiplasmodial activity for extracts and constituents of *A. muricata* leaves has been reported previously by Gbeassor et al. (1990), Rupprecht, Hui, and McLaughlin (1990), and Misra et al. (1991). The malaria remedy extract *Hedychium cylindricum* and the non-malaria remedy extract *Dianella nemorosa* (Liliaceae) also showed weak cytotoxicity against KB cells (Table 4.3).

At both screen concentrations larger numbers of malaria remedy and non-malaria remedy extracts were significantly active against chloroquine-resistant clone W2 than against clone D6. Further investigation will be required to determine whether these results indicate greater susceptibility of clone W2 to antiplasmodial or cytotoxic effects.

The  $\text{IC}_{50}$  values calculated for the more active samples (Table 4.4) confirm selective activity against chloroquine-sensitive *P. falciparum* clone D6 in the Kenyah malaria remedies *L. domesticum* and Leaman 89-X. The Meliaceae and other families in the order Rutales are known to be rich in limonoids, a class of extremely bitter, modified terpenes, for which potent biological activity against insects has been well documented (Champagne et al. 1992; Arnason et al. 1993). Antiplasmodial activity against *P. falciparum* has been reported for the limonoid gedunin ( $\text{IC}_{50} = 0.8 \mu\text{g ml}^{-1}$ ), a tetranortriterpenoid isolated from *Melia azedarach* (Khalid et al. 1986; Khalid, Duddeck, and Gonzales-Sierra 1989; MacKinnon 1995). Dukunolides -- tetranortriterpenoids similar in structure to gedunin -- have been identified as the bitter constituents of *Lansium domesticum* seeds

Table 4.3. Cytotoxicity of Kenyah malaria remedy and control extracts determined with human epidermoid carcinoma (KB) cells in vitro

Extract	Part	Number of samples <sup>a</sup>	KB cells % survival $\pm$ S.E. <sup>b,c</sup> 20 $\mu$ g ml <sup>-1</sup>
<b>I. Malaria remedies</b>			
<i>Alstonia scholaris</i>	leaves	3	101.4 $\pm$ 0.9 a-c
	bark	3	97.6 $\pm$ 2.5 a-c
<i>Annona muricata</i>	leaves	3	82.0 $\pm$ 3.0 bc*
<i>Carica papaya</i>	leaves	3	96.8 $\pm$ 2.4 a-c
<i>Fagraea racemosa</i>	leaves and fruit	6	101.8 $\pm$ 1.7 a-c
<i>Hedychium cylindricum</i>	stalk	9	91.4 $\pm$ 1.7 bc***
<i>Lansium domesticum</i>	bark	6	109.5 $\pm$ 6.7 a-c
<i>Lansium domesticum</i> (cf., <i>Aglaia dookoo</i> )	bark	9	106.4 $\pm$ 4.4 a-c
<i>Piper arborescens</i>	root	9	94.5 $\pm$ 3.7 a-c
<i>Piper betle</i>	leaves	6	92.2 $\pm$ 5.0 a-c
	stems	6	102.3 $\pm$ 3.9 a-c
<i>Premna glandulosa</i>	leaves	9	109.4 $\pm$ 2.4 a-c
<i>Schefflera</i> sp.	leaves	9	111.3 $\pm$ 2.8 ab
Unidentified sp. 89-X	natural oil	3	97.7 $\pm$ 1.0 a-c
<b>II. Non-malaria remedies</b>			
<i>Ageratum conyzoides</i>	leaf, stem	6	100.4 $\pm$ 5.7 a-c
<i>Albizia chinensis</i>	bark	9	94.7 $\pm$ 3.4 a-c
<i>Dianella nemurosa</i>	whole plant	3	79.9 $\pm$ 1.1 c**
<i>Diospyros borneensis</i>	leaves	9	94.9 $\pm$ 2.4 a-c

Table 4.3. continued

Extract	Part	Number of samples <sup>a</sup>	KB cells		
			% survival $\pm$ S.E. <sup>b,c</sup> 20 $\mu$ g ml <sup>-1</sup>		
<i>Etilingera eliator</i>	fruit	9	114.8	$\pm$ 2.2	a
	stalk	9	112.9	$\pm$ 7.2	a
<i>Etilingera</i> sp. 1	stalk	9	103.2	$\pm$ 3.6	a-c
<i>Homalomena pendula</i>	rhizome	3	103	$\pm$ 4.8	a-c
<i>Leucosyke alba</i>	leaves	9	113.2	$\pm$ 8.7	a
	bark	9	109	$\pm$ 2.7	a-c
<i>Parkia speciosa</i>	bark	3	106.3	$\pm$ 5.4	a-c
<i>Plectranthus scutellaroides</i>	leaves	3	92.5	$\pm$ 2	a-c
<i>Pongamia pinnata</i>	stem	3	105.5	$\pm$ 5.1	a-c
<i>Smilax barbata</i>	rhizome	9	107.7	$\pm$ 3.8	a-c

<sup>a</sup>Sample numbers greater than 3 indicate two or more biological replicates.

<sup>b</sup>Survival of KB cells was determined by analyzing protein content with a protein-binding dye. The initial (zero-day) absorbance was subtracted from the test absorbance (day 3) and this difference was divided by the DMSO-control (day 3) absorbance minus the initial (zero-day) absorbance to obtain percent growth. Results are means of at least three replicates for each sample. S.E. = standard error of the mean. Crude extract samples were screened in cultured KB cells at a concentration of 20  $\mu$ g ml<sup>-1</sup> in DMSO.

<sup>c</sup>Hypothesis tests:

**Null hypothesis 4:** the mean percent survival of KB cells is not significantly different in the presence of different extracts.  $H_0$  was rejected at  $P = .05$ . Mean percent viability determinations followed by different letters were significantly different from each other in Tukey's multiple range test.

**Null hypothesis 5:** mean survival of KB cells in the presence of test extracts is not significantly lower than zero-drug controls.  $H_0$  was rejected in a paired t-test at the following levels: \* =  $P < .05$ ; \*\* =  $P < .01$ ; \*\*\* =  $P < .001$ .

**Null hypothesis 3:** Mean percent survival of KB cells in the presence of test (malaria remedy) extracts is not significantly lower than in control (non-malaria remedy) extracts.  $H_0$  was accepted in a two-sample t-test ( $P = .05$ ).

Table 4.4. Approximate IC<sub>50</sub> values (in ng ml<sup>-1</sup>) of active Kenyah malaria and non-malaria remedy extracts and selected compounds tested against *Plasmodium falciparum* and KB cells

Extract/Compound	Part	<i>Plasmodium falciparum</i>		KB cells
		Clone D6 IC <sub>50</sub> <sup>a</sup>	Clone W2 IC <sub>50</sub> <sup>a</sup>	IC <sub>50</sub> <sup>b</sup>
<b>I. Malaria remedy extracts</b>				
<i>Lansium domesticum</i> (cf., <i>Aglaia dookoo</i> )				
sample 18	bark	>20,000	6310	>20,000
sample 20	bark	9364	3105	>20,000
sample 63	bark	12853	3650	>20,000
<i>Lansium domesticum</i>				
sample 41	bark	>20,000	8780	>20,000
sample 42	bark	9890	3352	>20,000
Unidentified sp. (Leaman 89-X)	oil	5970	>20,000	>20,000
<b>II. Non-malaria remedy extracts</b>				
<i>Albizia chinensis</i>	bark	>20,000	9600	>20,000
<i>Etilingera eliator</i>				
sample 43	fruit	>20,000	9610	>20,000
sample 47	stalk	>20,000	8820	>20,000
sample 48	stalk	>20,000	>12,050	>20,000
<i>Etilingera</i> sp. (Leaman 89-1)	stalk	>20,000	15890	>20,000
<b>III. Compounds</b>				
Chloroquine		4.9	90.3	>17,400
Quinine		8.6	29.5	>20,000
Mefloquine		6.5	0.8	3500
Artemisinin		2.0	0.5	>20,000

<sup>a</sup>IC<sub>50</sub> values, expressed here in ng ml<sup>-1</sup>, were calculated using semi-log plots from the means of 2 replicates at 6 concentrations (20,000 - 27.5 ng ml<sup>-1</sup>) for samples showing less than 50% viability of *P. falciparum* in 10 and 20 µg ml<sup>-1</sup> screens, and less than 50% survival of KB cells at 20 µg ml<sup>-1</sup>. IC<sub>50</sub> values for all other samples were assumed to be higher than the highest screen concentration. *Plasmodium falciparum* clone D6 is chloroquine sensitive; clone W2 is chloroquine resistant.

<sup>b</sup>KB = human epidermoid carcinoma.

(Nishizawa et al. 1985a, 1985b, 1988). Rocaglamide, an insecticidal, antileukemic, and cytotoxic benzofuran, has been identified as an active constituent in species of the closely related genus *Aglaia* used widely in remedies for fever, heart ailments, and inflammation (King et al. 1982; Duh et al. 1993; Janprasert et al. 1993).

The IC<sub>50</sub> values also indicate selective activity against chloroquine-resistant clone W2 in *L. domesticum* and non-malaria remedies *Albizia chinensis* (Osbeck) Merr. (Fabaceae) and *Etlintera* spp. *Albizia chinensis* was used by the Kenyah exclusively to poison fish (Appendix 4.1); related species are used to treat malaria (Kokwaro 1976) and fever (Mokkhasmit et al. 1971; Adesina 1982; Singh 1986). Bark extracts of *A. anthelmintica* were not active against *P. falciparum* (Weenen et al. 1990). Triterpenes, a class of compound for which Phillipson and Wright (1991) reported antiplasmodial activity, have been isolated from the bark of *A. chinensis* (Rawa et al. 1989). Numerous triterpenoids, and indole and isoquinoline alkaloids have been isolated from related species (Nogueira Prista, Alves, and Almeida e Silva 1962; Smith 1977; Glasby 1991).

The stalk and tart endosperm of *Etlintera eliator* and the stalk and young buds of *Etlintera* sp. are used by the Kenyah in numerous remedies other than malaria, including treatment of a mysterious illness described as *ya'a tudep* (Appendix 4.1). Active constituents of *Etlintera*, especially, may be quite different in structure and activity than quinine and the 4-aminoquinoline derivatives to which clone W2 is resistant; the Zingiberaceae are rich in volatile oils but contain few alkaloids or other classes of compound known to have antimalarial activity (Evans 1989). No published information about the biological activity or constituents of *Etlintera* species was found; Suffness et al. (1988) reported weak antitumor activity and the absence of

cytotoxic activity for *Nicolaia eliator*, a synonym for *E. eliator* (Burt and Smith 1986; Smith 1986).

#### 4.3.3. Remedy importance value and efficacy: hypothesis tests

A primary focus of the present study is on quantitative methods as a means of relating human knowledge and patterns of use to biologically useful properties and activities. A few studies have examined quantitatively the relationship between degree of local consensus and efficacy of traditional remedies. Trotter and Logan (1986), for example, compared a frequency ranking of all types of remedies reported by residents of the lower Rio Grande Valley with their activity against brine shrimp, and found degree of consensus to be strongly correlated with toxicity.

In the previous section, simple quantitative analyses were used to identify significant levels of activity in crude extracts from *P. falciparum* screen results. Significant reduction of the viability of *P. falciparum* was observed in at least one of the four screens for all but two of the malaria remedy extracts, and for all of the non-malaria remedy extracts (Table 4.2, note c, null hypothesis 2). At the lower screen concentration, six of the malaria remedy extracts and seven of the non-malaria remedy extracts significantly reduced viability of *P. falciparum*.

These results do not support the hypothesis that extracts used in traditional remedies for malaria are more likely to be effective antimalarials than are biologically active materials used for other purposes. To test this hypothesis somewhat differently, the overall effect on mean percent viability of *P. falciparum* of malaria remedy extracts was compared with that of non-malaria remedy extracts (Table 4.2, note c, null hypothesis 3). Only for chloroquine-

sensitive clone D6 at  $10 \mu\text{g ml}^{-1}$  were the malaria remedy extracts significantly more effective as inhibitors of *P. falciparum* than were the non-malaria remedy extracts ( $P = .05$ ).

The main hypothesis was therefore restated to differentiate between groups of malaria remedies having different local importance values (Table 4.5, note c, null hypothesis 7). For both screen concentrations and for both *P. falciparum* clones D6 and W2, the group of remedies most widely known among the Kenyah healers surveyed ( $IV_{\text{mal}} = 4$ ) was significantly active (null hypothesis 8), and was significantly more active than remedies with lower importance values (Table 5.5, note c, null hypothesis 7), including the non-malaria remedy extracts ( $IV_{\text{mal}} = 0$ ). At  $20 \mu\text{g ml}^{-1}$ , however, the non-malaria remedy extracts were significantly more active than were the malaria remedies for which there was little consensus between healers ( $IV_{\text{mal}} = 2$ ).

#### 4.4. Conclusions

A simple method for quantifying consensus among the Apo Kayan Kenyah concerning remedies for malaria was combined with simple statistical analyses of variance in the effect of purported antimalarial and non-antimalarial extracts on the human malaria agent *Plasmodium falciparum*. This analysis has enabled an evaluation of the widely held assumption in ethnobotany and ethnopharmacology that remedies for which local consensus is great are likely to be effective and, more specifically, that a large degree of local consensus is a good indicator of biological efficacy in the context of Kenyah treatments for malaria.

Table 4.5. Importance value index ( $IV_{mal}$ ) of Kenyah malaria remedy and non-malaria remedy extracts and their effect on *Plasmodium falciparum* in vitro

Mean $IV_{mal}^a$	Number of Species	Number of Samples	<i>Plasmodium falciparum</i> Mean % viability $\pm$ S.E. <sup>b,c</sup>	
			10 $\mu$ g ml <sup>-1</sup>	20 $\mu$ g ml <sup>-1</sup>
<b>I. Chloroquine-sensitive clone D6</b>				
0	12	93	103.6 $\pm$ 0.9 a	89.2 $\pm$ 2.4 b <sup>***</sup>
1	4	33	106.2 $\pm$ 1.0 a	96.6 $\pm$ 2.2 ab
2	5	33	105.2 $\pm$ 1.8 a	103.4 $\pm$ 3.1 a
4	2	18	82.0 $\pm$ 6.2 b <sup>**</sup>	46.1 $\pm$ 7.9 c <sup>***</sup>
Total	23	177	102.2 $\pm$ 0.9	88.8 $\pm$ 1.7
<b>II. Chloroquine-resistant clone W2</b>				
0	12	93	95.0 $\pm$ 0.9 a <sup>***</sup>	70.6 $\pm$ 2.8 b <sup>***</sup>
1	4	33	98.9 $\pm$ 2.3 a	80.8 $\pm$ 3.1 ab <sup>**</sup>
2	5	33	98.2 $\pm$ 1.6 a	84.7 $\pm$ 3.4 a <sup>***</sup>
4	2	18	81.7 $\pm$ 2.6 b <sup>***</sup>	27.5 $\pm$ 7.1 c <sup>***</sup>
Total	23	177	95 $\pm$ 0.8	70.7 $\pm$ 1.9

<sup>a</sup>Mean of importance values ( $IV_{mal}$ ) for malaria remedies, described in Table 4.1.  $IV_{mal}=0$  for non-malaria remedy plants (Appendix 4.1).

<sup>b</sup>Viability of *P. falciparum* is expressed as percent of [<sup>3</sup>H]hypoxanthine uptake of zero-drug control, and was calculated as the mean of all samples from species with the same remedy importance value for malaria ( $IV_{mal}$ ). S.E. = standard error of the mean. Crude extract samples were screened in *P. falciparum* cultured in DMSO at 10 and 20  $\mu$ g ml<sup>-1</sup>.

<sup>c</sup>Hypothesis tests:

**Null hypothesis 7:** mean percent viability of *P. falciparum* is not significantly different for extracts with different remedy importance values for malaria ( $IV_{mal}$ ).  $H_0$  was rejected in a comparison of means/multiple range (Tukey) test ( $P = .05$ ). Means followed by the same letter were not significantly different from each other.

**Null hypothesis 8:** viability of *P. falciparum* in the presence of extracts with a given  $IV_{mal}$  is not significantly lower than zero-drug controls.  $H_0$  was rejected at the following levels: \* =  $P < .05$ ; \*\* =  $P < .01$ ; \*\*\* =  $P < .001$ .

These results demonstrate that traditionally used malaria remedies with high importance values ( $IV_{mal}$ ) are more likely to be effective antimalarials. Inhibition of *P. falciparum* in an in vitro bioassay, supplemented by an assessment of cytotoxic activity, provides an indication of potential biological efficacy that is highly relevant to treatment of the erythrocytic phase of human malaria infections through selective antiplasmodial action (Phillipson and Wright 1991). The present study may underestimate the effectiveness of the remedies used by the Kenyah to treat malaria, however, since the in vitro test did not detect other types of biological activity that may be helpful in the treatment of malaria and relief of its symptoms. For example, antipyretic activity has been reported for alkaloids found in *Alstonia scholaris* (Mukerji, Gosh, and Siddons 1942), and complex interactions of traditional malaria remedies with oxidant-generating foods may enhance their efficacy (Etkin and Ross 1991).

This study has demonstrated that two malaria remedies that are widely known among the Kenyah have strong in vitro selective antiplasmodial activity. Neither was widely known beyond the Apo Kayan, and neither has been reported previously as a treatment for malaria. It is likely that these remedies play an important role in treatment and control of malaria among the Apo Kayan Kenyah. They are worthy of further investigation, not only as potential drug therapies for malaria, but also as safe and effective traditional remedies for local use. While popular local remedies for malaria were found to more effectively inhibit *P. falciparum* in vitro than did the less widely known remedies, there was also significant activity against chloroquine-resistant *P. falciparum* in three samples selected from biologically active remedies with a wide range of local applications other than as malaria treatments.

The results of this work emphasize the importance of traditional knowledge and biological diversity, not only to the search for new effective treatments for malaria and other ailments, but also to the continuing contribution of traditional remedies to human health.

**CHAPTER 5**  
**ETHNOMEDICINE AND CHEMICAL ECOLOGY:**  
**PATTERNS OF HUMAN PREFERENCE AND BIOLOGICAL ACTIVITY**  
**IN THE APO KAYAN MEDICINAL FLORA**

**5.1. Introduction**

Demonstrating a rational, empirical basis for human selection and use of traditional remedies has been the objective of much ethnobotanical research. While it has been widely recognized that systems of medicine, both traditional and modern, have a cultural and symbolic aspect that is difficult to measure in biological terms, the relationship between medicinal use and biological activity has been confirmed by many laboratory studies. Methods used include identifying active constituents with therapeutic modes of action relevant to the traditional use (eg., Marles 1988; Arnason, Hebda, and Johns 1981; Grosvenor, Supriono, and Gray 1995) and demonstrating correlation between consensus on use and biological activity in plants (Trotter and Logan 1986).

The current understanding of the occurrence and distribution of biological activity in plants is based largely on the study of plant-herbivore interactions (Fraenkel 1959; Rosenthal and Janzen 1979; Harborne 1988). Many of the so-called secondary metabolites, or compounds not evidently required in primary plant metabolism have been shown to play an important role in plant defense against fungi, insects, and other animal herbivores. These metabolites are believed to have evolved in plants as defenses against pests and pathogens (Ehrlich and Raven 1964). Biological activity is distributed neither uniformly nor randomly in plants. Patterns of distribution of biological activity and

biologically active secondary metabolites observed are geographic, taxonomic, morphological, and ecological in nature (Levin and York, 1978; McKey 1979; Rosenthal and Janzen 1979).

The existence of significant relationships between use of, preference for, and therapeutic efficacy of traditional remedies provides indirect evidence of selection for biological activity (Johns 1990). Such a relationship between Kenyah remedies for malaria and antiplasmodial activity was shown by the results of an *in vitro* screen reported in Chapter 4.

Herbal remedies used in ethnomedicine are derived from thousands of species of plants, but these represent a small sample of the global flora. Another focus of ethnobotanical research has examined taxonomic and ecological relationships between the medicinal flora and the surrounding flora from which it has been selected (eg., Moerman 1979, 1991; Phillips and Gentry 1993b). A biological basis for selection has been either proposed or assumed.

In this chapter, the biological basis for human selection of and preference for plant remedies from the flora available to them is considered more directly, first by comparing the distribution of biological activity in the flora used medicinally by the Apo Kayan Kenyah with that in the non-medicinal flora, and second, by evaluating the relationship between biological activity of and human preference for particular attributes of the medicinal flora. In the first case, human selection of medicinal plants for their biological activity would be expected to result in a distribution of biological activity in the medicinal flora that differs from that of the surrounding non-medicinal flora. In the second case, human preference for attributes of medicinal plants, such as plant part, life form, habitat,

and taxon, would be expected to reflect patterns of biological activity in the medicinal flora. The following two null hypotheses are examined:

1. A linear, dependent relationship does not exist between the frequency distribution of biological activity in a sample of the non-medicinal flora and that in the Kenyah medicinal flora.
2. A dependent, linear relationship does not exist between the frequency distribution of biological activity within particular attributes of the Kenyah medicinal flora and quantitative indicators of Kenyah selection of and preference for these attributes.

In section 5.2, the attributes of the plants examined are defined, as are the measurements of human preference used in this study, field tests for biological activity, sample selection from the non-medicinal flora, and statistical tests of the hypotheses examined. In section 5.3.1, profiles of the distribution of preference for and biological activity in the medicinal and non-medicinal flora are described and illustrated. The observed distribution of biological activity in the Apo Kayan flora in relation to plant chemical ecology is discussed in section 5.3.2. Results of a quantitative comparison of biological activity in the non-medicinal and medicinal Apo Kayan flora are presented and discussed in section 5.3.3. Results of a quantitative evaluation of the relationships between indicators of human preference and the distribution of biological activity among attributes of the medicinal flora are presented and discussed in section 5.3.4.

Plant availability and local plant management strategies are also examined in relation to preference indicators and biological activity to obtain a preliminary understanding of the contribution of traditional science to conservation and

management of locally important medicines derived from plants (section 5.3.1).

## 5.2. Materials and Methods

The data presented in this chapter were collected in the Apo Kayan region of East Kalimantan, Indonesian Borneo, between March and June of 1989, and in August of 1990. The circumstances and locations of the ethnobotanical surveys, treatment and identification of the collections, and assignment of medicinal importance values are described in detail in Chapter 3.

### 5.2.1. Attributes of medicinal plants

The Kenyah system of plant classification distinguishes numerous attributes of plants that correspond to plant part, specific and higher order taxa, life form, and habitat (App. 3.2). Life form and taxonomic attributes are articulated in local names of plants; plant part attributes are defined by responses to survey questions about remedy preparation (Chapter 3, section 3.3.1; App. 3.1).

The analysis presented here focuses on locally defined attributes that reflect the Kenyah perception of the plant world, since these are most likely to form the basis for selection of plant remedies. Where more than one Kenyah specific taxon falls within a single scientific species, the Kenyah species are indicated as varieties of the scientific species, but have been treated as independent species in the biological assays. Higher order taxa are externally defined, however, following established scientific nomenclature for families (Cronquist 1981) and superorders (Thorne 1976, 1981). Superorders are used here rather than

orders to facilitate quantitative analysis of a large range of taxa.

Forest habitat attributes follow forest age-class categories defined by Kenyah nomenclature. Many centuries of shifting cultivation of rice and vegetables in the Apo Kayan by the Kenyah and other swidden cultivators have created a patchwork of forest, fallow, and fields of different ages and floristic composition. The Kenyah distinguish stages of forest succession based on time since the last clearing, as well as on species composition, and soil type and fertility (Mackie 1986; Soedjito 1982; and Sangat-Roemantyo 1982). The medicinal flora was sorted among four major habitat age classes: *bekan* (disturbed sites/1-4 year fallow fields); *jekau metan* (young secondary forest/open thicket, 5-24 years fallow); *jekau bete'* (mature secondary forest, 25-50 years fallow); and *empa'* (primary forest, >50 years fallow). Five overlapping age-class categories were created for species found in more than one habitat.

Availability attributes (commonness, rareness) are externally assigned, but are based on observations of Kenyah consultants about whether a locally defined species is easy or difficult to find. Generally speaking, plants that are reliably encountered during daily travels and activities are considered easy to find (common). Plants that require specific search activities or are encountered only by chance are considered difficult to find (rare). Disagreement between consultants was unusual, and is indicated in the data as "uncertain". For the purpose of this study, measurement of plant population parameters for so large a number of species was not feasible. Local perceptions of availability are likely to aggregate a large number of such parameters over both time and space, however, and are therefore useful elements of Kenyah science.

Local management strategies were defined by observation of the locations in which plants were collected. Some species were encountered only in wild populations, some only in homegardens (cultivated), and some in both situations (cultivated and wild). Based on consultants' descriptions of plant treatments, the latter are either transplanted from the wild or grown in homegardens from wild seed.

#### 5.2.2. Indicators of human preference

Measures of consensus, and species and remedy frequencies are types of quantitative data used in ethnobotanical research to indicate human preferences for particular components of the plant world (e.g., Adu-Tutu et al. 1979; Moerman 1979, 1991; Trotter and Logan 1986; Johns, Kokwaro, and Kimanani 1990; Phillips and Gentry 1993a, 1993b; Johns et al. 1994). Both types of data are used in this study to quantify Kenyah preferences for particular attributes of the medicinal flora. A regression residual derived from selection frequency is also examined as an indicator of preference in this study. Its derivation and relevance are described more fully in section 5.2.5 below.

For the purpose of the following discussion, the selection frequency of a plant attribute is defined as the frequency of all remedies (for plant parts) or all medicinally used species having that particular attribute. For example, if leaves are used in more remedies than bark, leaves have the higher selection frequency.

The importance value (IV) index for Kenyah traditional remedies (unique species-use combinations, *sensu* Johns et al. 1994) was calculated from consensus data, and is a relative measure of the consistency of local knowledge of remedies within and between the three Kenyah villages surveyed (see Chapter 3, section 3.2.3). The remedy

importance value ( $IV_{\text{remedy}}$ ) is used to determine the relative importance of plant parts used in Kenyah remedies. For example, the importance value for leaves used in Kenyah remedies is calculated as the mean  $IV_{\text{remedy}}$  for all remedies employing leaves. Species importance value ( $IV_{\text{species}}$ ) is calculated as the sum of  $IV_{\text{remedy}}$  values for each species. Mean  $IV_{\text{species}}$  values are used to quantify the relative medicinal importance of life forms, habitats, taxa, availability categories, and management categories.

### 5.2.3. Biological assays

The distribution of larvicidal, antifungal, and phototoxic activity in the Apo Kayan flora selected by the Kenyah for medicinal use is compared with that in a sample of the surrounding non-medicinal flora, according to a variety of morphological, taxonomic, and other attributes that are relevant to how the Kenyah visualize and classify their environment. The biological assays include a sensitive and widely used animal assay (brine shrimp, *Artemia salina* Leach) and a microbial assay (brewer's yeast, *Saccharomyces cerevisiae*) that are reliable in the field. The phototoxicity assay was included as an example of a test for a more specific type of biological activity.

Biological assays were performed in the field using fresh plant material from 138 of the 203 medicinal species collected during the ethnobotanical survey, and from 40 species not used medicinally (see section 5.2.4 below). Plant material usually was collected at the same time as and from the population of the voucher specimen. The assays were begun within 24 hours of collection of the specimens.

Fresh samples of plant material were tested for phototoxic and antifungal activities against brewer's yeast, and for larvicidal activity against brine shrimp nauplii. The

brewer's yeast assay followed methods developed by Daniels (1965) and adapted to a field study by Reyes (1982). Methods for the brine shrimp assay developed by Meyer et al. (1982) and elaborated by Arnason, Marles, and Aucoin (1991) were substantially altered for the present study to make use of a minimal amount of easily transported equipment. Another adaptation for the field has been published by Trotter et al. (1983).

Laboratory facilities were established in an abandoned house with a firepit but without running water or electricity. Water was hauled from the Kayan River and sterilized, along with laboratory glassware and equipment, in a pressure cooker. Limitations of time, equipment, and other constraints resulted in small and often unduplicated samples. Reproductive tissues were not available for many species. Numerous experiments were destroyed by animals, accounting for many of the blanks in the bioassay results.

The methods used in the field for these assays are described in detail below. These assays are not specific to particular constituents or modes of action, but rather were selected to indicate the presence or absence of a wide range of biologically active constituents. Brine shrimp assays are widely used as convenient, general screens for useful bioactive compounds, and respond to a broad spectrum of antibiotic compounds in higher plants (Meyer et al. 1982; Marles 1988; Alkofahi et al. 1989; Solis et al. 1993). Phototoxicity has been observed in relatively few classes of compounds and taxa, and is associated with more specific modes of action (Towers 1984; Arnason, Marles, and Aucoin 1991; Arnason, Philogen, and Towers 1992; Downum 1992).

### *Brewer's yeast assay*

*Saccharomyces cerevisiae* was cultured on Sabouraud dextrose agar prepared by lightly spreading an aqueous suspension of the culture on plates with a sterile wire loop. Agar medium and plates were sterilized in a pressure cooker over a wood fire. The plates were flamed immediately prior to pouring the agar medium, and stored at room temperature (18-25° C) in sealed ziplock bags overnight prior to inoculation.

To initiate the assay, samples of material from fresh plant specimens (within 24 hours of collection) were placed on the inoculated plates. Each plate was divided into four zones to allow space for samples from three test specimens and the control disks. Approximately 0.5 mm<sup>2</sup> samples of available material (leaf margin, stem, bark, wood, flower parts, fruit, seed, root, and rhizome tissue) were removed from each specimen, macerated lightly, and placed on an inoculated plate. Paper disks, 5 mm in diameter, prepared from Whatman No. 1 filter paper, were soaked with 30 µl of the phototoxic compound  $\alpha$ -terthienyl (1 mg ml<sup>-1</sup> in 95% ethanol) applied with a 10 µl Hamilton syringe. These disks were air dried and added to each plate as a positive control. Negative controls were prepared by soaking identical paper disks with 30 µl of 95% ethanol.

Plates were prepared in duplicate. One set was exposed to long-wave ultraviolet light for 5 hours. Ultraviolet light was initially supplied by two 6-inch, 6-watt black lamps (Phillips F6T5/B1-B), operated on two 6-volt Duracell alkaline batteries, under a black cotton sheet. After one month the connections on the lamp corroded from the high humidity and the experiments were moved into the courtyard, where one set of plates was exposed to sunlight for 5 hours. A sealed ziplock bag containing a layer of water approximately 1 cm deep was placed over the petri plates to

prevent the agar from melting in the sun. The other set was kept in the dark, wrapped in aluminum foil. Both sets were incubated at approximately 30° C through the night (wrapped in an insulated groundsheet with loosely sealed thermoses of hot water) and examined for inhibition of the yeast culture 24 hours after treatment.

Scoring of results follow the method of Wat, Johns, and Towers (1980). Samples that produced zones of inhibition of growth only on the irradiated plates were considered phototoxic (P). Samples that produced zones of inhibition similar in size on both the irradiated and dark plates were considered antifungal (F). Samples that produced a larger zone of inhibition on the irradiated plate than on the dark plate were considered both phototoxic and antifungal (P/F).

#### *Brine shrimp assay*

Ethanollic extracts of plant material were examined for their larvicidal activities against brine shrimp nauplius larvae (*Artemia salina* Leach). For most plant specimens, separate extracts were made of available plant parts. Extracts were prepared on the day of collection by crushing one gram of plant material with a glass rod in one ml of 2% ethanol in 10-ml plastic medicine bottles. These were covered and allowed to sit overnight.

Sea water (brine) was prepared by dissolving crude sea salt (purchased in the Jakarta Bay fish market) in boiled water (38 g sea salt 1<sup>-1</sup> H<sub>2</sub>O). Brine shrimp gastrulae (obtained from a pet shop) were added to the brine in an open beaker covered with loosely woven cotton gauze. The solution was aerated every few hours by gentle agitation in the hand. The beaker was placed in indirect sunlight during the day and incubated at approximately 30° C overnight (wrapped in an insulated groundsheet with loosely sealed thermoses of

hot water) for two days to allow the shrimp nauplii to mature.

To initiate the assay, 30  $\mu$ l aliquots of plant extracts were added to 3 ml aliquots of brine/*Artemia* solution in 25-cell plastic compartment trays, resulting in an initial test concentration of  $1 \times 10^4 \mu\text{g ml}^{-1}$ . (The 30  $\mu$ l aliquots of extract were approximated by one drop from an eye dropper; most extracts contained too much suspended tissue or were too dry to be taken up efficiently with a 10  $\mu$ l Hamilton syringe. The brine/*Artemia* solution was transferred from beaker to tray using a 5 ml syringe). A negative control was prepared for each trial by adding a 30  $\mu$ l aliquot of 2% ethanol to 3 ml of brine/shrimp solution in one compartment of each tray.

After 24 hours, the dead larvae were counted under a 7x magnifying lens. A sheet of graph paper was placed under the tray to facilitate counting large numbers of larvae. The larvae still alive were killed by adding 3 ml of 95% ethanol to the solution. The total number of shrimp was counted, and the percent mortality calculated. The observed mortality for each extract was corrected by subtracting the observed percent mortality of the positive control. Crude extracts resulting in mortality rates greater than 50% were considered larvicidal (L).

#### 5.2.4. Sample selection from non-medicinal flora

The ten most abundant terrestrial plant species in each of four habitat types were collected and samples tested in the two biological assays described above. The habitat types were those defined by Kenyah nomenclature for forest age-classes (section 5.2.1 above). The most abundant plants were identified from the results of a forest composition study conducted simultaneously with the present study in the

Long Sungai Barang vicinity by R. Yusuf, a forest ecologist with the Indonesian Institute of Sciences (LIPI).

The plot/quadrat sampling method used by R. Yusuf (unpublished field data) to determine relative species abundance followed the methods of Oosting (1960). Primary and secondary forest sites were sampled within 0.4 ha plots and a fallow field was sampled within a 0.25 ha plot. Abundance of tree species in primary and secondary forest sites was determined by counting individual saplings (2-10 cm dbh) within 5 m<sup>2</sup> quadrats, and counting individual mature trees (dbh > 10 cm) within 10 m<sup>2</sup> quadrats. Abundance of all species, including herbs, found within 1 m<sup>2</sup> quadrats was determined for the fallow field site.

This method of sampling resulted in small sample sizes for some attributes in the non-medicinal flora. For example, reproductive parts were not available for all species; vines and epiphytes, and rare species were excluded by the sampling criteria for dominance and stem diameter; and some cultivated species were excluded by the omission of homegarden plots from the range of habitats sampled. Sampling a range of taxa of non-medicinal species sufficient for a comparison of biological activity with the medicinal flora was not feasible during this study.

#### 5.2.5. Quantitative analysis

A series of simple, least-squares linear regressions were used to test a set of null hypotheses related to the two major hypotheses proposed above (section 5.1). In the first case, the null hypothesis that a linear, dependent relationship does not exist between the frequency distribution of biological activity in the sample of the non-medicinal flora and that in the Kenyah medicinal flora was tested separately for each type of biological activity

as well as for the sum of their frequencies (sum  $f$ ), for each of three plant attributes: plant part, life form, and habitat. Non-medicinal samples were not adequate for other plant attributes. Acceptance of the null hypothesis at the significance level of 5% or less was taken to indicate selection by the Kenyah for or against biological activity with respect to the attribute examined.

In the second case, the null hypothesis that a dependent, linear relationship does not exist between the frequency distribution of biological activity within particular attributes of the Kenyah medicinal flora and quantitative indicators of Kenyah selection of and preference for these attributes was tested separately for importance value and selection frequency, for each of the three types of biological activity and for sum  $f$ , for each of five plant attributes: species, plant part, life form, habitat, and superorder. Rejection of the null hypothesis was taken to suggest that selection and preference are related to biological activity for the particular attribute examined.

Also included in this second set of hypothesis tests is an examination of a preference indicator derived from species frequencies proposed by Moerman (1979, 1991). Moerman compared species frequencies of taxonomic orders in the North American medicinal flora with those in the general flora and used regression residuals to identify over-represented and under-represented taxa in the medicinal flora. He then proposed that over-represented taxa are more likely to be biologically active than are taxa whose frequencies can be predicted from their frequencies in the general North American flora and taxa that are under-represented with respect to the general flora.

A similar analysis is presented here as a test of Moerman's hypothesis (section 5.3.4). This test involves the

calculation of regression residuals from a comparison of species frequencies in superorders in the Kenyah medicinal flora with estimated species frequencies in superorders in the Borneo flora. The medicinal flora and general flora of North America are well documented and may both be considered a census rather than a sample of the relevant populations (Moerman 1991). The data used here for the Borneo flora are less adequate for the test than are those used by Moerman for North American flora, however. The Kenyah medicinal flora is a subset of a little-known medicinal flora of Borneo, and is compared in this treatment to an enumeration of the Borneo flora from 1921 data (Merrill 1921) that likely underestimates the number of Borneo species by more than 15% (Burley 1990). Floristic survey data for the Apo Kayan do not exist, and a concise, recent enumeration of Borneo flora is not available (see Chapter 2). The results of this particular test are therefore interpreted cautiously.

Small sample sizes, particularly of some plant parts and taxonomic groups, are recognized here as a constraint in interpreting the results of these analyses. Small samples are more likely to influence tests of the relationships between the non-medicinal and medicinal flora than tests of the relationships between preference indicators and the medicinal flora, however. The non-medicinal flora selected for the bioassays is a small sample of a large and biologically diverse local flora, while the medicinal flora tested in the bioassays represents 68% of the species documented, and can be considered a large sample of the Kenyah medicinal flora.

### **5.3. Results and discussion**

The occurrence and distribution of biological activity in plants used by Kenyah healers and herbalists in local

remedies and poisons was compared with that in the non-medicinal flora in the vicinity of Long Sungai Barang, East Kalimantan, Indonesian Borneo. Detailed results of field bioassays are reported in Table 5.1. A few conspecific varieties were recognized by the Kenyah as distinct taxa; these are treated as independent taxa in Table 5.1 and in the analyses of these data described below. Higher order taxonomic affiliations, medicinal importance value (IV<sub>species</sub>), parts used, availability, life form, habitat, availability, and management strategy associated with individual species are summarized in Table 5.2.

#### 5.3.1. Profiles of preference and biological activity

##### *Plant part*

Most traditional remedies employ a particular plant part or parts, rather than the entire plant. Leaves were used in 60% of all medicinal species (Fig. 5.1a; App. 5.1), accounting for 52% of 438 remedies described by Kenyah healers and herbalists (Chapter 3, section 3.3.1). Leaves are the easiest tissue to collect from most plants, and are usually abundant. Only 13 remedies (3%) require use of the whole plant (the aerial portion of small herbaceous plants). More aerial parts are used than underground parts, which require special tools to harvest, or reproductive parts, which are not always available. However, seeds, rhizomes, and fruit were more important as remedies than were other plant parts (Fig. 5.1b; App. 5.1).

In the non-medicinal flora, larvicidal and antifungal activity appear to be more frequent in woody and persistent parts than in reproductive and underground parts, although small sample sizes or missing data may affect these results (Fig. 5.2a,b; App. 5.2). Phototoxic activity was found only in the rhizome of *Hornstedtia scyphifera* (Zingiberaceae)

Table 5.1. Larvicidal (L), antifungal (F), and phototoxic (P) activity in the medicinally used and non-medicinal (control) flora of the Apo Kayan

Scientific name	Voucher <sup>a</sup>	Plant part and biological activity <sup>b</sup>											
		Leaf	Stem	Bark	Wood	Sap	Fruit	Flower	Seed	Root	Rhizome		
		P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L
<b>Part I. Medicinally used species</b>													
<i>Adenostemma laevnia</i> Kuntze o.k.	67	0/0/0*	0/0/+	-/-	-/-	-/-	-/-	-/-	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
<i>Aeschynanthus elongata</i> C.B. Clarke	198	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Aeschynanthus obconica</i> C.B. Clarke	145	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Ageratum conyzoides</i> L.	2	0/0/0*	0/0/0	-/-	-/-	-/-	-/-	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
<i>Aglaia dookoo</i> Griff.	30	0/0/0	-/-	0/0/+*	-/-	-/-	0/0/+*	-/-	-/-	-/-	-/-	-/-	-/-
<i>Aglaia</i> sp.	187	0/0/+	-/-	0/0/+*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Aglaonema</i> sp.	288	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Albizia chinensis</i> (Osbeck) Merr.	108	0/0/0	0/+/-	0/+/+*	-/-	-/-	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
<i>Alocasia longiloba</i> Miq.	103	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Alpinia galanga</i> (L.) Sw.	61	0/0/0	0/0/+*	-/-	-/-	-/-	-/-	-/-	0/+/+*	-/-	-/-	-/-	-/-
<i>Alpinia muflca</i> Roxb.	179	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Astonia scholaris</i> (L.) R. Br.	188	0/0/+	-/-	0/0/+	-/-	-/-	0/0/+*	-/-	-/-	-/-	-/-	-/-	-/-
<i>Anomum ligulatum</i> R.M. Smith	85	-/0/0	-/0/0*	-/-	-/-	-/-	-/-	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Ampelocissus imperialis</i> (Miq.) Bl.	44	0/0/+*	0/0/+	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Ampelocissus pilipes</i> Planch.	41	0/0/+*	0/0/+	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Ananas comosus</i> (L.) Merr.	243	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Anellema herbaceum</i> (Roxb.) Wall.	132	0/0/0*	0/0/0*	-/-	-/-	-/-	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
<i>Anisomeles</i> sp.	229	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Annona muricata</i> L.	65	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Aquilaria beccariana</i> van Tiegh.	112	0/+/0	0/0/0	-/-	0/+/>*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Astronia macrophylla</i> Bl. Bijdr.	146	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Blechnum orientale</i> L.	87	0/0/0*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Blumea balsamifera</i> (L.) DC.	51	0/0/0*	0/0/0	-/-	-/-	-/-	-/-	-/-	0/0/0	-/-	-/-	-/-	0/0/0
<i>Blumea pubigera</i> (L.) Merr. (var. 1)	141	0/0/0*	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Blumea pubigera</i> (L.) Merr. (var. 2)	262	0/0/0*	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Breynia</i> cf. <i>rhaminoides</i> (Retz.) Muell.-Arg.	202	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Buddleja asiatica</i> Lour.	134	0/0/+*	0/0/0	-/-	-/-	-/-	-/-	-/-	0/0/0	-/-	-/-	-/-	0/0/0

Table 5.1. continued

Scientific name	Voucher <sup>a</sup>	Plant part and biological activity <sup>b</sup>											
		Leaf	Stem	Bark	Wood	Sap	Fruit	Flower	Seed	Root	Rhizome		
		P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L
<i>Callicarpa longifolia</i> Lam.	72	-/0/0 *	-/-/	-/-/	-/-/	-/-/	-/0/0	-/0/0	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *
<i>Calophyllum biflorum</i> M.R. Henderson & Wyatt-Smith	144	-/0/0 >	-/-/	-/0/0 *	-/-/	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Calophyllum spectabile</i> Willd.	140	0/0/0	-/-/	0/0/0 *	-/-/	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Capsicum frutescens</i> L.	205	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *
<i>Carica papaya</i> L.	185	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *
<i>Casearia borneensis</i> Merr.	34	0/0/0 *	-/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *
<i>Cassia elata</i> L.	70	0/0/0 *	0/0/0 *	-/0/0	-/0/0	-/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
<i>Chrysanthemum</i> cf., <i>morifolium</i> DC.	254	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *
<i>Cinnamomum</i> sp. 1	211	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *
<i>Cinnamomum</i> sp. 2	290	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *
<i>Cissus simplex</i> Blanco	31	0/0/0 *	0/0/0 *	-/0/0	-/0/0	-/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
<i>Citrus</i> cf., <i>aurantium</i> L.	248	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *
<i>Cleistocalyx operculatus</i> (Roxb.) Merr. & Perry	191	0/0/0 *	-/0/0 *	0/0/0 *	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Clerodendrum</i> sp.	238	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *
<i>Cocos nucifera</i> L.	249	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *
<i>Coix lacryma-jobi</i> L.	89	-/0/0	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *	-/0/0 *
<i>Colocasia esculenta</i> (L.) Schott	94	0/0/0	0/0/0 >	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Costus speciosus</i> (Koenig) Smith	104	0/0/0 >	0/0/0 *	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Cratogeomys sumatranum</i> (Jack) Bl.	14	0/0/0 *	0/0/0 *	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Crinum asiaticum</i> L.	97	0/0/0 >	0/0/0 >	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Croton tiglium</i> L.	18	0/0/0 >	-/0/0	0/0/0 >	-/0/0	-/0/0	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *	0/0/0 *
<i>Cucumis</i> cf., <i>saiva</i> L.	301	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Curculigo</i> sp.	46	0/0/0	0/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Curcuma longa</i> L.	60	0/+/0	0/+/0	-/0/0	-/0/0	-/0/0	0/+/0	0/+/0	0/+/0	0/+/0	0/+/0	0/+/0	0/+/0
<i>Cyathula prostrata</i> (L.) Bl.	66	-/0/0 *	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Cyperus kytingia</i> Endl.	113	0/0/0 *	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Cyrtandra mammillata</i> Hallier f.	137	0/0/0 >	0/0/0 >	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Deemonorops halifernus</i> Becc.	115	0/0/0	0/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0
<i>Deemonorops pericarpenthus</i> Miq.	285	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0	-/0/0

Table 5.1. continued

Scientific name	Voucher <sup>a</sup>	Plant part and biological activity <sup>b</sup>											
		Leaf	Stem	Bark	Wood	Sap	Fruit	Flower	Seed	Root	Rhizome		
		P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L
<i>Dalbergia pinnata</i> (Lour.) Prain	203	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Dalbergia velutina</i> Benth.	142	-/0/>*	-/-	-/0/0	-/-	-/-	-/-	-/-	-/-	-/0/0	-/-	-/0/0	-/-
<i>Dendrocnide simulans</i> (L.f.) Chew	11	0/0/0*	-/-	0/0/0	-/-	-/-	-/-	-/-	-/-	0/0/0*	-/-	0/0/0*	-/-
<i>Derris elliptica</i> (Wallich) Benth.	91	0/0/0	-/-	0/0/+*	-/-	-/-	-/-	-/-	-/-	0/0/+	-/-	0/0/+	-/-
<i>Desmodium</i> cf., <i>triflorum</i> (L.) DC.	222	-/-*	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Dianella nemorosa</i> Lam.	110	0/+>*	0/+/-*	-/-	-/-	-/-	0/++	-/-	-/-	0/++*	-/-	0/++*	-/-
<i>Dicranopteris linearis</i> (Burm.f.) Underw.	12	0/0/+	0/0/>*	-/-	-/-	-/-*	-/-	-/-	-/-	-/-	-/-	0/0/0	-/-
<i>Diospyros borneensis</i> Hiem	121	+/0/>	-/-	-/-	0/+/0	-/-	-/-	0/++*	-/-	0/++*	-/-	-/-	-/-
<i>Diplazium</i> sp.	26	0/0/0*	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/0	-/-
<i>Drimys piperita</i> Hook.f.	90	0/+/+*	-/-	0/++	-/-	-/-	-/-	0/++	-/-	-/-	-/-	0/++	-/-
<i>Drymaria cordata</i> Willd.	86	0/0/-*	0/0/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/-	-/-
<i>Drymaria sparsisora</i> Moore	9	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Dysophylla auricularia</i> Bl.	127	0/0/0*	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/+	-/-	0/0/0*
<i>Elephantopus</i> sp.	45	0/+/>*	0/+/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Elephantopus scaber</i> L.	256	-/-*	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Embellia ribes</i> Burm.f.	82	0/0/+*	-/-	0/+/>*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Emilia sonchifolia</i> (L.) DC.	167	0/0/0*	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/>	-/-	-/-
<i>Erigeron linifolius</i> Willd.	231	-/-*	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Eriodendron anfractuosum</i> DC.	183	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Etilingera eliator</i> (Jack) R.M. Smith	40	0/0/+	0/0/>*	-/-	-/-	-/-	0/0/+*	-/-	-/-	0/0/+*	-/-	0/0/-	0/0/+
<i>Etilingera</i> cf., <i>purpurea</i> Roxb.	48	-/-	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Etilingera</i> sp. 1	1	0/0/0	0/+/0	-/-	-/-	-/-	-/-	-/-	-/-	0/0/0*	-/-	0/+/0	0/0/+
<i>Etilingera</i> sp. 3	35	-/-	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-*
<i>Etilingera</i> sp. 4	63	-/0/>	-/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/0/>*
<i>Eurycoma longifolia</i> Jack	93	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-*	-/-
<i>Fagraea racemosa</i> Jack (ex Wall.)	7	0/0/+*	-/-	0/+/+	-/-	-/-	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-
<i>Ficus</i> cf., <i>uncinulata</i> King Becc.	73	-/-*	-/-	-/-	-/-	-/-	-/-*	-/-	-/-	-/-*	-/-	-/-	-/-
<i>Garcinia</i> sp.	164	-/-	-/-	-/-*	-/-	-/0*	-/-	-/-	-/-	-/-	-/-	-/-	-/-

Table 5.1. continued

Scientific name	Plant part and biological activity <sup>b</sup>													
	Voucher <sup>a</sup>	Leaf	Stem	Bark	Wood	Sap	Fruit	Flower	Seed	Root	Rhizome			
	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L			
<i>Garuga</i> sp.	236	-/-	-/-	-/-*	-/-	-/-*	-/-	-/-	-/-	-/-	-/-			
<i>Globba atrosanguinea</i> T. & B.	257	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-*			
<i>Globba</i> sp.	135	0/0/>>	0/0/>>*	-/-	-/-	-/-	-/-	-/-	-/-	0/0/>>	0/0/>>*			
<i>Glochidion arborescens</i> Bl.	38	0/0/+*	0/0/>>	0/0/>>	-/-	-/-	-/-	-/-	-/-	0/0/>>	-/-			
<i>Glochidion</i> sp.	75	-/-+*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-			
<i>Hedychium cyindricum</i> Ridley	29	0/0/>>	0/0/>>*	-/-	-/-	-/-*	-/-	-/-	-/-	0/0/0	0/+/>>*			
<i>Hedychium</i> sp.	62	-/0/>>	-/0/>>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/0/>>*			
<i>Hedyolis</i> cf., <i>sumatrana</i> Merr.	95	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-			
<i>Heilopsis artocarpoides</i> Elm.	77	-/0/+*	-/-	-/0/+	-/-*	-/-	-/-	-/-	-/-	-/-	-/-			
<i>Homalanthus populineus</i> (Geisel.) Pax	33	0/0/0*	-/-	0/0/0	-/-	-/-	-/-	0/0/0	-/-	-/-	-/-*			
<i>Homalomena humilis</i> (Jack) Hook.f.	150	-/-	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-*			
<i>Homalomena rubra</i> Hassk. (var. 1)	43	0/0/0	0/0/>>	-/-	-/-	-/-	-/-	0/0/0	-/-	-/-	0/0/>>*			
<i>Homalomena rubra</i> Hassk. (var. 2)	251	0/0/+*	0/0/>>	-/-	-/-	-/-	-/-	0/0/0	-/-	-/-	0/0/0*			
<i>Homstedtia havilandii</i> (K. Schum.) K. Schum.	5	0/0/+*	0/0/>>*	-/-	-/-	-/-	-/-	0/0/>>	-/-	0/0/0	0/0/0*			
<i>Homstedtia</i> sp.	123	0/0/>>	0/0/>>	-/-	-/-	-/-	-/-	-/-	-/-	0/0/>>	0/0/>>			
<i>Hoya coronaria</i> Bl.	200	-/->*	-/0	-/-	-/-	-/-	-/-	-/-	-/-	0/0/>>	-/-			
<i>Hydrocotyle javanica</i> Thunb.	105	0/0/>>*	0/0/0*	-/-	-/-	-/-	-/-	0/0/0	-/-	0/0/>>	-/-			
<i>Hyptis capitata</i> Jacq.	208	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-			
<i>Hyptis rhomboidea</i> Mart & Gal.	8	0/0/0*	0/0/0*	-/-	-/-	-/-	-/-	0/0/0	-/-	0/0/0	-/-			
<i>Ilex</i> sp.	83	-/-+	-/-	-/-+*	-/-	-/-	-/-	-/-	-/-	-/-	-/-			
<i>Impatiens balsamina</i> L.	217	-/-	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-*	-/-			
<i>Justicia gendarussa</i> Bum.f.	119	0/0/>>*	-/-	-/-	0/0/>>	-/-	-/-	0/0/0	-/-	0/0/0	-/-			
<i>Kadsura scandens</i> Bl. (var. 1)	55	-/-+*	-/-+	-/-*	-/-	-/-	-/-	-/-	-/-	-/0	-/-			
<i>Kadsura scandens</i> Bl. (var. 2)	71	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/0/>>*			
<i>Kaempferia galanga</i> L.	57	-/0/>>	-/0/>>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-			
<i>Kalanchoe pinnata</i> (Lam.) Pers.	74	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-			
<i>Labisia purmila</i> Benth. & Hook.f.	78	0/0/+*	0/0/0	-/-	-/-	-/-	-/-	0/0/0	-/-	0/0/0	0/0/>>*			
<i>Leea</i> cf., <i>indica</i> (Burm.f.) Merr.	180	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-			

Table 5.1. continued

Scientific name	Voucher <sup>a</sup>	Plant part and biological activity <sup>b</sup>											
		Leaf P/F/L	Stem P/F/L	Bark P/F/L	Wood P/F/L	Sap P/F/L	Fruit P/F/L	Flower P/F/L	Seed P/F/L	Root P/F/L	Rhizome P/F/L		
<i>Leersia hexandra</i> Swartz	122	0/0/>*	0/0/>*	-/-	-/-	-/-	-/-	0/0/0	-/-	0/0/-	-/-	-/-	
<i>Leucosyke alba</i> Zoll. & Mor.	102	0/0/>*	-/-	0/0/-*	-/-	-/-	0/0/0	-/-	-/-	-/-	-/-	-/-	
<i>Litsea aff. robusta</i> Bl.	224	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-*	-/-	-/-	-/-	
<i>Litsea cubeba</i> (Lour.) Pers.	16	0/0/+	-/-	0/0/>*	-/-	-/-	0/0/+*	0/0/0	-/-	-/-	-/-	-/-	
<i>Litsea noronhae</i> Bl.	99	0/0/0	-/-	0/0/0*	-/-	-/-	-/-*	-/-	-/-*	-/-	-/-	-/-	
<i>Lophatherum gracile</i> Brongn.	120	0/0/0	0/0/-	-/-	-/-	-/-	-/-	0/0/-	-/-	0/0/-	-/-	0/0/0*	
<i>Loranthus constrictus</i> Danser	125	0/0/>*	-/-*	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	
<i>Loranthus fuscus</i> Bl.	128	0/0/>*	-/-*	0/0/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	
<i>Ludwigia hyssopifolia</i> (G. Don. f.) Exell	111	0/0/+*	0/+/0*	-/-	-/-	-/-	-/-	0/0/-	-/-	0/0/0	-/-	-/-	
<i>Lycopodium cernuum</i> L.	80	-/-*	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	
<i>Lycopodium</i> sp.	117	0/0/>*	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-	0/0/0	-/-	-/-	
<i>Lygodium microphyllum</i> (Willd.) Alston	21	0/0/>*	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-	0/0/+	-/-	-/-	
<i>Macaranga gigantea</i> Muell.-Arg.	118	0/0/>	0/0/>*	-/-	-/-*	-/-*	-/-*	-/-	-/-	-/-	-/-	-/-	
<i>Macaranga</i> sp.	147	-/->*	-/-*	-/->*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	
<i>Maesa ramentacea</i> (Roxb.) A. DC.	210	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	
<i>Manihot esculenta</i> Crantz	250	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	
<i>Medinilla crassifolia</i> (Bl.) Bl.	19	0/0/+*	0/0/-	-/-	-/-	-/-	0/0/+	-/-	-/-	-/-	-/-	-/-	
<i>Melastoma malabathricum</i> L.	20	0/0/+*	-/-	0/0/>	-/-	-/-	0/0/+	-/-	-/-	-/-	-/-	-/-	
<i>Melodorum aff. kenfii</i> Hook. f. & Thoms.	184	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-*	-/-	-/-	
<i>Merremia borneensis</i> Merr.	68	0/0/0*	0/0/0*	-/-	-/-	-/-*	-/-*	0/0/>	-/-	-/-	-/-	-/-	
<i>Merremia umbellata</i> (L.) Haill. f.	136	0/0/>*	0/0/0	-/-	-/-	-/-	0/0/0	-/-	-/-	-/-	-/-	-/-	
<i>Miscanthus floridulus</i> (Labill.)	215	-/-	-/-*	-/-	-/-	-/-*	-/-*	-/-	-/-	-/-	-/-	-/-	
<i>Musa borneensis</i> Becc.	53	-/-	-/-*	-/-	-/-	-/-*	-/-*	-/-*	-/-*	-/-	-/-	-/-	
<i>Musa</i> spp.	244	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	
<i>Mussaenda laxiflora</i> Merr.	69	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-*	-/-	-/-	
<i>Myrmeconuclea strigosa</i> (Korth.) Merr.	204	-/-	-/-*	-/-	-/-	-/-	-/-	-/-	-/-	-/-*	-/-	-/-	
<i>Nauclaea purpurascens</i> Korth.	100	0/0/+*	0/0/-	0/0/>*	-/-	-/-	-/-	0/0/+	-/-	-/-	-/-	-/-	
<i>Neonuclea calycina</i> (Bartl. ex DC.)	42	0/0/>*	-/-	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	
<i>Nephetium crotetalium</i>	108	0/0/+	-/-+	0/+/+*	-/-	-/-	-/-	-/+	-/-	-/-	-/-	-/-	

Table 5.1. continued

Scientific name	Voucher <sup>a</sup>	Plant part and biological activity <sup>b</sup>											
		Leaf	Stem	Bark	Wood	Sap	Fruit	Flower	Seed	Root	Rhizome		
		P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L	P/F/L
<i>Nephtellium cf. cuspidatum</i> Bl.	88	0/0/0	-/-	0/0/0 *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Nephtolepis biserrata</i> Schott	25	0/+> *	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/0	-/-
<i>Nicotiana tabacum</i> L.	221	-/- *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Oldenlandia diffusa</i> Roxb.	50	-/- *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Oldenlandia verticillata</i> Korth.	96	0/0/> *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/-	-/-
<i>Orthosiphon caudatus</i>	58	-/0/> *	-/0/0	-/-	-/-	-/-	-/-	-/0/0	-/-	-/-	-/0/0	-/0/0	-/-
<i>Oryza sativa</i> L.	300	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Palaquium calophyllum</i> (Tesy.)	143	-/0/>	-/-	-/0/> *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/0/0	-/-
<i>Pandorea pandorana</i> v. Steenis	138	0/0/> *	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/>	-/-
<i>Perkia speciosa</i> Roxb.	133	0/0/+ *	0/0/-	0/0/+ *	+/0/- *	-/-	0/0/> *	-/-	0/0/> *	-/-	-/-	-/-	-/-
<i>Paspalum conjugatum</i> Bergius	101	0/0/0 *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/-	-/-
<i>Passiflora foetida</i> L.	216	-/- *	-/- *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Peristrophe bivalvis</i> (L.) Merr.	223	-/- *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Phyllanthus niruri</i> L.	28	0/0/- *	0/0/- *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/-	-/-	-/-
<i>Pinanga corqnata</i> Bl.	220	-/-	-/-	-/- *	-/-	-/-	-/-	-/-	-/-	-/-	-/- *	-/-	-/-
<i>Piper arborescens</i> Miq.	39	0/0/+ *	0/0/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/0 *	-/-
<i>Piper betle</i> L.	114	0/+/+ *	0/0/0	+/0/0	-/-	-/-	-/-	-/-	-/-	-/-	+/0/-	-/-	-/-
<i>Piper pekatatum</i> L.	52	0/0/0 *	0/0/0 *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/0	0/0/>	-/-
<i>Piper</i> sp.	148	-/- *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/- *
<i>Plectranthus scutellaroides</i> (L.) R. Br.	6	0/0/0 *	0/0/0 *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	+/0/0	0/0/-	-/-
<i>Polyalthia</i> (?) sp.	240	-/- *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Polygonum barbatum</i> L.	116	0/+/+ *	0/+/> *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/+/+	-/-	-/-
<i>Pongamia pinnata</i> (L.) Merr.	124	0/0/>	+/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Pothos ovatifolius</i> Engl.	149	-/- *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Premna glandulosa</i> Merr. (var. 1)	23	0/0/+ *	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Premna glandulosa</i> Merr. (var. 2)	36	0/+/0 *	-/-	0/+/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/+/>	-/-
<i>Psidium guajava</i> L.	32	-/0/0 *	-/-	-/0/0	-/-	-/-	-/0/0	-/-	-/0/0	-/-	-/0/0	-/-	-/-
<i>Rhaphidophora montana</i> Schott	235	-/-	-/- *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Rhizanthus</i> sp.	245	-/-	-/-	-/-	-/-	-/-	-/0/> *	-/-	-/0/> *	-/-	-/0/> *	-/-	-/-

Table 5.1. continued

Scientific name	Voucher <sup>a</sup>	Plant part and biological activity <sup>b</sup>													
		Leaf	Stem	Bark	Wood	Sap	Fruit	Flower	Seed	Root	Rhizome	P/F/L	P/F/L	P/F/L	P/F/L
<i>Rourea mimosoides</i> (Vahl) Planch	13	-/0/+ *	-/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/0/0	-/-
<i>Rubus moluccanus</i> L.	3	-/->	-/-+ *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Saccharum officinarum</i> L.	288	-/-	-/-+ *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Saraca declinata</i> (Jack) Miq.	196	0/0/0 *	-/-	0/0/> *	-/-	-/-	-/-	-/-	0/0/+	-/-	-/-	-/-	-/-	-/-	-/-
<i>Scheffera</i> cf., <i>oblongifolia</i> Merr.	182	-/-+ *	-/-	-/-+	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Schizostachyum latifolium</i> Gamble	206	-/-+ *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Scleria sumatrensis</i> Retz.	129	0/+> *	-/-	-/-	-/-	-/-	-/-	-/-	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-
<i>Scyphostegia borneensis</i> Stapf	98	0/0/0 *	-/-	0/+>	-/-	-/-	-/-	-/-	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-
<i>Sesamum indicum</i> L.	278	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Sida rhombifolia</i> L.	17	+/0/0 *	+/0/-	-/-	-/-	-/-	-/-	-/-	+/0/>	-/-	-/-	-/-	-/-	-/-	-/-
<i>Smilax barbata</i> Wall.	92	0/0/0	0/+> *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Smilax odoratissima</i> Bl.	130	0/0/0 *	0/0/> *	-/-	-/-	-/-	-/-	0/0/-	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-
<i>Solanum</i> cf., <i>melongena</i> L.	207	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Solanum torvum</i> Sw.	214	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Spatholobus ferrugineus</i> Benth.	22	0/0/>	-/-+ *	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Spermacoce laevis</i> Lam.	106	0/0/> *	0/0/- *	-/-	-/-	-/-	-/-	-/-	0/0/-	-/-	-/-	-/-	-/-	0/0/+	-/-
<i>Spermacoce ocymoides</i> Burm.f.	199	-/-+ *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Syzygium</i> cf., <i>confertum</i> (Korth.) Merr. & Perry	10	0/0/+ *	0/0/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Tacca</i> cf., <i>cristata</i> Jack	239	-/-+ *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Tetracera scandens</i> Merr.	131	0/0/>	-/-+ *	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Thelypteris unita</i>	27	0/0/> *	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Timonius</i> sp.	37	0/+> *	-/-	+/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Trichosanthes bracteata</i> Voigt	107	0/0/> *	0/0/+ *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Trigonopleura malayana</i> Hook.f.	139	0/0/0 *	-/-	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Uncaria cordata</i> (Lour.) Merr.	47	-/-	-/-+ *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Urena lobata</i> L.	24	0/0/0	0/0/0	-/-	-/-	-/-	-/-	0/0/-	+/0/0 *	-/-	-/-	-/-	-/-	0/0/0	-/-
<i>Zingiber cassumunar</i> Roxb.	219	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Zingiber longipedunculatum</i> Ridley	49	0/0/0	0/0/0 *	-/-	-/-	-/-	-/-	-/-	0/0/0 *	-/-	-/-	-/-	-/-	0/0/>	0/0/> *
<i>Zingiber officinale</i> Rosc.	64	0/0/0	0/0/> *	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/>	0/0/> *

Table 5.1. continued

Scientific name	Voucher <sup>a</sup>	Plant part and biological activity <sup>b</sup>														
		Leaf	Stem	Bark	Wood	Sap	Fruit	Flower	Seed	Root	Rhizome	P/F/L	P/F/L	P/F/L	P/F/L	
<i>Ziziphus borneensis</i> Merr.	188	-/+/	-/+/	-/+/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
undetermined	253	-/+/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
undetermined	59	-/0/>*	-/0/0	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/0/>*	
Part II. Non-medicinal (control) species																
<i>Aglaia triplex</i> Ridley	157	-/0/>	-/+/	-/0/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Ardisia</i> cf., <i>fuliginosa</i> Bl. Bijdr.	175	0/0/0	-/+/	0/0/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Baccaurea</i> sp.	174	0/0/+	-/+/	0/0/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Castanopsis javanica</i> (Bl.) A. DC.	172	0/0/>	-/+/	0/0/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Cyanotis capitata</i> (Bl.) Hassk.	170	0/0/-	0/+/-	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Cyrtococcum accrescens</i>	168	0/0/-	0/0/-	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Glochidion macrocarpum</i>	189	0/0/+	-/+/	0/0/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Gynnacranthera contracta</i> Warb.	160	0/0/0	-/+/	0/0/>	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Hornstedtia scyphifera</i>	84	0/0/>	0/0/0	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Ilex cymosa</i> Bl.	195	0/0/+	-/+/	0/0/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Imperata cylindrica</i> (L.) Rausch.	165	0/0/>	0/0/-	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Lithocarpus elegans</i> (Bl.) Hatus ex Soepadmo	76	0/0/0	-/+/	-/+/	0/0/0	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Lithocarpus leptogyne</i> (Korth.) Soepadmo	153	0/0/+	-/+/	0/0/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Mallothus caudatus</i> Merr.	162	-/0/+	-/+/	-/0/>	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Millettia splendens</i> Bl. ex Miq.	171	0/0/0	-/+/	0/0/0	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Ochanostachys ameritacea</i> Mast.	155	-/0/+	-/+/	-/0/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Persea rimosa</i>	190	0/0/0	-/+/	0/0/>	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Polyalthia glauca</i> (Hassk.) Boerl.	163	-/0/>	-/+/	-/0/>	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Popowia piscocarpa</i> (Bl.) Endl.	158	-/0/0	-/+/	-/0/>	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Prunus arborea</i> (Bl.) Kalkman	159	0/0/0	-/+/	0/0/>	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Rhodarnia chinerea</i> Jack	177	0/0/+	-/+/	0/0/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Saurauia</i> sp.	192	0/0/+	-/+/	0/0/+	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	
<i>Schinus wallichii</i> (DC.) Korth.	173	0/0/>	-/+/	0/0/>	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	-/+/	

Table 5.1. continued

Scientific name	Voucher <sup>a</sup>	Plant part and biological activity <sup>b</sup>															
		Leaf	Stem	Bark	Wood	Sap	Fruit	Flower	Seed	Root	Rhizome	P/F/L	P/F/L	P/F/L	P/F/L		
<i>Scleria cf., laevis</i> Retz.	166	0/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Scorodocarpus borneensis</i> Becc.	154	-/0/+	-/-	-/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Syzygium valdevenosum</i>	151	-/0/+	-/-	-/-	-/0/+	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Tetrasigma pedunculare</i>	161	-/0/+	-/-	-/-	-/-	-/-	-/0/-	-/0/>	-/-	-/-	-/-	-/-	-/-	-/0/>	-/-	-/-	-/-
<i>Torenia polygonoides</i> Benth.	169	0/0/-	0/0/-	-/-	-/-	-/-	-/-	0/0/-	-/-	-/-	-/-	-/-	-/-	0/0/-	-/-	-/-	-/-
<i>Vatica umbonata</i>	152	-/0/+	-/-	-/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Vernonia arborea</i> Buch.-Ham.	176	0/0/0	-/-	0/0/0	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Vernonia</i> sp.	193	0/0/+	-/-	0/0/+	-/-	-/-	-/-	-/-	-/-	-/-	-/-	0/0/0	-/-	-/-	-/-	-/-	-/-
<i>Xanthomyrtus cf., flavida</i>	178	0/0/>	-/-	0/0/+	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Xanthophyllum ellipticum</i> Korth.	194	0/+/+	-/-	0/0/+	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-
<i>Xanthophyllum flavescens</i>	158	-/0/>	-/-	-/0/>	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-

<sup>a</sup> Voucher numbers, series Leaman-89. - Non-medicinal collections are commonly occurring species in the Apo Kayan.

<sup>b</sup> (P) phototoxic (light-activated inhibition of brewer's yeast, *Saccharomyces cerevisiae*); (F) antifungal (inhibition of brewer's yeast); (L) larvicidal (toxicity to brine shrimp, *Artemia salina* Leach). (+) active (for brine shrimp, +: LD50<104 ppm; >: LD50>104 ppm); (0) not active; (-) not tested. (\*) part is used medicinally by the Kenyah.

Table 5.2. Taxonomic and ecological characteristics of the medicinally used and non-medicinal (control) flora of the Apo Kayan plateau

Scientific name	Family	Superorder <sup>a</sup>	VN <sup>b</sup>	IV <sup>c</sup>	Part used <sup>d</sup>	Avail <sup>e</sup>	Life form	Habitat <sup>f</sup>	Mgmt <sup>g</sup>
<b>Part I. Medicinally used species</b>									
<i>Adenostemma lavenia</i>	Asteraceae	Asteriflorae	67	0	lf	common	herb	ds	wild
<i>Aeschynanthus elongata</i>	Gesneriaceae	Gentianiflorae	198	2	lf	uncertain	vine	msf	wild
<i>Aeschynanthus obconica</i>	Gesneriaceae	Gentianiflorae	145	1	lf	rare	vine	pf	wild
<i>Ageratum conyzoides</i>	Asteraceae	Asteriflorae	2	6	yif,lf	common	herb	ysf	wild
<i>Aglaia dookoo</i>	Meliaceae	Rutiflorae	30	4	bk,sd	common	tree	pf,msf	cult/wild
<i>Aglaia</i> sp.	Meliaceae	Rutiflorae	187	4	bk	rare	tree	pf	wild
<i>Aglaonema</i> sp.	Araceae	Ariflorae	288	1	rz	common	herb	msf	wild
<i>Albizia chinensis</i>	Fabaceae	Rutiflorae	108	4	bk	uncertain	tree	pf,msf	wild
<i>Alocasia longiloba</i>	Araceae	Ariflorae	103	3	lf,st,rt/all	rare	herb	msf	wild
<i>Alpinia galanga</i>	Zingiberaceae	Commeliniflorae	61	10	st,rz	common	herb	gd	cult
<i>Alpinia mutica</i>	Zingiberaceae	Commeliniflorae	179	4	st	common	herb	msf,rt	wild
<i>Alstonia scholaris</i>	Apocynaceae	Gentianiflorae	188	1	sep	rare*	tree	pf,msf	wild
<i>Amomum ligulatum</i>	Zingiberaceae	Commeliniflorae	85	2	st	rare	herb	ysf	wild
<i>Ampelocissus imperialis</i>	Vitaceae	Comiflorae	44	4	yif	common	vine	ysf	wild
<i>Ampelocissus pilipes</i>	Vitaceae	Comiflorae	41	2	yif	rare	vine	msf	wild
<i>Ananas comosus</i>	Bromeliaceae	Commeliniflorae	243	1	fr	common	shrub	gd	cult
<i>Anellema herbageum</i>	Commelinaceae	Commeliniflorae	132	2	yif,st	common	herb	ysf	wild
<i>Anisomeles</i> sp.	Lamiaceae	Lamiiflorae	229	1	all	common	herb	ds	wild
<i>Annona muricata</i>	Annonaceae	Annoniflorae	65	4	lf	rare	tree	gd	cult
<i>Aquilaria beccariana</i>	Thymelaeaceae	Malviflorae	112	7	wd-inf	rare*	tree	pf,msf	wild
<i>Astronia macrophylla</i>	Melastomataceae	Myrtiflorae	146	3	yif,st	uncertain	tree	pf	wild
<i>Blechnum orientale</i>	Polypodiaceae	Pteridophyta	87	2	yif	common	herb	ds	wild
<i>Blumea balsamifera</i>	Asteraceae	Asteriflorae	51	2	lf	common	herb	ds	wild
<i>Blumea pubigera</i> (var. 1)	Asteraceae	Asteriflorae	141	7	lf	rare	vine	ysf	wild
<i>Blumea pubigera</i> (var. 2)	Asteraceae	Asteriflorae	262	6	lf	rare	vine	ysf	wild
<i>Breynia</i> cf., <i>rhamnoides</i>	Euphorbiaceae	Malviflorae	202	1	rt	uncertain	vine	ysf	wild
<i>Buddleja asiatica</i>	Loganiaceae	Gentianiflorae	134	4	yif,st	rare	shrub	ysf,ds	wild
<i>Callicarpa longifolia</i>	Verbenaceae	Lamiiflorae	72	2	rt,yif	common	tree	msf	wild
<i>Calophyllum biflorum</i>	Celastraceae	Theiflorae	144	4	bk	rare	tree	pf,msf	wild

Table 5.2. continued

Scientific name	Family	Superorder <sup>a</sup>	VN <sup>b</sup>	IV <sup>c</sup> <sub>sp</sub>	Part used <sup>d</sup>	Avail <sup>e</sup>	Life form	Habitat <sup>f</sup>	Mgmt <sup>g</sup>
<i>Calophyllum spectabile</i>	Clusiaceae	Theiflorae	140	1	bk	uncertain	tree	pf,msf	wild
<i>Capsicum frutescens</i>	Solanaceae	Solaniflorae	205	5	lf,rt	common	shrub	gd	cult
<i>Cerica papaya</i>	Cariaceae	Cistiflorae	185	2	latex(fr),lf	common	tree	gd	cult
<i>Casearia borneensis</i>	Flacourtiaceae	Cistiflorae	34	7	lf,bk,wd,fr	common	tree	pf,msf	tran
<i>Cassia alata</i>	Fabaceae	Rutiflorae	70	16	lf	common	shrub	ysf	wild
<i>Chrysanthemum cf., morifolium</i>	Asteraceae	Asteriflorae	254	2	lf	common	herb	gd	cult
<i>Cinnamomum sp. 1</i>	Lauraceae	Annoniflorae	211	2	st,rt	rare	tree	msf	wild
<i>Cinnamomum sp. 2</i>	Lauraceae	Annoniflorae	290	3	rt	common	tree	msf	wild
<i>Cissus simplex</i>	Vitaceae	Comiflorae	31	5	yif,sap(st) fr,lf	rare	vine	msf	wild
<i>Citrus cf., aurantium</i>	Rutaceae	Rutiflorae	248	14	fr,lf	common	tree	gd	cult/wild
<i>Cleistocalyx operculatus</i>	Myrtaceae	Myrtiflorae	191	1	lf,bk	common	tree	pf,msf,ysf	wild
<i>Clerodendrum sp.</i>	Verbenaceae	Lamiliflorae	238	1	lf	uncertain	shrub	msf	wild
<i>Cocos nucifera</i>	Arecaceae	Areciflorae	249	1	fr	rare	tree	gd	cult
<i>Coix lacryma-jobi</i>	Poaceae	Commeliniflorae	89	5	st,rt	rare	herb	ds,rr	cult/wild
<i>Colocasia esculenta</i>	Araceae	Ariflorae	94	5	st	common	herb	ds	cult/wild
<i>Costus speciosus</i>	Zingiberaceae	Commeliniflorae	104	3	st,rz	common	herb	ysf	wild
<i>Crafoxyllum sumatranum</i>	Clusiaceae	Theiflorae	14	4	rt,lf	common	tree	msf	wild
<i>Crinum asiaticum</i>	Liliaceae	Liliiflorae	97	1	lf	rare	herb	ysf,rr	wild
<i>Croton tiglium</i>	Euphorbiaceae	Malviflorae	18	6	sd,fr,rt	rare	tree	ysf	tran
<i>Cucumis cf., sativa</i>	Cucurbitaceae	Cistiflorae	301	4	sd	common	vine	gd	cult
<i>Curculigo sp.</i>	Liliaceae	Liliiflorae	46	5	rz	rare	herb	msf,rr	wild
<i>Curcuma longa</i>	Zingiberaceae	Commeliniflorae	60	3	rz	common	herb	gd	cult
<i>Cyathula prostrata</i>	Amaranthaceae	Chenopodiiflorae	66	3	rt,lf	common	herb	ds	wild
<i>Cyperus kyllingia</i>	Cyperaceae	Commeliniflorae	113	4	all	common	herb	ds	wild
<i>Cyrtandra mammillata</i>	Gesneriaceae	Gentianiflorae	137	2	yif	rare	herb	msf,ysf	wild
<i>Daemonorops hallierianus</i>	Arecaceae	Areciflorae	115	1	st	rare	vine	pf,msf	wild
<i>Daemonorops perlacanthus</i>	Arecaceae	Areciflorae	285	3	sd	rare	vine	pf,msf	wild
<i>Daibergia pinnata</i>	Fabaceae	Rutiflorae	203	3	yif	uncertain	vine	ysf	wild
<i>Daibergia velutina</i>	Fabaceae	Rutiflorae	142	1	lf	common	vine	ysf,ds	wild
<i>Dendrocnide stimulans</i>	Urticaceae	Malviflorae	11	4	lf,rt	common	tree	ysf	wild
<i>Derris elliptica</i>	Fabaceae	Rutiflorae	91	8	bk	rare	vine	msf	tran

Table 5.2. continued

Scientific name	Family	Superorder <sup>a</sup>	VN <sup>b</sup>	IV <sub>sp</sub> <sup>c</sup>	Part used <sup>d</sup>	Avail <sup>e</sup>	Life form	Habitat <sup>f</sup>	Mgmt <sup>g</sup>
<i>Desmodium cf., triflorum</i>	Fabaceae	Rutiflorae	222	2	all	common	herb	ds	wild
<i>Dianella nemorosa</i>	Liliaceae	Liliiflorae	110	1	all	rare	herb	ds	wild
<i>Dicranopteris linearis</i>	Gleicheniaceae	Pteridophyta	12	2	sap(st)	common	shrub	ds	wild
<i>Diospyros borneensis</i>	Ebenaceae	Theiflorae	121	4	fr	rare	tree	pf,rr	wild
<i>Diplazium sp.</i>	Thelypteridaceae	Pteridophyta	26	3	lf	common	herb	ds	wild
<i>Drimys piperita</i>	Winteraceae	Annoniflorae	90	4	lf	rare	tree	pf	wild
<i>Drymaria cordata</i>	Caryophyllaceae	Chenopodiiflorae	86	1	all	common	herb	ds	wild
<i>Drymaria sparsisora</i>	Polypodiaceae	Pteridophyta	9	4	rz	common	epiphyte	pf,msf	wild
<i>Dysophylla auricularia</i>	Lamiaceae	Lamiiflorae	127	1	lf	rare	herb	ds	wild
<i>Elephoglossum sp.</i>	Asplenaceae	Pteridophyta	45	2	yif	common	vine	pf,msf	wild
<i>Elephantopus scaber</i>	Asteraceae	Asteriflorae	256	2	all	rare	herb	ds	wild
<i>Embellia ribes</i>	Myrsinaceae	Theiflorae	82	7	bk,lf	common	vine	msf	wild
<i>Emilia sonchifolia</i>	Asteraceae	Asteriflorae	167	1	lf	common	herb	ds	wild
<i>Erigeron linifolius</i>	Asteraceae	Asteriflorae	231	2	lf,st	common	herb	ds	wild
<i>Erodendron anfractuosum</i>	Bombacaceae	Malviflorae	183	5	lf	common	tree	gd	cult
<i>Etilingera eliator</i>	Zingiberaceae	Commeliniflorae	40	8	fr,st	common	herb	ysf	wild
<i>Etilingera puncea</i>	Zingiberaceae	Commeliniflorae	48	2	st	common	herb	ysf	wild
<i>Etilingera sp. 1</i>	Zingiberaceae	Commeliniflorae	1	6	bd(fr),fr	common	herb	ysf	wild
<i>Etilingera sp. 3</i>	Zingiberaceae	Commeliniflorae	35	4	st,rz	rare	herb	msf	wild
<i>Etilingera sp. 4</i>	Zingiberaceae	Commeliniflorae	63	7	rz	common	herb	gd	cult/wild
<i>Eurycoma longifolia</i>	Simarubaceae	Rutiflorae	93	3	rt,lf	common*	tree	pf	wild
<i>Fagraea racemosa</i>	Loganiaceae	Gentianiflorae	7	9	lf	common	tree	msf	wild
<i>Ficus cf., uncinata</i>	Moraceae	Malviflorae	73	3	fr,yif	rare	tree	ysf	wild
<i>Garcinia sp.</i>	Clusiaceae	Theiflorae	164	1	resin(bk)	uncertain	tree	pf	wild
<i>Garuga sp.</i>	Bursaraceae	Rutiflorae	236	1	sap(bk)	uncertain	tree	msf	wild
<i>Globba atrosanguinea</i>	Zingiberaceae	Commeliniflorae	257	1	rz	rare	herb	ds	wild
<i>Globba sp.</i>	Zingiberaceae	Commeliniflorae	135	2	rz,st	rare	herb	ds	wild
<i>Glochidion arborescens</i>	Euphorbiaceae	Malviflorae	38	2	lf	rare	tree	msf	wild
<i>Glochidion sp.</i>	Euphorbiaceae	Malviflorae	75	3	lf	common	tree	ysf	wild
<i>Hedychium cylindricum</i>	Zingiberaceae	Commeliniflorae	29	7	sap,rz	common	epiphyte	pf,msf	wild
<i>Hedychium sp.</i>	Zingiberaceae	Commeliniflorae	62	6	rz	rare	herb	ysf	cult/wild

Table 5.2. continued

Scientific name	Family	Superorder <sup>a</sup>	VN <sup>b</sup>	IV <sup>c</sup>	Part used <sup>d</sup>	Avail <sup>e</sup>	Life form	Habitat <sup>f</sup>	Mgmt <sup>g</sup>
<i>Hedyotis</i> cf., <i>sumatrana</i>	Rubiaceae	Gentianiflorae	95	1	lf	rare	vine	ds	wild
<i>Helicopsis arctropoides</i>	Proteaceae	Proteiflorae	77	4	yif,wd	common	tree	pf,msf	wild
<i>Homalanthus populneus</i>	Euphorbiaceae	Malviflorae	33	4	lf	common	tree	ysf	wild
<i>Homalomena humilis</i>	Araceae	Ariflorae	150	2	rz,st	uncertain	herb	msf	wild
<i>Homalomena rubra</i> (var. 1)	Araceae	Ariflorae	43	8	rz	common	herb	pf,msf	wild
<i>Homalomena rubra</i> (var. 2)	Araceae	Ariflorae	251	6	rz,lf	common	herb	msf	wild
<i>Hornstedtia havilandii</i>	Zingiberaceae	Commeliniflorae	5	8	rz,st	common	herb	ysf	wild
<i>Hornstedtia</i> sp.	Zingiberaceae	Commeliniflorae	123	4	st	common	herb	gd	cult/wild
<i>Hoya coronaria</i>	Asclepiadaceae	Gentianiflorae	200	6	lf	uncertain	vine	msf	wild
<i>Hydrocotyle javanica</i>	Apiaceae	Comiflorae	105	7	lf,all	common	herb	ds	wild
<i>Hyptis capitata</i>	Lamiaceae	Lamiliflorae	208	1	yif	common	herb	ds	wild
<i>Hyptis rhomboidea</i>	Lamiaceae	Lamiliflorae	8	3	all	common	herb	ds	wild
<i>Ilex</i> sp.	Aquifoliaceae	Comiflorae	83	2	bk	common	tree	msf	wild
<i>Impatiens balsamina</i>	Balsaminaceae	Geraniflorae	217	6	rt,st	common	herb	gd	cult
<i>Justicia gendarussa</i>	Acanthaceae	Gentianiflorae	119	1	lf	common	tree	msf,rr	wild
<i>Kadsura scandens</i> (var. 1)	Schisandraceae	Annoniflorae	55	3	lf,bk	common*	vine	pf	wild
<i>Kadsura scandens</i> (var. 2)	Schisandraceae	Annoniflorae	71	4	lf	common*	vine	msf	wild
<i>Kaempferia galanga</i>	Zingiberaceae	Commeliniflorae	57	2	rz	rare	herb	gd	cult
<i>Kalanchoe pinnata</i>	Crassulaceae	Rosiflorae	74	3	lf	rare	herb	gd	cult/wild
<i>Labisia pumila</i>	Myrsinaceae	Theiliflorae	78	2	lf,rz	rare	herb	pf,msf	wild
<i>Leea</i> cf., <i>indica</i>	Leeaceae	Comiflorae	180	1	yif	uncertain	tree	msf	wild
<i>Leersia hexandra</i>	Poaceae	Commeliniflorae	122	4	lf,st	common	herb	ds	wild
<i>Leucosyke alba</i>	Urticaceae	Malviflorae	102	3	bk,lf	uncertain	tree	msf,rr	wild
<i>Litsea aff. robusta</i>	Lauraceae	Annoniflorae	224	2	sd	uncertain	tree	gd	tran
<i>Litsea cubeba</i>	Lauraceae	Annoniflorae	16	14	fr,bk	rare	tree	ysf	tran
<i>Litsea noronhae</i>	Lauraceae	Annoniflorae	99	6	bk,fr,sd	uncertain	tree	msf	wild
<i>Lophatherum gracile</i>	Poaceae	Commeliniflorae	120	2	rz	common	herb	ds	wild
<i>Loranthus constrictus</i>	Loranthaceae	Santaliflorae	125	5	dlf,st	common	parasite	pf,msf	wild
<i>Loranthus fuscus</i>	Loranthaceae	Santaliflorae	126	6	dlf,st,all	common	parasite	pf,msf	wild
<i>Ludwigia hyssopifolia</i>	Onagraceae	Myrtiflorae	111	3	lf,st	common	herb	ysf	wild
<i>Lycopodium cernuum</i>	Lycopodiaceae	Pteridophyta	80	1	branch(lf,st)	common	herb	ds	wild

Table 5.2. continued

Scientific name	Family	Superorder <sup>a</sup>	VN <sup>b</sup>	IV <sub>p</sub> <sup>c</sup>	Part used <sup>d</sup>	Avail <sup>e</sup>	Life form	Habitat <sup>f</sup>	Mgmt <sup>g</sup>
<i>Lycopodium</i> sp.	Lycopodiaceae	Pteridophyta	117	1	lf	common	herb	msf	wild
<i>Lygodium microphyllum</i>	Schizaeaceae	Pteridophyta	21	3	lf	common	vine	ysf,ds	wild
<i>Macaranga gigantea</i>	Euphorbiaceae	Malviflorae	118	1	latex(st,wd)	common	tree	ysf	wild
<i>Macaranga</i> sp.	Euphorbiaceae	Malviflorae	147	2	bk,lf(pt)	rare	tree	pf,msf	tran
<i>Maesa ramentacea</i>	Myrsinaceae	Theiflorae	210	2	lf	uncertain	vine	unknown	wild
<i>Manihot esculenta</i>	Euphorbiaceae	Malviflorae	250	6	lf	common	shrub	gd	cult
<i>Medinilla crassifolia</i>	Melastomataceae	Myrtiflorae	19	3	yif	common	vine	pf,msf	wild
<i>Melastoma malabathricum</i>	Melastomataceae	Myrtiflorae	20	6	lf	common	shrub	ysf,ds	wild
<i>Melodorum aff. kentii</i>	Annonaceae	Annoniflorae	184	1	rt	uncertain	tree	pf	wild
<i>Merremia borneensis</i>	Convolvulaceae	Solaniflorae	88	4	lf,sap(st)	common	vine	ysf	wild
<i>Merremia umbellata</i>	Convolvulaceae	Solaniflorae	136	2	lf	rare	vine	ysf	wild
<i>Miscanthus floridulus</i>	Poaceae	Commeliniflorae	215	6	st	common	shrub	ds	wild
<i>Musa borneensis</i>	Musaceae	Commeliniflorae	53	2	sap(st),bd(fl)	common	gt. herb	ysf	wild
<i>Musa</i> spp.	Musaceae	Commeliniflorae	244	7	lf	common	gt. herb	ysf	cult/wild
<i>Mussaenda laxiflora</i>	Rubiaceae	Gentianiflorae	69	2	lf,rt	common	vine	ysf	wild
<i>Myrsineconaucea strigosa</i>	Rubiaceae	Gentianiflorae	204	1	rt,st	common	shrub	ysf,rr	wild
<i>Naucea purpurascens</i>	Rubiaceae	Gentianiflorae	100	4	lf,bk	uncertain	tree	msf,rr	wild
<i>Neonaucea calycina</i>	Rubiaceae	Gentianiflorae	42	2	lf	uncertain	tree	pf,msf	wild
<i>Nephelium crispetalum</i>	Sapindaceae	Rutiflorae	109	1	bk	rare	tree	msf	wild
<i>Nephelium</i> cf., <i>cuspidatum</i>	Sapindaceae	Rutiflorae	88	2	bk	common	tree	msf	tran
<i>Nephrolepis biserrata</i>	Polypodiaceae	Pteridophyta	25	5	yif	common	herb	ds	wild
<i>Nicotiana tabacum</i>	Solanaceae	Solaniflorae	221	9	lf	common	shrub	gd	cult
<i>Oldenlandia diffusa</i>	Rubiaceae	Gentianiflorae	50	3	sh(yf)	common	herb	ds,rr	wild
<i>Oldenlandia verticillata</i>	Rubiaceae	Gentianiflorae	86	2	lf	rare	herb	ds	wild
<i>Orthosiphon caudatus</i>	Lamiaceae	Lamiiflorae	58	1	dif	common	shrub	gd	cult
<i>Oryza sativa</i>	Poaceae	Commeliniflorae	300	10	sd	common	herb	gd	cult
<i>Palaquium calophyllum</i>	Sapotaceae	Theiflorae	143	2	bk	rare	tree	pf	wild
<i>Pandorea pandorana</i>	Bignoniaceae	Gentianiflorae	138	1	lf	rare	vine	pf,msf	wild
<i>Partia spectosa</i>	Fabaceae	Rutiflorae	133	4	lf,bk,wd,fr	common	tree	pf,gd	tran
<i>Paspalum conjugatum</i>	Poaceae	Commeliniflorae	101	3	lf	common	herb	ds	wild
<i>Passiflora foetida</i>	Passifloraceae	Cistiflorae	216	1	st	common	vine	ds	wild

Table 5.2. continued

Scientific name	Family	Superorder <sup>a</sup>	VN <sup>b</sup>	IV <sup>c</sup>	Part used <sup>d</sup>	Avail <sup>e</sup>	Life form	Habitat <sup>f</sup>	Mgmt <sup>g</sup>
<i>Peristrophe bivalvis</i>	Acanthaceae	Gentianiflorae	223	1	lf	common	herb	msf	wild
<i>Phyllanthus niruri</i>	Euphorbiaceae	Malviflorae	28	5	all,lf,st	rare	herb	ds	wild
<i>Pinanga coronata</i>	Arecaceae	Areciflorae	220	9	sd,bk	rare	tree	gd	cult/wild
<i>Piper arborecens</i>	Piperaceae	Annoniflorae	39	7	rt,lf	common	vine	pf,msf	wild
<i>Piper betle</i>	Piperaceae	Annoniflorae	114	15	lf	common	vine	gd	cult
<i>Piper peltatum</i>	Piperaceae	Annoniflorae	52	7	lf,st	common	herb	ds	wild
<i>Piper sp.</i>	Piperaceae	Annoniflorae	148	5	rz,lf	uncertain	vine	pf,msf	wild
<i>Plectranthus scutellaroides</i>	Lamiaceae	Lamiiflorae	6	5	lf,st	common	herb	ysf,ds	wild
<i>Polyalthia sp.</i>	Annonaceae	Annoniflorae	240	1	lf	uncertain	vine	msf,rr	wild
<i>Polygonum barbatum</i>	Polygonaceae	Theiflorae	116	5	all	rare	herb	ds,rr	wild
<i>Pongamia pinnata</i>	Fabaceae	Rutiflorae	124	4	rt	rare	shrub	msf	tran
<i>Pothos ovatifolius</i>	Araceae	Ariflorae	149	1	lf	uncertain	vine	pf,msf	wild
<i>Premna glandulosa (var. 1)</i>	Verbenaceae	Lamiiflorae	23	4	lf	rare	vine	ysf	wild
<i>Premna glandulosa (var. 2)</i>	Verbenaceae	Lamiiflorae	36	4	lf	rare	vine	ysf	wild
<i>Psidium guajava</i>	Myrtaceae	Myrtiflorae	32	3	lf	common	tree	ysf	cult
<i>Rhaphidophora montana</i>	Araceae	Ariflorae	235	1	st	uncertain	vine	msf,rr	wild
<i>Rhizanthes sp.</i>	Rafflesiaceae	Rafflesiflorae	245	4	bd(fl)	rare	parasite	msf	wild
<i>Rourea mimosoides</i>	Connaraceae	Rutiflorae	13	2	lf	common	shrub	pf,msf	wild
<i>Rubus moluccanus</i>	Rosaceae	Rosiflorae	3	2	st	common	vine	ysf,ds	wild
<i>Saccharum officinarum</i>	Poaceae	Commeliniflorae	298	1	st	common	herb	gd	cult
<i>Saraca declinata</i>	Fabaceae	Rutiflorae	196	2	bk,yif	common	tree	msf,rr	wild
<i>Schefflera cf., oblongifolia</i>	Araliaceae	Corniflorae	182	5	yif,lf	uncertain	tree	pf,msf	wild
<i>Schizostachyum latifolium</i>	Poaceae	Commeliniflorae	206	2	lf	common	shrub	f,msf,ysf,d	wild
<i>Scleria sumatrensis</i>	Cyperaceae	Commeliniflorae	129	2	yif,rt	common	herb	ds	wild
<i>Scyphostegia borneensis</i>	Scyphostegiaceae	Cistiflorae	98	4	lf	common	tree	msf	wild
<i>Sesamum indicum</i>	Pedaliaceae	Gentianiflorae	278	4	sd	common	herb	gd	cult/wild
<i>Sida rhombifolia</i>	Malvaceae	Malviflorae	17	3	yif	common	shrub	gd	cult/wild
<i>Smilax barbata</i>	Smilacaceae	Liliiflorae	92	4	rz	rare	vine	pf	wild
<i>Smilax odoratissima</i>	Smilacaceae	Liliiflorae	130	2	lf,all	common	vine	ysf	wild
<i>Solanum cf., melongena</i>	Solanaceae	Solaniflorae	207	2	yfr	common	vine	gd	cult
<i>Solanum torvum</i>	Solanaceae	Solaniflorae	214	2	rt	common	shrub	ds	wild

Table 5.2. continued

Scientific name	Family	Superorder <sup>a</sup>	VN <sup>b</sup>	IV <sup>c</sup> <sub>sp</sub>	Part used <sup>d</sup>	Avail <sup>e</sup>	Life form	Habitat <sup>f</sup>	Mgmt <sup>g</sup>
<i>Spatholobus ferrugineus</i>	Fabaceae	Rutiflorae	22	4	sap(st)	common	vine	ysf,ds	wild
<i>Spermacoce laevis</i>	Rubiaceae	Gentianiflorae	106	1	lf,st	common	herb	ds	wild
<i>Spermacoce ocymoides</i>	Rubiaceae	Gentianiflorae	199	1	lf	common	herb	ds	wild
<i>Syzygium cf., confertum</i>	Myrtaceae	Myrtiflorae	10	3	yf	common	tree	msf,rr	wild
<i>Tacca cf., cristata</i>	Taccaceae	Liliiflorae	239	1	lf	uncertain	herb	msf,rr	wild
<i>Tetracera scandens</i>	Dilleniaceae	Theiflorae	131	2	sap(st)	common	vine	ysf	wild
<i>Thelypteris unita</i>	Thelypteridaceae	Pteridophyta	27	6	yf	common	herb	ds	wild
<i>Timonius</i> sp.	Rubiaceae	Gentianiflorae	37	3	mlf	common	tree	msf	wild
<i>Trichosanthes bracteata</i>	Cucurbitaceae	Cistiflorae	107	5	lf,st	common	vine	ysf	wild
<i>Trigonopteleura malayana</i>	Euphorbiaceae	Malviflorae	139	6	lf	rare	tree	pf,msf	wild
<i>Uncaria cordata</i>	Rubiaceae	Gentianiflorae	47	2	sap(st)	common	vine	msf	wild
<i>Urena lobata</i>	Malvaceae	Malviflorae	24	2	fl	common	shrub	ds	cult/wild
<i>Zingiber cassumunar</i>	Zingiberaceae	Commeliniflorae	219	4	rz	rare	herb	gd	cult
<i>Zingiber longipedunculatum</i>	Zingiberaceae	Commeliniflorae	49	6	st,fl	rare	herb	ysf	wild
<i>Zingiber officinale</i>	Zingiberaceae	Commeliniflorae	64	10	rz,st	common	herb	ds	cult/wild
<i>Ziziphus borneensis</i>	Rhamnaceae	Malviflorae	186	1	bk	rare	vine	msf	wild
undetermined	Poaceae	Commeliniflorae	253	1	lf	common	herb	ds	wild
undetermined	Zingiberaceae	Commeliniflorae	59	2	sh(yf),rz,rt	common	herb	ysf	tran
Part II. Non-medicinal species									
<i>Aglaia triplex</i>	Meliaceae	Rutiflorae	157			common	tree	pf	wild
<i>Ardisia cf., fuliginosa</i>	Myrsinaceae	Theiflorae	175			common	tree	pf,msf	wild
<i>Beccaurea</i> sp.	Euphorbiaceae	Malviflorae	174			common	tree	msf	wild
<i>Castanopsis javanica</i>	Fagaceae	Hamamelidiflorae	172			common	tree	msf	wild
<i>Cyanotis capitata</i>	Commelinaceae	Commeliniflorae	170			common	herb	ds	wild
<i>Cyrtococcum accrescens</i>	Poaceae	Commeliniflorae	168			common	herb	ds	wild
<i>Dicranopteris linearis</i>	Gleicheniaceae	Pteridophyta	81			common	shrub	ds	wild
<i>Glochidion macrocarpum</i>	Euphorbiaceae	Malviflorae	189			common	tree	ysf	wild
<i>Gymnacranthera contracta</i>	Myrsinaceae	Annoniflorae	160			common	tree	pf	wild
<i>Homstedtia scyphifera</i>	Zingiberaceae	Commeliniflorae	84			rare	herb	ysf,rr	wild

Table 5.2. continued

Scientific name	Family	Superorder <sup>a</sup>	VN <sup>b</sup>	IV <sup>c</sup> <sub>sp</sub>	Part used <sup>d</sup>	Avail <sup>e</sup>	Life form	Habitat <sup>f</sup>	Mgmt <sup>g</sup>
<i>Ilex cymosa</i>	Aquifoliaceae	Corniflorae	195			common	tree	ysf	wild
<i>Imperata cylindrica</i>	Poaceae	Commeliniflorae	165			common	herb	ds	wild
<i>Lithocarpus elegans</i>	Fagaceae	Hamamelidiflorae	76			rare	tree	msf	wild
<i>Lithocarpus leptogyme</i>	Fagaceae	Hamamelidiflorae	153			common	tree	pf	wild
<i>Mallotus caudatus</i>	Euphorbiaceae	Malviflorae	162			common	tree	pf	wild
<i>Milletia splendidissima</i>	Fabaceae	Rutiflorae	171			common	tree	ysf	wild
<i>Ochanostachys amentacea</i>	Otlacaceae	Solaniflorae	155			common	tree	pf	wild
<i>Persea rimosa</i>	Lauraceae	Annoniflorae	190			common	tree	ysf,msf,pf	wild
<i>Polyalthia glauca</i>	Annonaceae	Annoniflorae	163			common	tree	pf	wild
<i>Popowia piscocarpa</i>	Annonaceae	Annoniflorae	158			common	tree	pf	wild
<i>Prunus arborea</i>	Rosaceae	Rosiflorae	159			common	tree	pf,msf,ysf	wild
<i>Rhodarmia cinerea</i>	Myrtaceae	Myrtiflorae	177			common	tree	msf	wild
<i>Saurauia</i> sp.	Actinidiaceae	Theiflorae	192			common	tree	ysf	wild
<i>Schima wallichii</i>	Theaceae	Theiflorae	173			common	tree	msf	wild
<i>Scleria</i> cf., <i>laevis</i>	Cyperaceae	Commeliniflorae	166			common	herb	ds	wild
<i>Scorodocarpus borneensis</i>	Otlacaceae	Solaniflorae	154			common	tree	pf	wild
<i>Syzygium valdevenosum</i>	Myrtaceae	Myrtiflorae	151			common	tree	pf,msf,ysf	wild
<i>Tetrastigma pedunculare</i>	Vitaceae	Corniflorae	161			rare	vine	msf	wild
<i>Torenia polygonoides</i>	Scrophulariaceae	Gentianiflorae	169			common	herb	ds	wild
<i>Vatica umbonata</i>	Dipterocarpaceae	Theiflorae	152			common	tree	pf	wild
<i>Vernonia arborea</i>	Asteraceae	Asteriflorae	176			common	tree	msf	wild
<i>Vernonia</i> sp.	Asteraceae	Asteriflorae	193			common	tree	ysf	wild
<i>Xanthomyrtus</i> cf., <i>flavida</i>	Myrtaceae	Myrtiflorae	178			common	tree	msf	wild
<i>Xanthophyllum ellipticum</i>	Polygalaceae	Geraniiflorae	194			common	tree	ysf	wild
<i>Xanthophyllum flavescens</i>	Polygalaceae	Geraniiflorae	156			common	tree	pf	wild

<sup>a</sup> Superorders follow Thorne (1981, 1983). Families follow Mabberley (1987).

<sup>b</sup> Voucher numbers, series Leaman-89-. Non-medicinal collections are commonly occurring species in the Apo Kayan.

(continued on next page)

Table 5.2. continued

- <sup>c</sup> Species medicinal importance value ( $IV_{species}$ ): sum of remedy importance values (see Chapter 3). Non-medicinal controls have no importance value.
- <sup>d</sup> leaf (l), young leaf (ylf), mature leaf (mlf), dry leaf (dlf), shoot (sh), stem (st), branch (br), bark (bk), wood (wd), sap (sp), fruit (fr), flower (fl), bud (bd), seed (sd), root (rt), rhizome (rz), all aerial parts (all); pathogen-infected wood (wd-inf).
- <sup>e</sup> Availability status determined by consensus reports of survey participants. (\*) listed as rare for Indonesia by Rifai et al. (1992) and Zuhud and Haryanto (1991).
- <sup>f</sup> Habitat: ds (disturbed site/fallow 0-4 yrs); ysf (young secondary forest, 5-25 yrs); msf (mature secondary forest, 25-50 yrs); pf (primary forest, 50+ yrs); rr (riversides); gd (homegarden).
- <sup>g</sup> Management type: wild (harvested from wild populations); cult (cultivated in homegardens or fields); tran (transplanted from wild populations to gardens or fields); cult/wild (found both wild and cultivated).

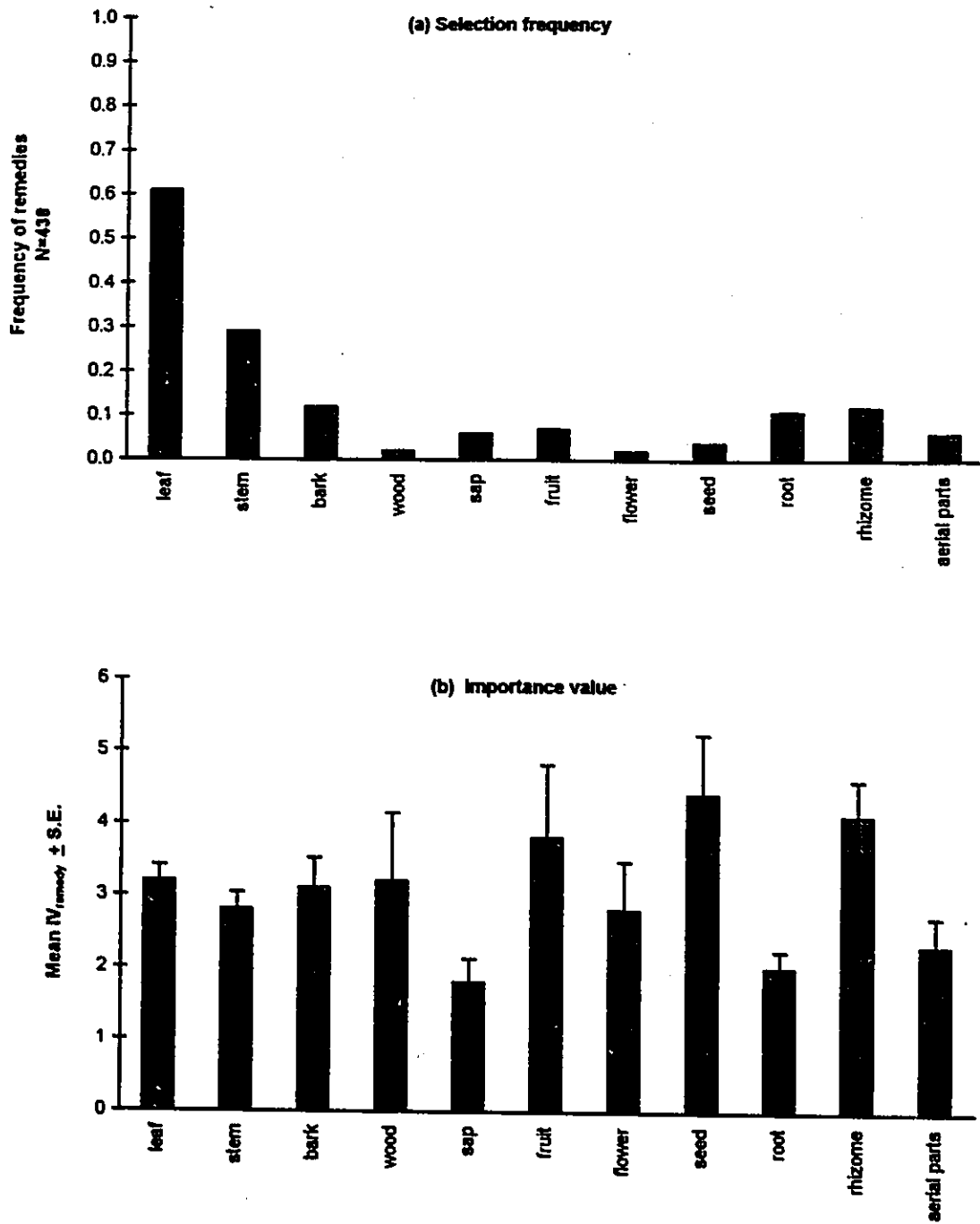


Figure 5.1. Preference indicators for plant parts used in Kenyah remedies: (a) selection frequency = frequency of plant part in reported remedies; and (b) its mean remedy importance value ( $IV_{remedy} \pm$  standard error of the mean).

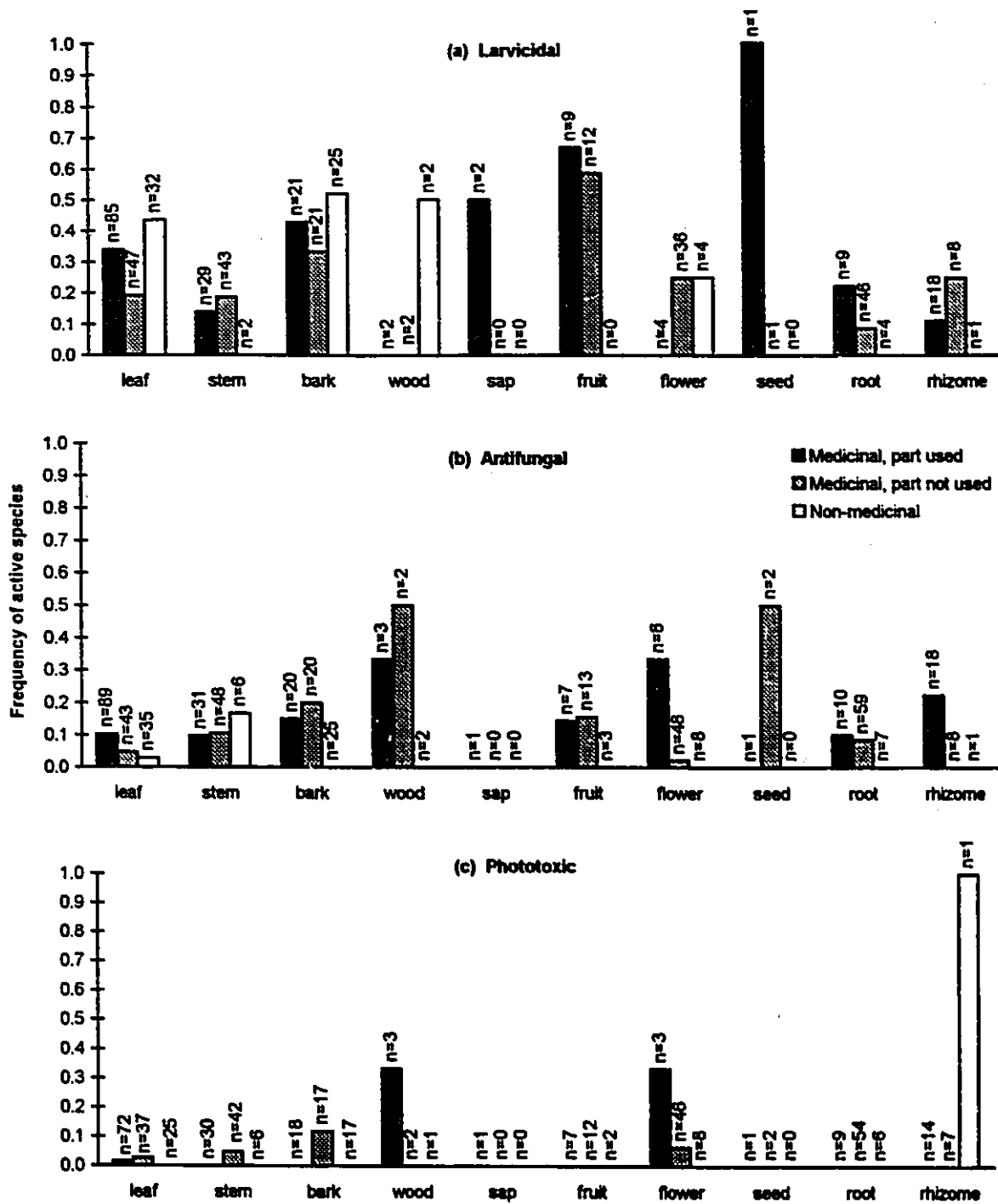


Figure 5.2. Frequency distribution by plant part of biological activity in the medicinally used and non-medicinal flora of the Apo Kayan. (a) Larvicidal=toxicity to brine shrimp ( $LD_{50} < 10^4$  ppm); (b) Antifungal=inhibition of brewer's yeast; (c) Phototoxic=light-activated inhibition of brewer's yeast. n=number of species tested in field bioassays.

(Fig. 5.2c). In the medicinal flora, biological activity appears to be more frequent in reproductive and woody parts than in leaves and underground parts. Phototoxic activity was observed in the medicinally used parts of only three species: leaves of *Sida rhombifolia* and flowers of *Urena lobata*, both in the family Malvaceae, and in the wood of *Parkia speciosa* (Fabaceae), but also occurred in unused parts of eight medicinal species.

There appears to be a trend within the medicinal flora toward selection of the active parts for use in Kenyah remedies (eg., selection for larvicidal activity in leaves, bark, fruit, possibly seeds, and roots, Fig. 5.2a) but there are also numerous exceptions (eg., phototoxic activity in leaves, stems, and bark, Fig. 5.2c) that suggest selection against biologically active parts. Comparing the medicinal and non-medicinal flora, antifungal activity may be more strongly selected than larvicidal and phototoxic activity, particularly in rhizomes, fruit, leaves, and flowers (Fig. 5.2b), which are among the most important plant parts (Fig. 5.1b).

The high frequency of biological activity observed in plant reproductive tissues (Fig. 5.2), and their importance in Kenyah remedies (Fig. 5.1b), is supported by the isolation of a variety of toxic compounds in flower nectars, fruits, and seeds (Harborne 1988). Although the sample sizes for seeds tested here are too small to support a test of the relationship between IV<sub>remedy</sub> and biological activity, there is evidence that seeds are particularly well defended from herbivory by toxins (Janzen 1976; McKey 1979; Rosenthal and Janzen 1979; Seigler 1979).

### *Life form*

The Kenyah use more herbs in traditional remedies than any other plant life form (Fig. 5.3a; App. 5.3). Herbs are not abundant in tropical forest formations (Richards 1953; Whitmore 1984), but are common and accessible in the forest gaps where people live, farm, and travel.

Epiphytes and parasitic plants are exceptionally important in Kenyah remedies given their low frequency in the medicinal flora (Fig. 5.3b). Two endemic hemi-parasitic epiphytes, *Loranthus constrictus* and *L. fuscus* (Loranthaceae) have ritual uses that suggest a stronger cultural than phytochemical basis for their selection (Chapter 3, section 3.3.1). Neither was active in any of the three assays (Table 5.1). Biologically active flavonoids, tannins, and triterpenoids have been isolated in the family Loranthaceae (Atta-ur-Rahman, Khan, and Khan 1973).

Moerman (1991) found that the medicinal flora used by native North Americans emphasized trees and shrubs, and under-represented grasses and grass-like plants. He proposed that more complex plants, with more parts to defend, would have a richer array of defensive chemicals with potential medicinal applications. The bioassay data presented in Figure 5.4. (App. 5.4) indicate that larvicidal and phototoxic activity are more frequent in more complex (woody) plants in both the non-medicinal and medicinal flora. It is unlikely that this trend is entirely due to the availability of more types of plant tissues. In the Kenyah medicinal flora, the frequency of larvicidal and phototoxic activity was greater in the leaves of woody plants than in herbs, and greatest in the leaves of shrubs (Tables 5.1, 5.2). The latter trend is supported by Levin and York's (1978) observation that alkaloids are present in higher concentrations and are more

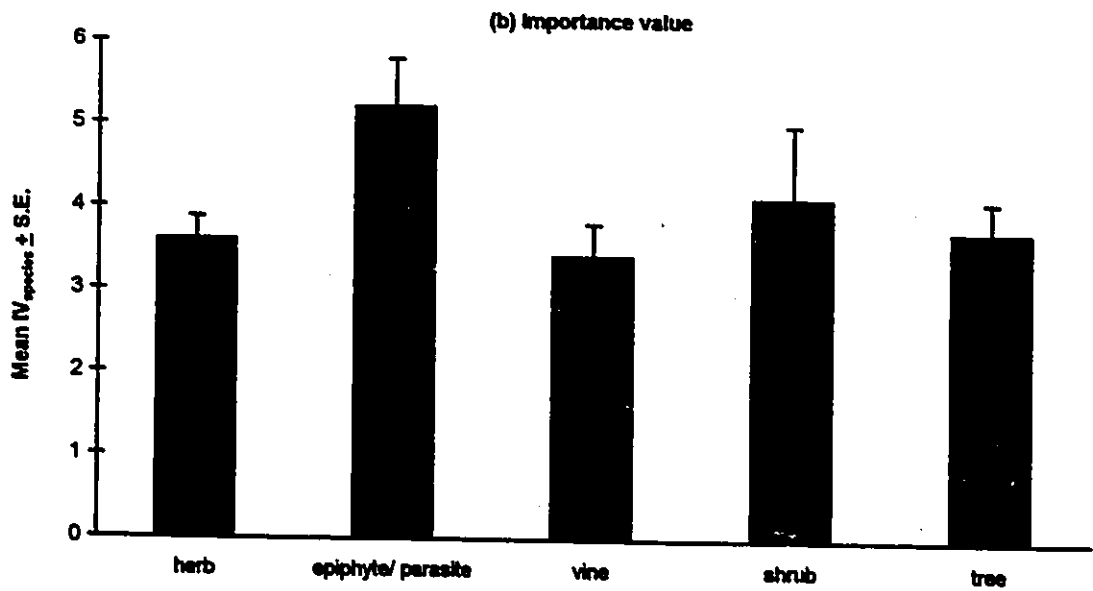
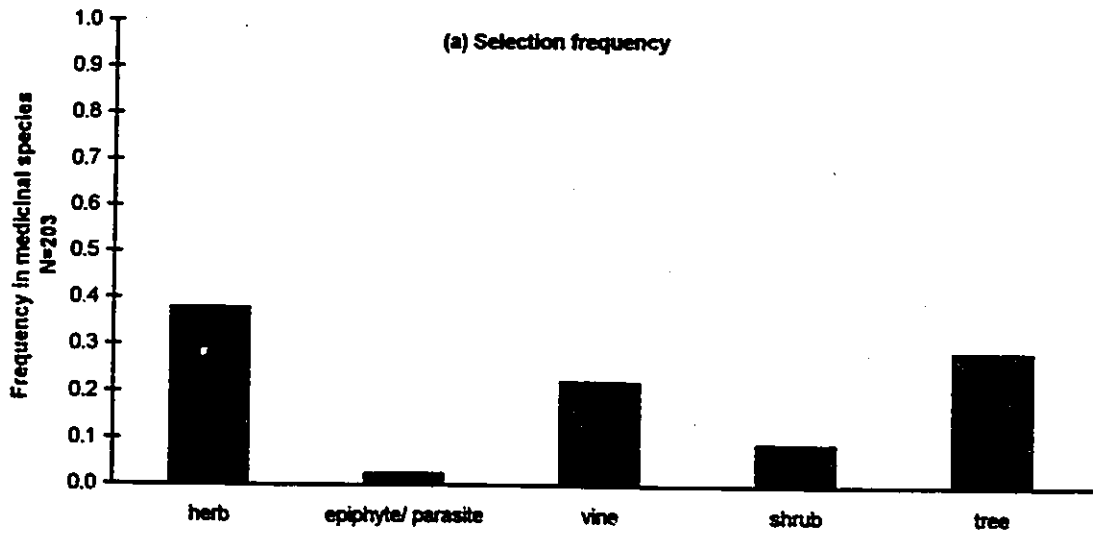


Figure 6.3. Preference indicators for life forms in the Kenyah medicinally used flora: (a) Selection frequency = frequency of life form in medicinally used species, and (b) its medicinal importance value = mean  $IV_{species} \pm$  standard error of the mean.

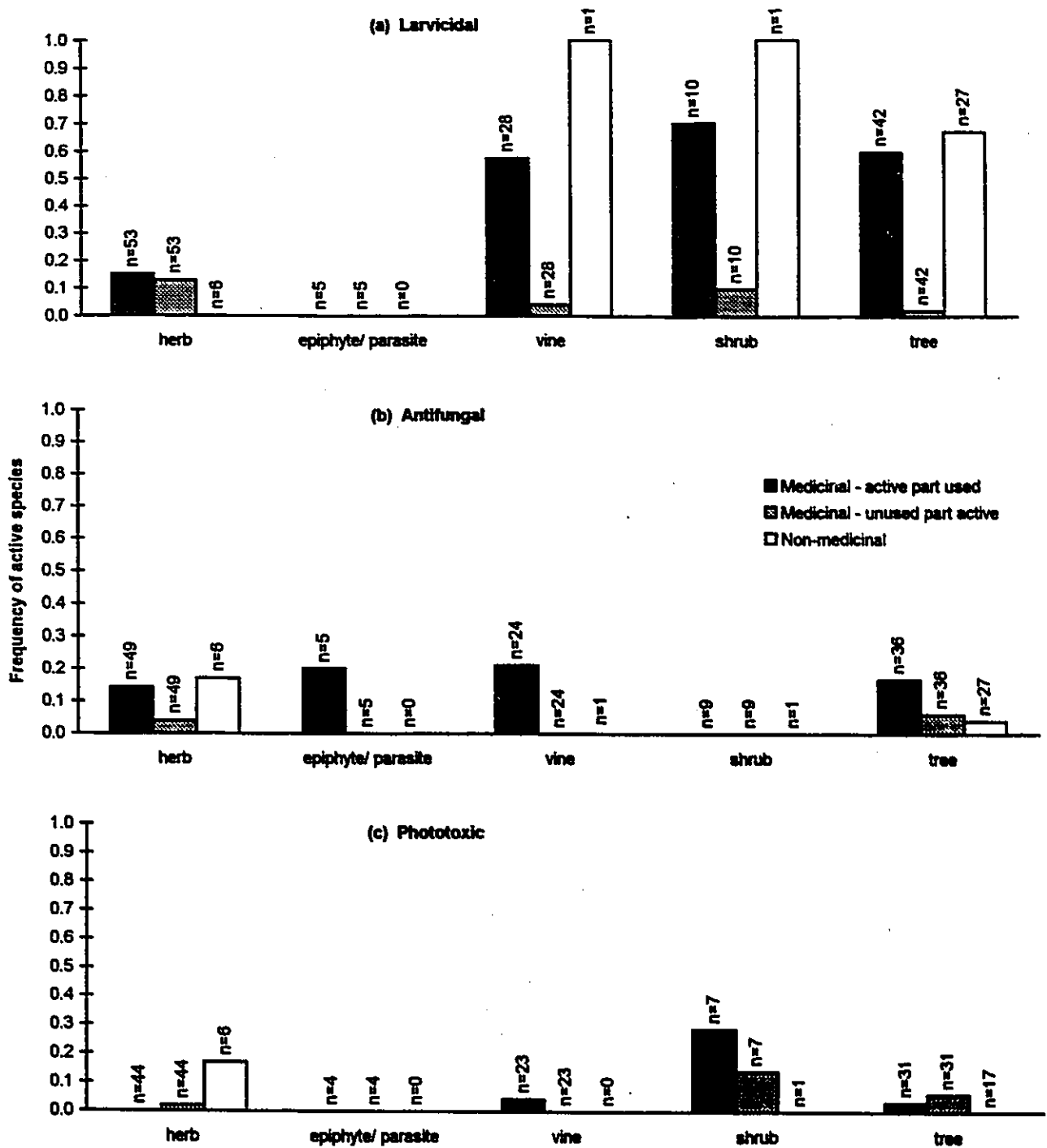


Figure 8.4. Frequency distribution by life form of biological activity in the medicinally used and non-medical flora of the Apo Kayan. (a) Larvicidal=toxicity to brine shrimp ( $LD_{50} < 10^4$  ppm); (b) Antifungal=inhibition of brewer's yeast; (c) Phototoxic=light-activated inhibition of brewer's yeast. n=number of species tested in field bioassays.

toxic in woody than in herbaceous species in the tropical flora, and by Coley's (1983) observation that growth-dominated plants in tropical forests have the most highly defended tissues.

Selection for biological activity is more apparent within the medicinal flora at the level of plant part than between the medicinal and non-medicinal flora at the level of life form. For example, larvicidal activity is more frequent in non-medicinal than in medicinally used trees, but the Kenyah select the majority of larvicidal parts in medicinally used trees for use in remedies (Fig. 5.4a).

### *Habitat*

The largest numbers of medicinally used species are found in secondary forest and disturbed sites (Fig. 5.5a; App. 5.5). Secondary forest is the most extensive feature of settlements of swidden cultivators, and is the habitat in which much of their daily work is done. Relatively few medicinal species are selected from primary or old-growth forests. Primary forest near Kenyah settlements is often left on mountain tops or in areas that are not attractive for cultivation or settlements.

Species selected from secondary forest and primary forest were most important in Kenyah remedies, while ubiquitous species and species selected from disturbed sites were least important (Fig. 5.5b). Secondary forest has a high frequency of biological activity (Fig. 5.6; App. 5.6), as predicted by Coley (1983) for late-succession, tropical forest. Frequencies of larvicidal and antifungal activity in the medicinal flora exceeded those in the non-medicinal flora in late-succession habitats, suggesting selection for the more active plants from the most biologically active age classes.

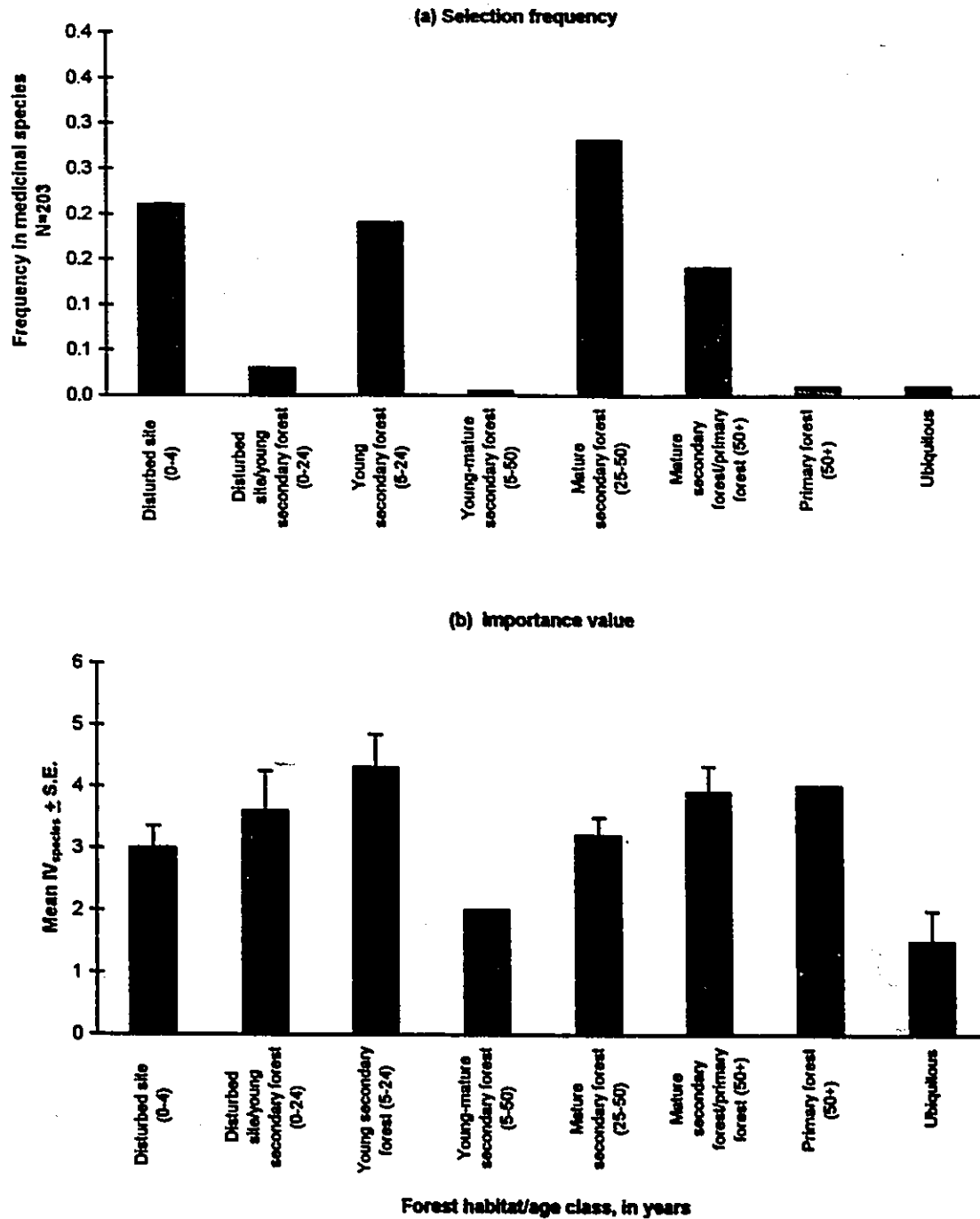


Figure 5.5. Preference indicators for forest habitats/age classes in the Kenyah medicinal flora: (a) selection frequency = frequency of habitat in medicinal flora; and (b) its medicinal importance value = mean  $IV_{\text{species}} \pm$  standard error of the mean.

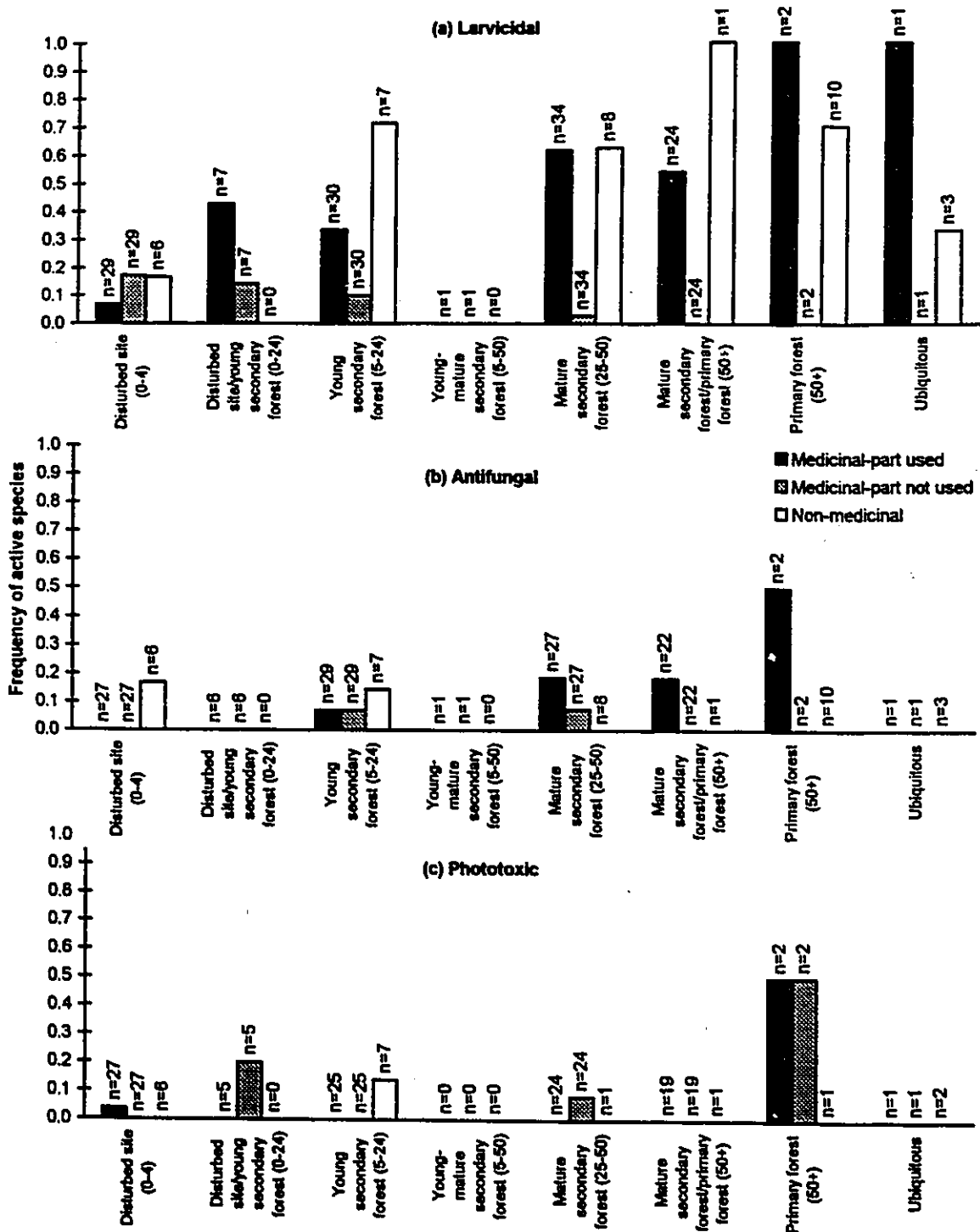


Figure 5.6. Frequency distribution by forest habitat/age class (years) of biological activity in the medicinal and non-medicinal flora of the Apo Kayan. (a) Larvicidal=toxicity to brine shrimp ( $LD_{50} < 10^4$  ppm); (b) Antifungal=inhibition of brewer's yeast; (c) Phototoxic=light-activated inhibition of brewer's yeast. n=number of species tested in field bioassays.

*Taxon (superorder)*

Plant materials selected by the Kenyah for medicinal use are derived from 203 species of plants, representing 59 families and 17 superorders of dicots, 11 families and 4 superorders of monocots, and 6 families in 2 divisions of lower plants (clubmosses and ferns) (Fig. 5.7a; App. 5.7 and 5.8). No medicinal uses of fungi or lichens were reported.

In the Kenyah system of taxonomy, the nomenclature for most plants is equivalent to a scientific species (App. 3.2). Broader taxonomic relationships are apparent in Kenyah nomenclature for a few groups, such as terrestrial ferns (*paku*), and members of the ginger family, Zingiberaceae (*lia*). The largest superorder in the medicinal flora, Commeliniflorae, includes the families Zingiberaceae (25 species) and Poaceae (9 species), two of the largest medicinally used families in the Kenyah medicinal flora. Among the smallest families are those that comprise species endemic to Borneo (Scyphostegiaceae, Proteaceae) and species introduced from the New World or Africa (Bromeliaceae, Caricaceae, Crassulaceae). Nearly half of all families in the medicinal flora are represented by a single species, a reflection of the extreme richness of the Borneo flora.

The most important families are Rutaceae and Piperaceae, in which the species *Citrus aurantium* (Rutiflorae) and *Piper betle* (Annoniflorae) have the highest medicinal importance values (Table 5.2; App. 5.8). The most important superorders are Geraniflorae (Fig. 5.7b), represented by the single species *Impatiens balsamina* (Balsaminaceae), and Santaliflorae, represented by the two epiphytic species *Loranthus constrictus* and *L. fuscus* described above. The clubmosses (Lycophyta) were among the least frequent and

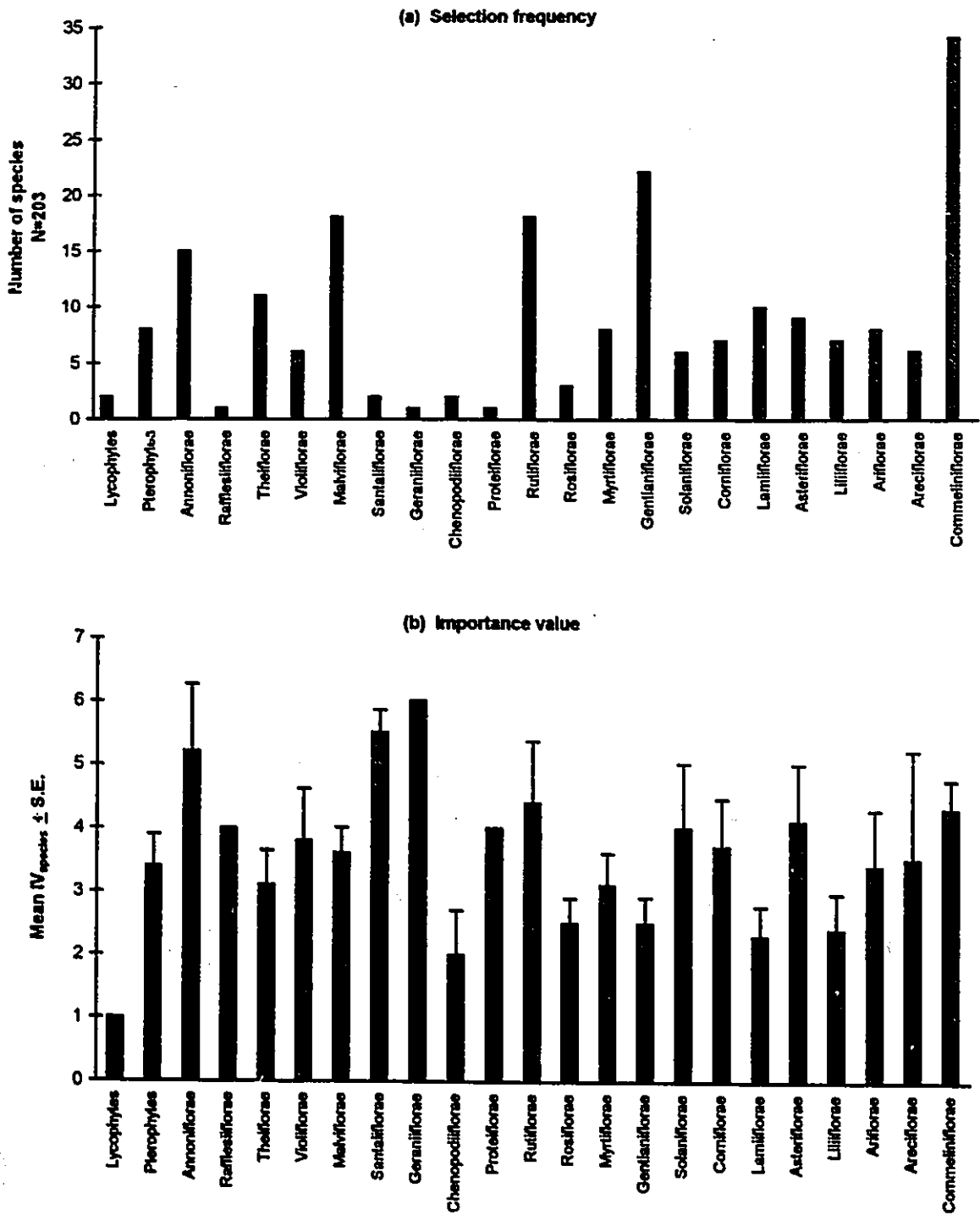
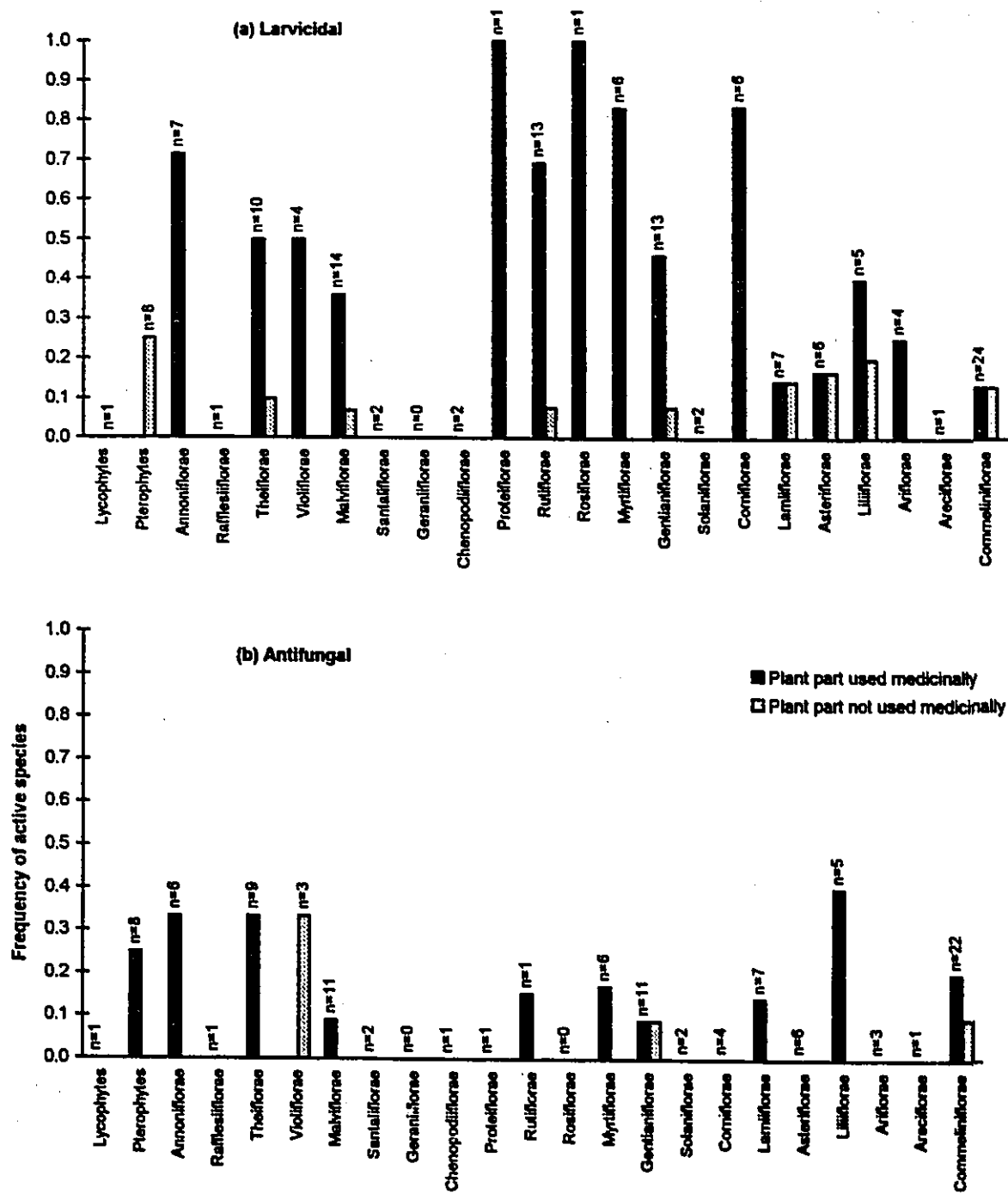


Figure 6.7. Preference indicators for superorders in the Kenyah medicinally used flora: (a) selection frequency = frequency of superorder in medicinally used species, and (b) its medicinal importance value ( $IV_{species}$ )  $\pm$  standard error of the mean.



**Figure 5.2.** Frequency distribution by superorder of biological activity in the medicinally used flora of the Apo Kayan. (a) Larvicidal—toxicity to brine shrimp ( $LD_{50} < 10^4$  ppm); (b) Antifungal—inhibition of brewer's yeast. n=number of species tested in field bioassays.

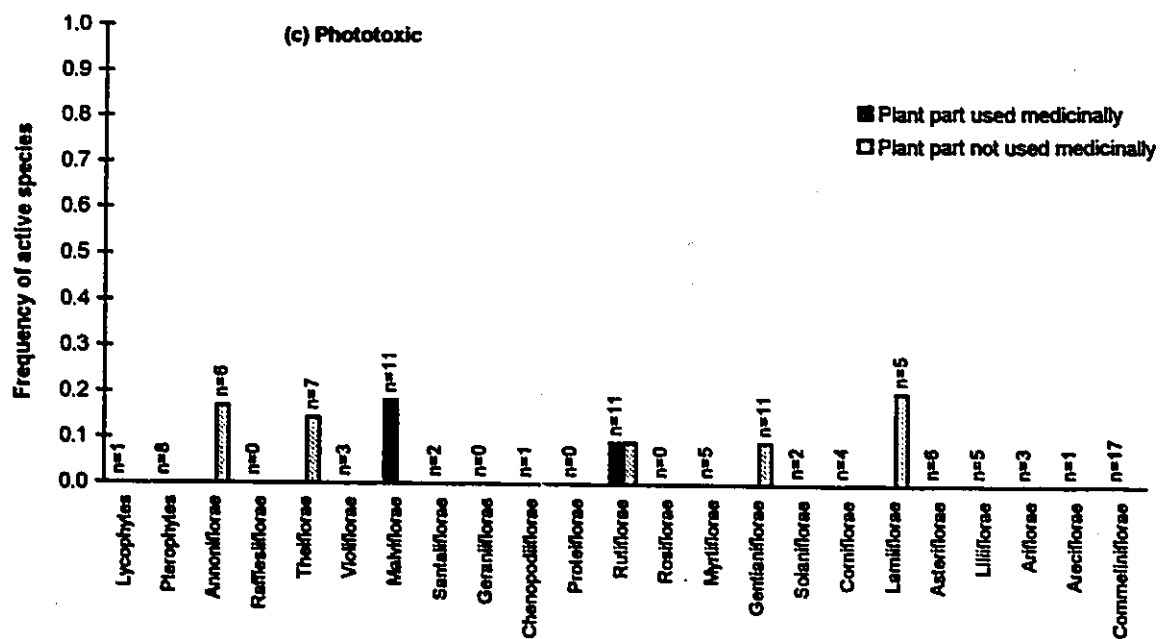


Figure 5.8 continued. (c) Phototoxic=light-activated inhibition of brewer's yeast.  
 n=number of species tested in field bioassays.

least important taxa in the medicinally used flora. These results are greatly influenced by sample size.

Biological activity was observed in 16 (73%) of the 22 superorders, in 35 (56%) of the 62 families, and in 78 (57%) of the 138 species for which materials were tested (Fig. 5.8; App. 5.9, 5.10; Table 5.1). Larvicidal activity was more frequent in dicots than in monocots, and more frequent in higher than in lower plants. Antifungal activity was more frequent in lower than in higher plants, and more frequent in monocots than in dicots. Phototoxic activity was observed in six superorders (all dicots). In only two superorders (Malviflorae, Rutiflorae) were the active parts used, however. *Piper betle* (Piperaceae/Annoniflorae), *Diospyros borneensis* (Ebenaceae/Theiflorae), and *Timonius* sp. (Rubiaceae/ Gentianiflorae) were active in all assays. In all three species, at least one of the parts used was active. The largest superorder, Commeliniflorae, had less than the overall mean frequency of biological activity in all three assays. *Citrus aurantium* and *Impatiens balsamina* were not tested; neither *Loranthus constrictus* nor *L. fuscus* was active.

#### Availability

Kenyah healers and herbalists identified 122 medicinally used species that they consider easy to find (common), and 60 species they consider difficult to find (rare) (Fig. 5.9a; App. 5.11). Reports were uncertain or in conflict for 13 species. Two species considered rare by the Kenyah are listed as endangered throughout Indonesia (Rifai, Rugayah, and Widjaja 1992; Zuhud and Haryanto 1990; Wadhwa 1994; see Table 5.2). Eight species considered common dominated habitats surveyed during selection of non-medicinal species (Yusuf, unpublished data). Common and rare species were valued equally by the Kenyah, but the medicinal importance

of species with uncertain availability was lower (Fig. 5.9b), indicating greater local knowledge of and consensus on valued species.

An emphasis on common species has been noted in other ethnobotanical studies. Phillips and Gentry (1993b) and Johns, Kokwaro and Kimanani (1990) have proposed that common species are more likely to be examined for medicinal properties than rare species, their uses more easily recalled, and are more likely to be available when needed.

Larvicidal and antifungal activity in the non-medicinal flora were more frequent in common than in rare species, but phototoxic activity was more frequent in rare species (Fig. 5.10; App. 5.12). In the medicinal flora, however, selection for larvicidal and antifungal activity in rare species suggests a more thorough exploration and exploitation of biological activity in resources that are difficult to find. As noted for other attributes, there appears to be overall selection of antifungal activity in the medicinal flora over the non-medicinal flora (Fig. 5.10b).

#### *Management strategy*

Human activity results in direct and indirect manipulations of the environment. In addition to the continuous creation of successional forest habitats through swidden cultivation, as described above, the Kenyah manipulate individual plant species in several ways: they harvest plants from wild populations, transplant seedlings from wild populations into fields or homegardens, and grow plants from seed. Cultivated species include those that have been introduced from other cultures and geographic regions and those that may have been domesticated locally.

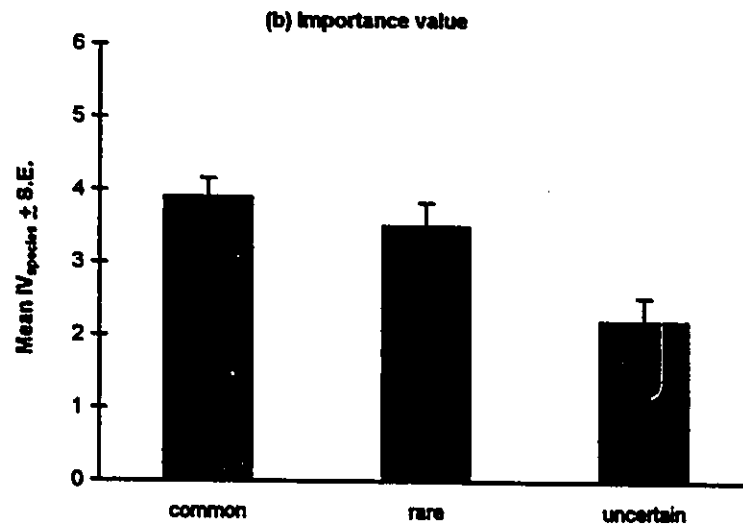
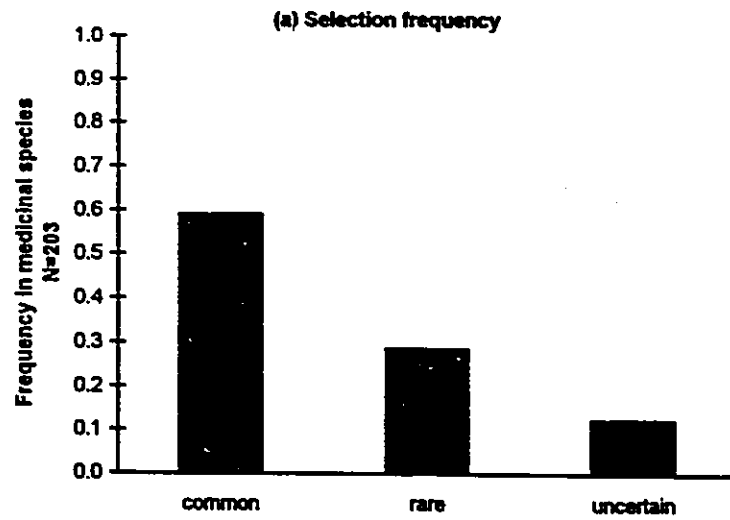
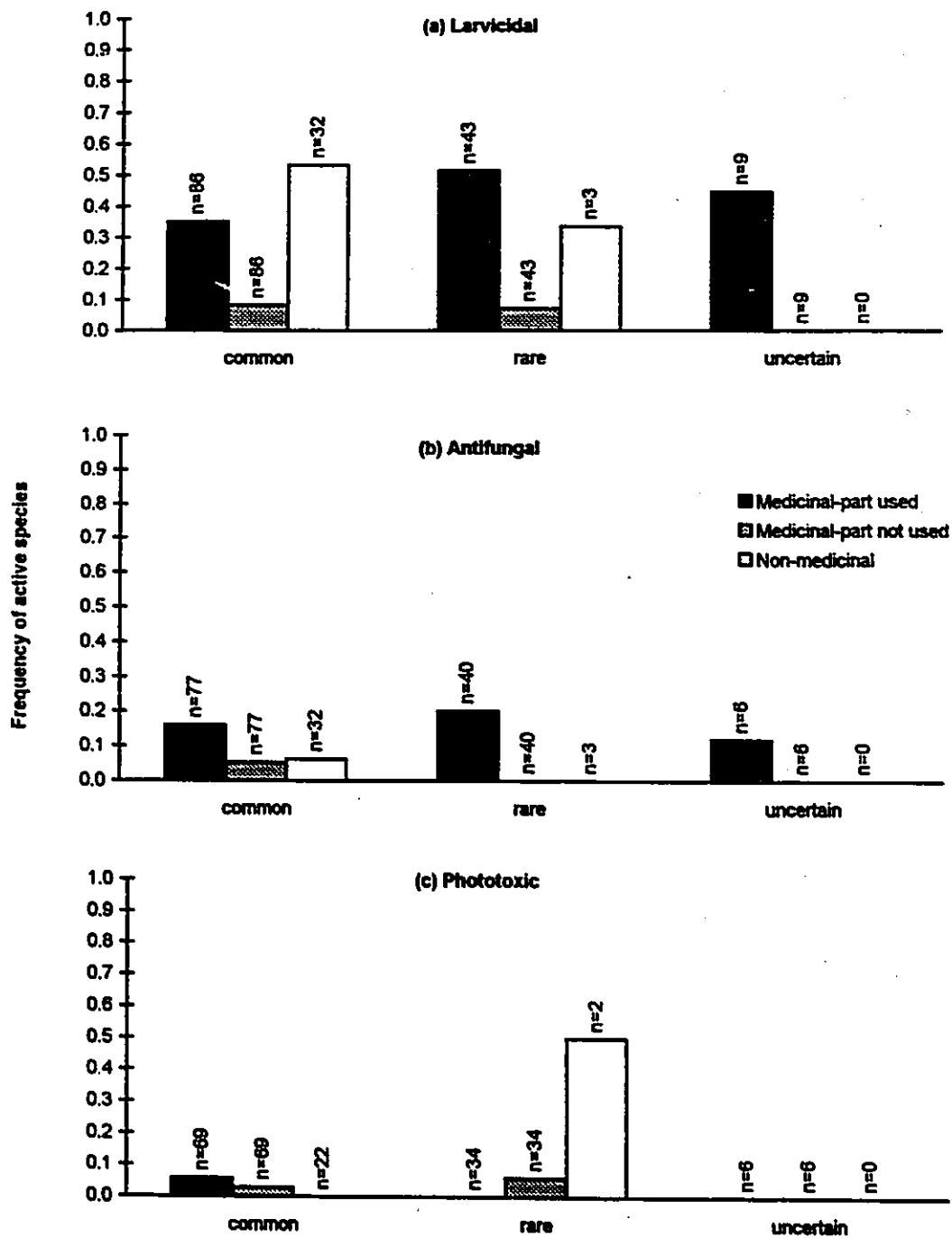


Figure 5.9. Preference indicators and availability of Kenyan medicinal species: (a) selection frequency = frequency of availability type in medicinal flora; (b) medicinal importance value = mean  $IV_{species} \pm$  standard error of the mean.



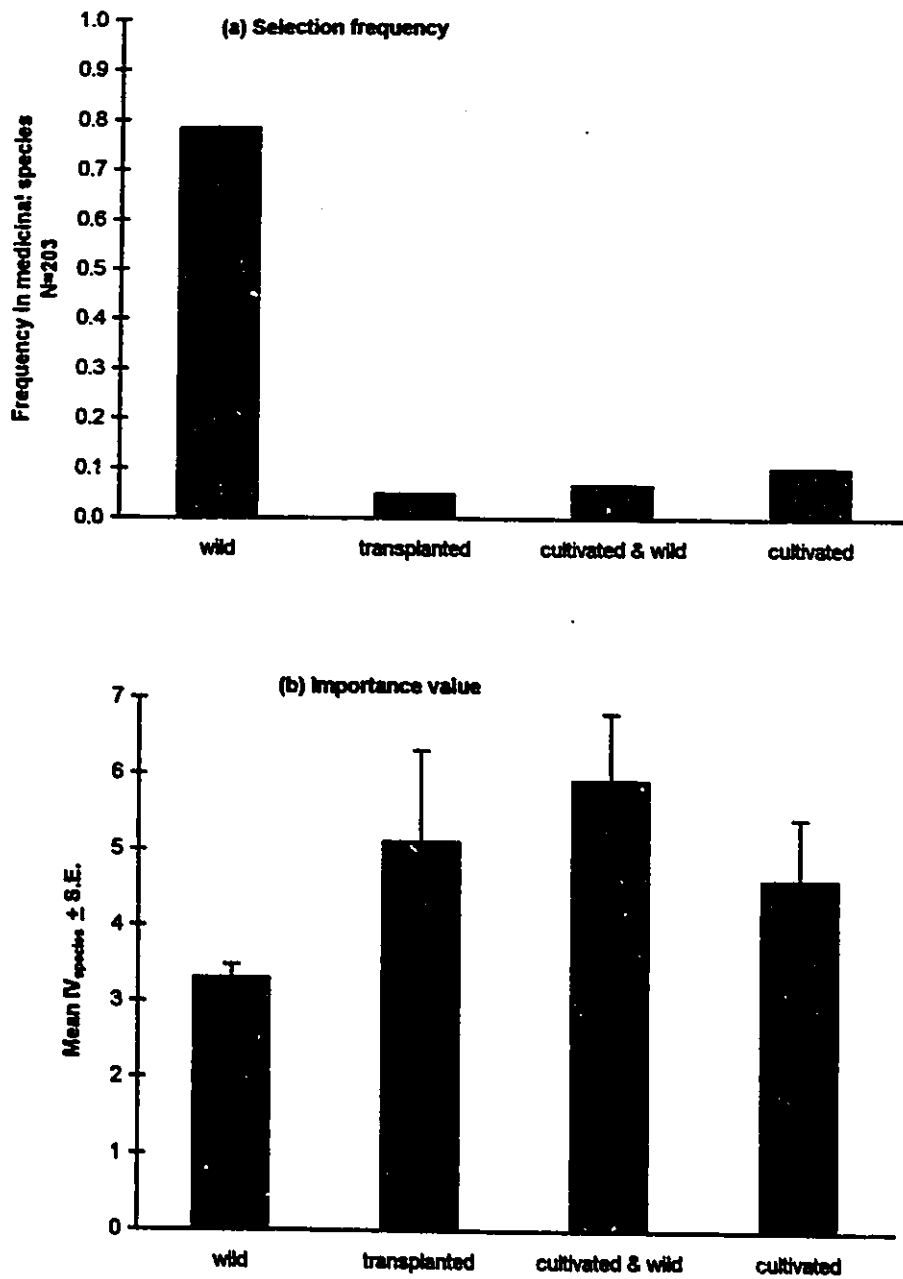
**Figure 5.10.** Frequency distribution according to plant availability of biological activity in the medicinally used and non-medicinal flora of the Apo Kayan. (a) Larvicidal=toxicity to brine shrimp ( $LD_{50} < 10^4$  ppm); (b) Antifungal=inhibition of brewer's yeast; (c) Phototoxic=light-activated inhibition of brewer's yeast. n=number of species tested in field bioassays.

Most medicinally used species were harvested from wild populations (Fig. 5.11a; App. 5.13). Wild species, were less important than managed groups, however (Fig. 5.11b). Species that are present in both wild and cultivated populations are most important in Kenyah remedies. Cultivated, old-world species (which include Rutaceae and Zingiberaceae) are more numerous and more important (34 species, mean  $IV_{\text{species}}=4.3$ ) than are cultivated new-world species (11 species, mean  $IV_{\text{species}}=3.4$ ). Wild old-world species (156 species) are more important (mean  $IV_{\text{species}}=2.7$ ) than are wild new-world species (5 species, mean  $IV_{\text{species}}=2.0$ ).

The frequency of larvicidal activity in transplanted medicinal species was higher than in both medicinal and non-medicinal species collected from wild populations (Fig. 5.12; App. 5.14). Selection for antifungal activity and against phototoxic activity in the medicinal flora over the non-medicinal flora is apparent in wild species, but cannot be determined for other management strategies from the samples collected. Within the medicinal flora, however, selection for the active parts is most apparent in cultivated species, a phenomenon predicted in domesticated species by John's model of human chemical ecology (Johns 1990).

### 5.3.2. Biological activity in the Apo Kayan flora

Biological activity in the non-medicinal flora of the Apo Kayan largely follows the distribution of biologically active compounds predicted by studies of plant defense against herbivores. In the sample of the non-medicinal Apo Kayan flora examined in this study, larvicidal activity was most frequently observed in persistent and woody plant parts (Fig. 5.2), woody plants (Fig. 5.4), mature secondary forest habitats (Fig. 5.6), and common species (Fig. 5.10). This



**Figure 5.11. Preference indicators and Kenyah management strategies for medicinally used flora: (a) selection frequency = frequency of management strategy in medicinal flora; and (b) its medicinal importance value = mean  $IV_{\text{species}} \pm$  standard error of the mean.**

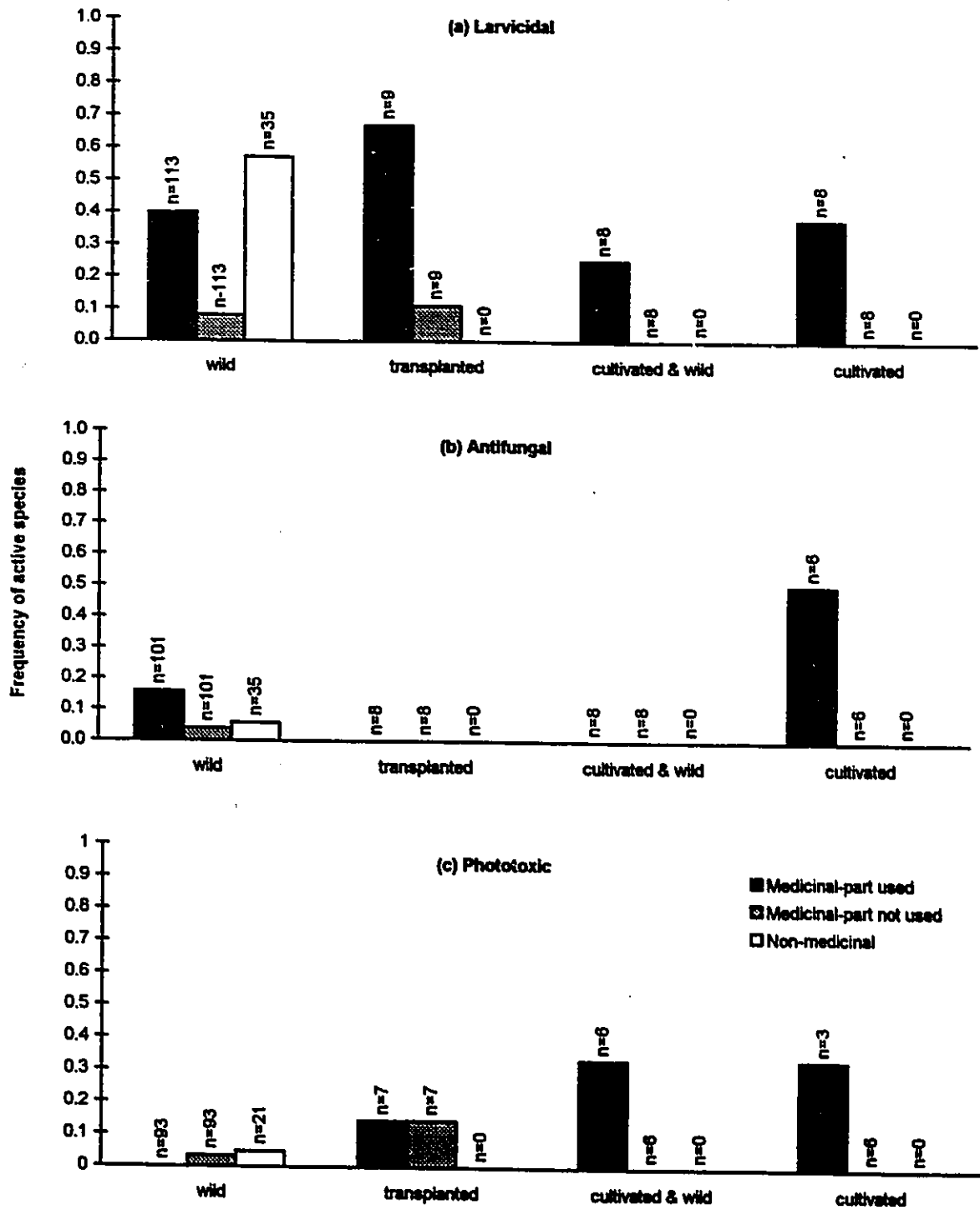


Figure 5.12. Frequency distribution by management strategy of biological activity in the medicinal used and non-medicinal flora of the Apo Kayan. (a) Larvicidal=toxicity to brine shrimp ( $LD_{50} < 10^4$  ppm); (b) Antifungal=inhibition of brewer's yeast; (c) Phototoxic=light-activated inhibition of brewer's yeast. n=number of species tested in field bioassays.

pattern follows the distribution of defenses in tropical forest species observed by Coley (1983). In her study of herbivory and plant defense in forest gaps in a tropical forest in Panama, Coley found that slow-growing, shade-tolerant, "persistent" species that dominate late succession habitats were better defended than were fast-growing "pioneer" species that dominate early succession habitats. Quantitative phytochemical defenses are high-molecular-weight, carbon-based compounds such as tannins and phenolics that, when present in relatively high concentrations in plant tissues, affect feeding and development of herbivores (Rhoades 1979; McKey 1979). These compounds are widely distributed in plant taxa.

The higher frequencies of antifungal and phototoxic activity in herbaceous plants (Fig. 5.4), disturbed-site species (Fig. 5.6), and rare species (Fig. 5.10) follows the distribution of qualitative defenses in "unapparent" plants predicted by Feeny (1976). Qualitative defenses are low-molecular-weight, nitrogen-rich or fat-rich compounds, such as alkaloids, polyketides, and terpenoids (Levin and York 1978; McKey et al. 1978). These compounds can be highly toxic at low concentrations, and are more narrowly and specifically distributed in plant taxa.

Toxic, deterrent, and inhibitory effects of secondary metabolites are believed to be an important component of a comprehensive defensive strategy that involves a range of morphological, ecological, and chemical adaptations. The substantial theoretical and experimental literature on this topic has been reviewed recently by Herms and Mattson (1992), and has been treated comprehensively also by Rosenthal and Janzen (1979) and Harborne (1988).

In medicine, these two modalities are likely to have different strengths as drugs. Tannins and other large

carbon-based compounds are more typically used as astringents, haemolytics, antivirals, and antibiotics, while the more toxic compounds have more specifically therapeutic uses (Lewis and Elvin-Lewis 1977; Goodman et al. 1985; Levin and York 1978; Evans 1989).

### 5.3.3. Biological activity in the Kenyah medicinal flora

The profile of biological activity in the Apo Kayan medicinal and non-medicinal flora overall shows a similar pattern for the three types of biological activity investigated (Fig. 5.13): in both the medicinal and non-medicinal species tested, the frequency of larvicidal activity was highest and the frequency of phototoxic activity was lowest. However, antifungal activity was more frequent and larvicidal activity was less frequent in the medicinal flora than in the non-medicinal flora. These results suggest that the Kenyah may be selecting for antifungal activity and against larvicidal activity in the medicinally used flora over non-medicinal controls. Although there are similarities between the two samples in the distribution of biological activity, the medicinal flora may not be merely a random subset of the surrounding flora.

The possibility that the Kenyah are selecting the medicinal flora from the Apo Kayan flora on the basis of biological activity is supported by quantitative analysis. The results of simple linear regressions of the frequencies of larvicidal, antifungal, and phototoxic activity in medicinal species tested, against frequencies of biological activity in the non-medicinal species tested with respect to plant part, life form, and habitat attributes (Figs 5.2, 5.4, and 5.6) are shown in Table 5.3. The absence of significant similarities between the frequencies of biological activity in the medicinal and the non-medicinal flora ( $P > 0.05$ ) supports the first null hypothesis proposed, that a linear,

Table 5.3. Quantitative comparison of the frequency of biological activity in the Kenyah medicinal flora and the non-medicinal Apo Kayan flora according to plant part, life form, and habitat

Attribute <sup>a</sup>	Frequency of biological activity <sup>b</sup>			Sum $f^c$
	Larvicidal (L)	Antifungal (F)	Phototoxic (P)	
Plant part (n=4-6)	n.s.	$P = .08$ # $r^2 = .42$	n.s.	n.s.
Life form (n=3)	$P = .055$ # $r^2 = .89$	n.s.	n.s.	$P = .12$ $r^2 = .97$
Habitat (n=6)	n.s.	n.s.	n.s.	n.s.

<sup>a</sup> Data categories for which the number of samples (parts, species) tested for biological activity < 1 were eliminated from the analysis.

<sup>b</sup> Frequency of parts or species tested in which part used medicinally was active. Larvicidal = toxicity to brine shrimp (LD50 < 104 ppm); antifungal = inhibition of brewer's yeast; phototoxic = light-activated inhibition of brewer's yeast.

n.s.:  $P$  is not significant. #:  $P < 0.1$

Probabilities ( $P$ ) and coefficients of determination ( $r^2$ ) resulting from unweighted least-squares linear regressions of the frequency of larvicidal, antifungal, and phototoxic activity in Kenyah medicinal flora versus the non-medicinal Apo Kayan flora.

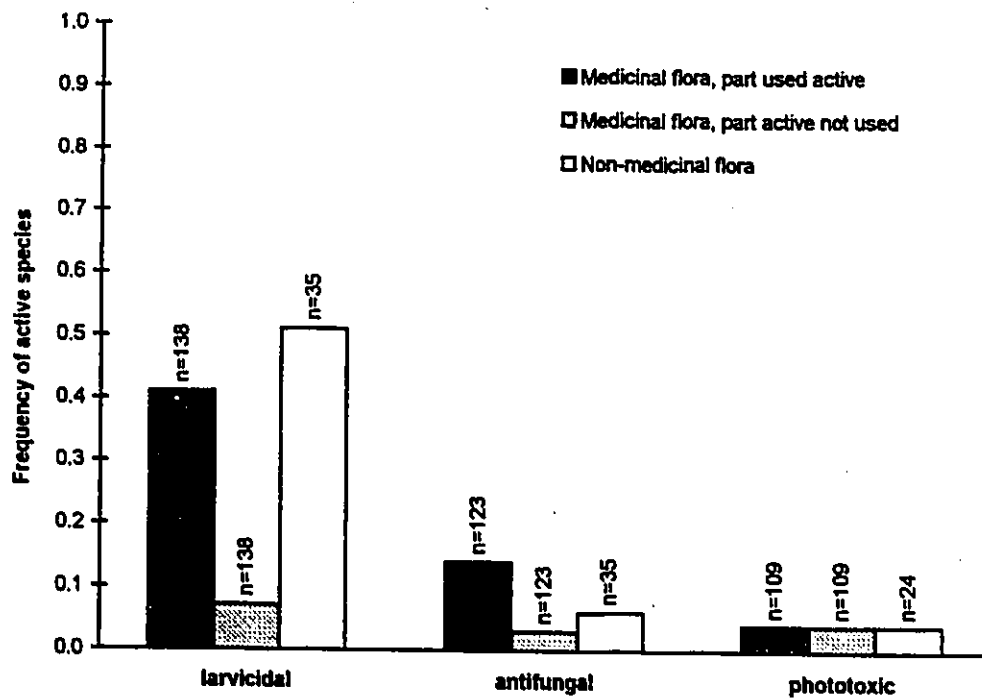
<sup>c</sup> Sum of frequencies of larvicidal, antifungal, and phototoxic activity. Results of multiple regressions of L, F, and P in the medicinal flora against the non-medicinal flora were not significant at the 5% probability level or less for any of the attributes examined.

dependent relationship does not exist between the frequency distribution of biological activity in a sample of the non-medicinal flora and that in the Kenyah medicinal flora. In other words, the plants selected for medicinal use are not a random subset of the surrounding flora. An alternate hypothesis is that the Kenyah selection of plant materials for medicinal use emphasizes particular types of biological activity.

In the medicinally used flora, biological activity is well exploited by the Kenyah (Fig. 5.13). A majority of the active parts were used medicinally: 85% of larvicidal and 83% of antifungal parts were used. Only 50% of phototoxic parts were used in Kenyah remedies, however. These data strongly suggest that once any plant has been selected for medicinal use, the active part is preferred.

#### 5.3.4. Preference indicators and biological activity

Based on the results shown in Table 5.4, the second null hypothesis proposed above -- that a dependent, linear relationship does not exist between the frequency distribution of biological activity within particular attributes of the Kenyah medicinal flora and quantitative indicators of Kenyah selection of and preference for these attributes -- can be rejected in a few cases ( $P < .05$ ), and an alternate hypothesis of a linear, dependent relationship between selection or preference and biological activity accepted. Importance values (IV) for plant species and plant part, and selection frequency for superorders reflect observed patterns in biological activity for these attributes within the medicinal flora. Since Kenyah remedies are defined by plant part, species, and use combinations (see Chapter 3), it is reasonable to speculate that a predictable association of biological activity with these attributes would influence the local importance of



**Figure 5.13. Frequency distribution by species of biological activity in the Apo Kayan flora: larvicidal = toxicity to brine shrimp ( $LD_{50} < 10^4$  ppm); antifungal = inhibition of brewer's yeast; phototoxic = light-activated inhibition of brewer's yeast. n=number of species tested in field bioassays.**

Table 5.4. Quantitative relationships between indicators of human preference and biological activity in the Kenyah medicinal flora

Attribute <sup>a</sup> Preference indicator <sup>b</sup>	Frequency (f) of biological activity <sup>c</sup>			Sum r <sup>d</sup>
	Larvicidal (L)	Antifungal (F)	Phototoxic (P)	
Species (n=13)				
IV <sub>species</sub> (n=13)	P = .0001 *** r <sup>2</sup> = .79	n.s.	P = .07 # r <sup>2</sup> = .27	P = .008 ** r <sup>2</sup> = .49
Plant part (n=8-10)				
Mean IV <sub>remedy</sub>	n.s.	n.s.	n.s.	P = .016 * r <sup>2</sup> = .64
Selection freq.	n.s.	n.s.	n.s.	n.s.
Life form (n=5)				
Mean IV <sub>species</sub>	n.s.	n.s.	n.s.	n.s.
Selection freq.	n.s.	n.s.	n.s.	n.s.
Habitat (n=4)				
Mean IV <sub>species</sub>	n.s.	n.s.	n.s.	n.s.
Selection freq.	n.s.	n.s.	n.s.	n.s.
Superorder (n=19)				
Mean IV <sub>species</sub>	n.s.	n.s.	n.s.	n.s.
Selection freq.	n.s.	n.s.	n.s.	P = .01 ** r <sup>2</sup> = .32
Residual	n.s.	n.s.	n.s.	n.s.
Availability (n=2)	insuff.	insuff.	insuff.	insuff.
Management strategy (n=4)				
Mean IV <sub>species</sub>	n.s.	n.s.	n.s.	n.s.
Selection freq.	n.s.	n.s.	n.s.	n.s.

<sup>a</sup> Data categories for which the number of samples (parts, species) tested for biological activity < 1 were eliminated from the analysis. Intermediate categories were excluded from the analysis of habitat data. Residual values for superorders were derived from a least-squares linear regression of Kenyah medicinal flora against the estimated Borneo flora (Fig. 5.18; App. 5.7).

<sup>b</sup> Indicators of selection: selection frequency (frequency with which a particular attribute appears in the medicinal flora); and residual values derived from an unweighted least-squares regression of the number of Kenyah medicinal species against the estimated number of Borneo species in 27 superorders (see Fig. 5.19). Indicators of preference: remedy importance value (IV<sub>remedy</sub>), species importance value (IV<sub>species</sub>), etc.

(continued on next page)

Table 5.4. continued

<sup>c</sup>  $f$  = frequency of parts or species tested in which part used is active. Larvicidal = toxicity to brine shrimp ( $LD_{50} < 10^4$  ppm). Antifungal = inhibition of brewer's yeast. Phototoxic = light-activated inhibition of brewer's yeast.

Probabilities ( $P$ ) and coefficients of determination ( $r^2$ ) resulting from unweighted least-squares linear regressions of selection frequency and importance value of locally defined attributes of medicinal plants versus their frequencies of larvicidal (L), antifungal (F), and phototoxic (P) activity.

n.s.:  $P$  is not significant. insuff. data insufficient for regression. \*:  $P < .1$ ; \*:  $P < .05$ ;

\*\* $P < .01$ .  $P'$  = significant outliers omitted from regression: for plant part, rhizome and sap were omitted; for superorder, Commelinidae were omitted.

<sup>d</sup> Sum  $f$  = sum of frequencies of larvicidal, antifungal, and phototoxic activity. Results of independent and multiple regressions of selection and preference indicators against L, F, and P were not significant ( $P = .05$ ).

remedies. Broader taxonomic relationships might then influence the frequency with which plant species are examined for biological activity.

#### *Importance value (IV)*

The majority of species in the Kenyah medicinal flora have a small number of uses and are known to one or two individuals (and therefore have a low  $IV_{\text{species}}$ ), while  $IV_{\text{species}}$  exceeds 10 for only 4 of the 203 species used medicinally (Fig. 5.14; App. 5.15). The frequency of biological activity in Kenyah medicinal species appears to increase with  $IV_{\text{species}}$  (Fig. 5.15; App. 5.16). A significant linear relationship between  $IV_{\text{species}}$  and biological activity is confirmed by the regression of  $IV_{\text{species}}$  against sum  $f$  (Table 5.4), illustrated in Figure 5.16 ( $P=.008$ ;  $r^2=.49$ ). This relationship is even stronger for larvicidal activity alone ( $P=.0001$ ;  $r^2=.79$ ). These results confirm, for a broader range of biological activity, the significant relationship between  $IV_{\text{remedy}}$  and antiplasmodial activity described in Chapter 4.

Remedy importance value ( $IV_{\text{remedy}}$ ) was found to be significantly related to sum  $f$  with respect to plant part if the data for rhizomes, a significant outlier, were omitted from the regression (Table 5.4; Fig. 5.17). It is likely that many of the rhizomes used in Kenyah remedies are selected for properties other than their toxic constituents. Of the 24 species from which rhizomes are selected for use in remedies, 14 (58%) are from the family Zingiberaceae. This family is rich in volatile oils, curcuminoids, tannins, phenolic acids, and terpenoids, but contains few highly toxic compounds such as alkaloids (Evans 1989). Moreover, many of the Kenyah medicinal uses of Zingiberaceae rhizomes overlap with nutritional uses (Chapter 3, section 3.3.1, Zingiberaceae). Other plant parts are more biologically

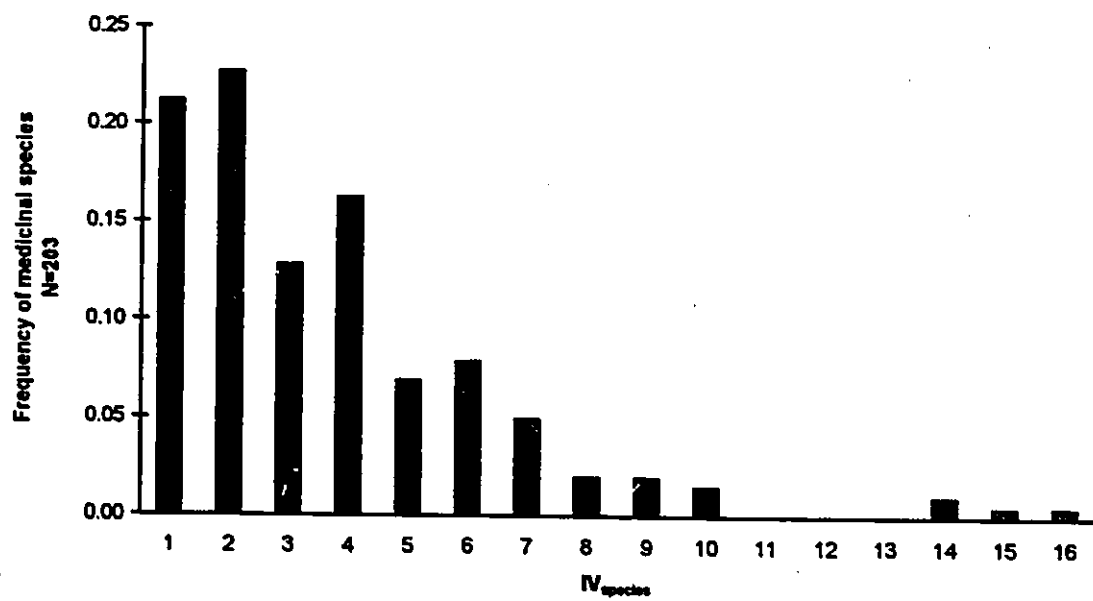


Figure 5.14. Frequency distribution of medicinal importance value ( $IV_{species}$ ) in the flora used medicinally by the Apo Kayan Kenyah. Species medicinal importance value = sum of remedy importance values (see Chapter 3).

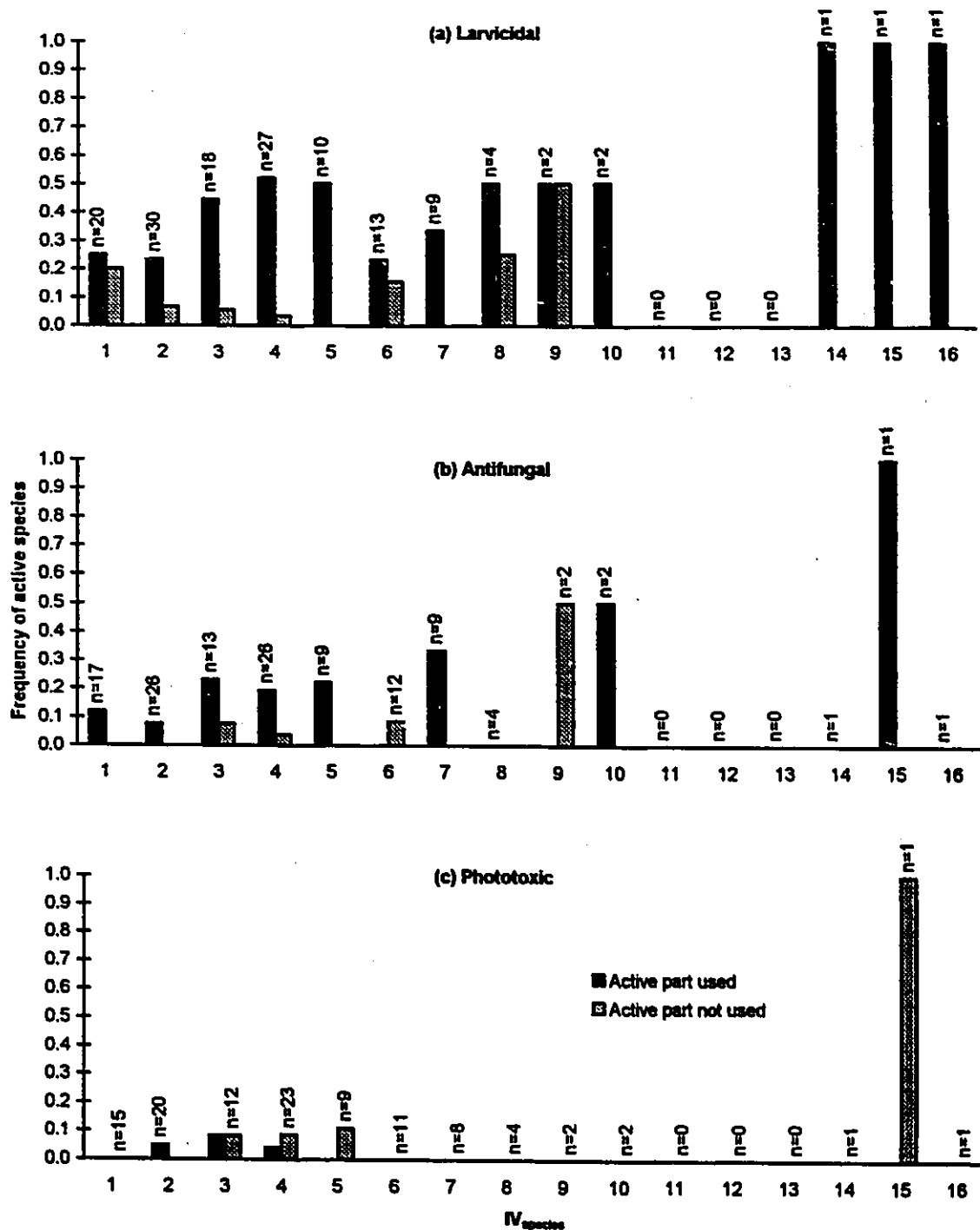


Figure 5.15. Frequency distribution by medicinal importance value ( $IV_{species}$ ) of biological activity in species used medicinally by the Apo Kayan Kenyah. (a) Larvicidal=toxicity to brine shrimp  $LD_{50} < 10^4$  ppm; (b) Antifungal=inhibition of brewer's yeast; (c) Phototoxic= light-activated inhibition of brewer's yeast. n=number of species tested in field bioassays.

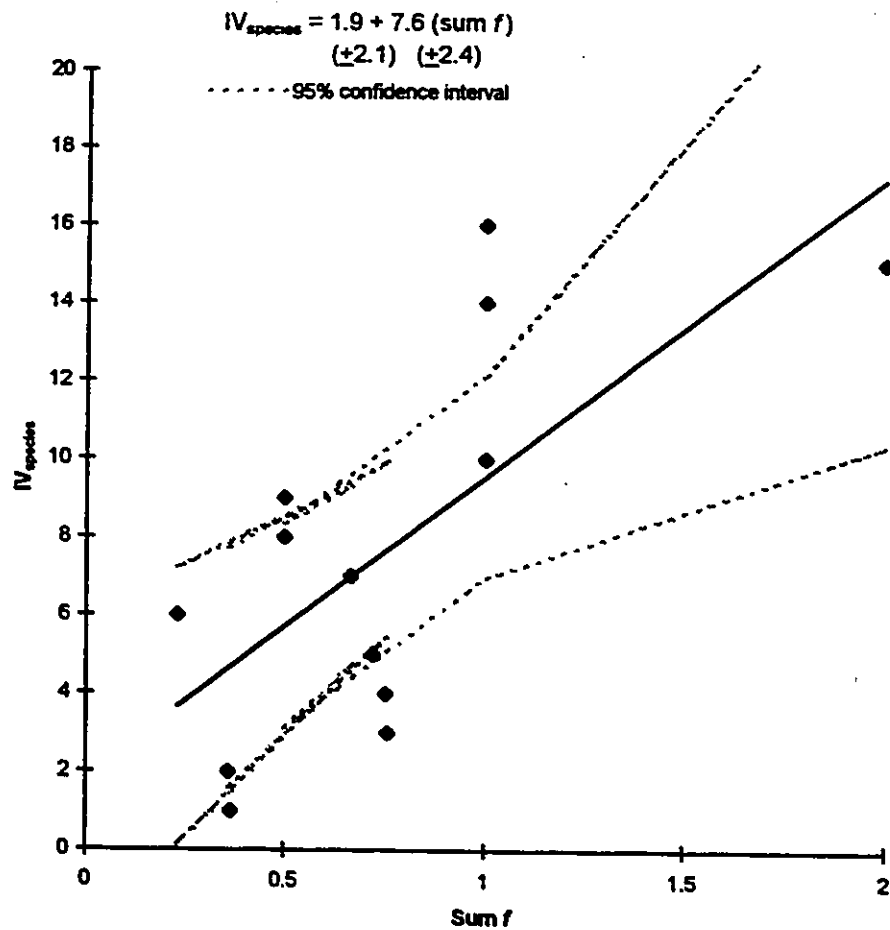


Figure 5.16. Plot of an unweighted least-squares linear regression of species importance value ( $IV_{\text{species}}$ ) against the sum of frequencies of larvicidal, antifungal, and phototoxic activity (sum  $f$ ) in the Apo Kayan medicinal flora.  $r^2 = .49$ ;  $P = .008$

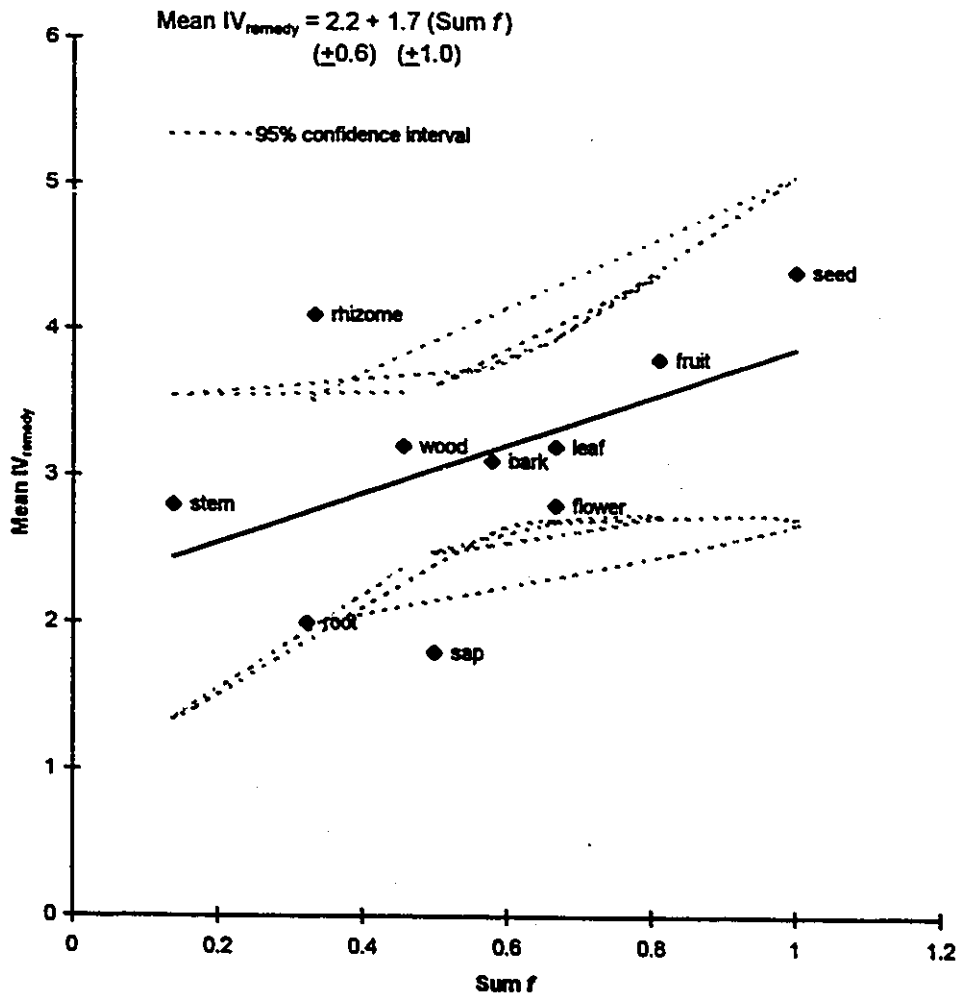


Figure 5.17. Plot of unweighted least-squares linear regression of mean remedy importance value ( $IV_{\text{remedy}}$ ) according to plant part against the sum of frequencies of larvicidal, antifungal, and phototoxic activity (sum  $f$ ) in the Apo Kayan medicinal flora.  $r^2 = .14$ ;  $P = .28$ . If the significant outlier rhizome is omitted,  $r^2 = .64$ ;  $P = .02$ . Mean  $IV_{\text{remedy}}$  for some parts exceeds 4 because some remedies require more than one part.

diverse, however, and more strictly medicinal in their use by the Kenyah.

### *Selection frequency*

Selection frequency was found to be significantly related to biological activity only for superorders (Table 5.4; Fig. 5.18). If the data for Commeliniflorae and Liliiflorae, significant outliers, are omitted, the frequency distribution of Kenyah medicinal species among superorders (Fig. 5.7a) was significantly related to the sum of frequencies of larvicidal, antifungal, and phototoxic activities (sum  $f$ ) (Fig. 5.8). Of the 36 species in Commeliniflorae, 21 (58%) are in the family Zingiberaceae (App. 5.9), and are likely to be valued for properties other than their toxic principles, as explained above in section 5.3.4.

When the number of species in superorders in the Kenyah medicinal flora were compared with the number of species in superorders in the Borneo flora (Fig. 5.19), a method of identifying preferred taxa developed by Moerman (1979, 1991), the Commeliniflorae was again identified as a significant outlier. Regression residuals are given in App. 5.7. Of the 27 superorders represented in the Kenyah medicinal flora, 13 are over-represented, 9 are under-represented, and 5 are within the range predicted by the estimated number of species available in the Borneo flora. Within these five superorders, only three families (Melastomataceae in Myrtiflorae, and Apocynaceae and Asclepiadaceae in Gentianiflorae) can be considered representative of a random sample of the available species (App. 5.11).

In his study of the North American medicinal flora, Moerman (1991) proposed that over-represented taxa are more likely

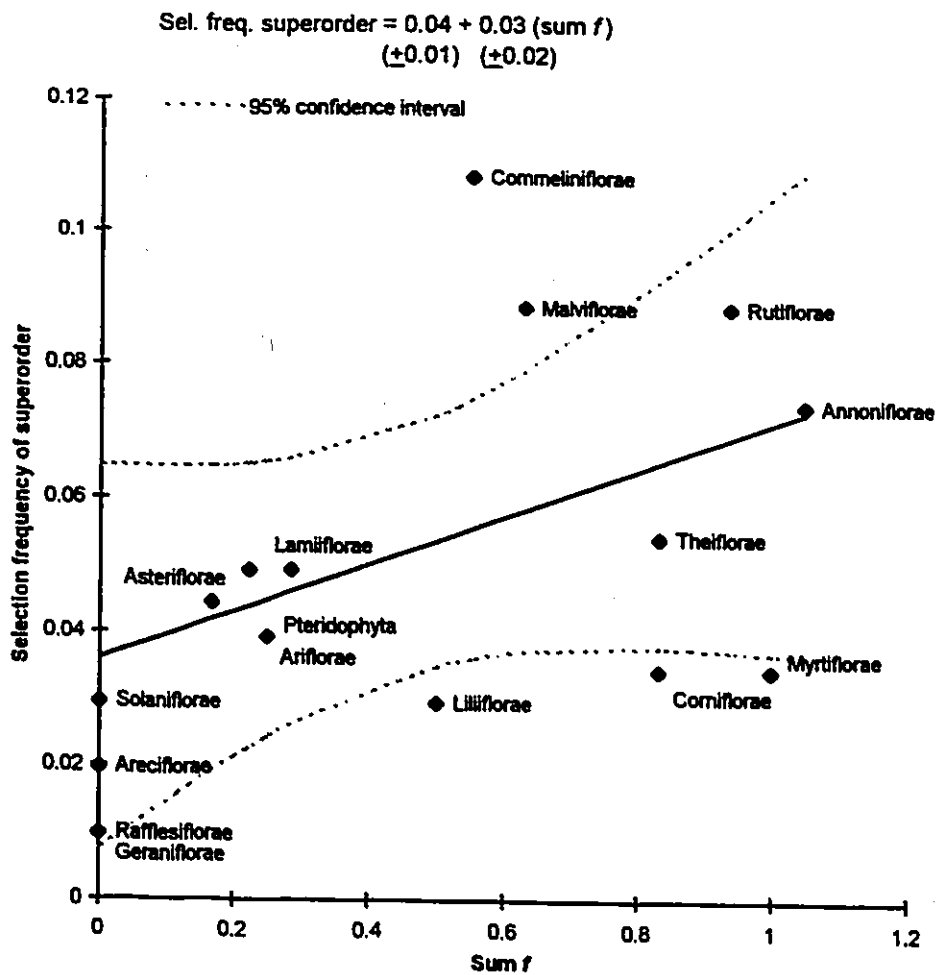


Figure 5.18. Plot of an unweighted least-squares linear regression of selection frequency for superorders (frequency of all medicinal species per superorder) in the Apo Kayan medicinal flora against the sum of larvicidal, antifungal, and phototoxic activity (sum  $f$ ).  $r^2 = .11$ ;  $P = .16$ . If the significant outliers Commeliniflorae and Liliiflorae are omitted,  $r^2 = .32$ ;  $P = .01$ .

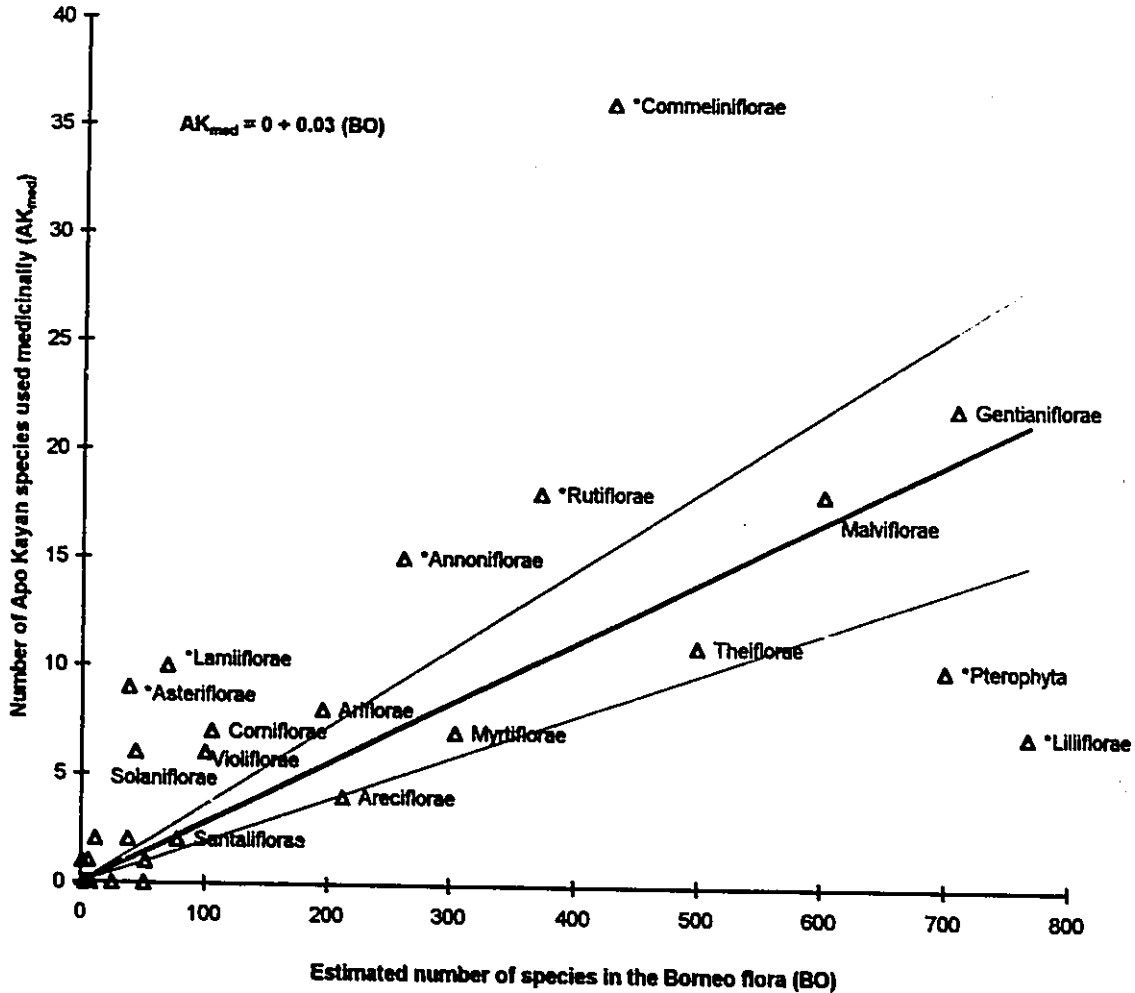


Figure 5.19. Regression plot of 27 superorders showing Apo Kayan medicinally used species versus estimated total Borneo species. Borneo flora is estimated from Merrill (1921); superorders follow Thorne (1981); a few other major taxa are included.  $r^2 = .64$ ;  $P = 0$ . Points beyond 95% confidence intervals are over-represented or under-represented in the Kenyah medicinal flora. Significant outliers (\*) exceed the standard error of the regression estimate ( $\pm 6.82$ ). Unlabelled points, from the origin: Nymphaeiflorae, Triuridiflorae, Alismatiflorae, Gymnospermae, Hamamelidiflorae ( $AK_{med}=0$ ); Proteiflorae, Rafflesiiflorae, Geraniiflorae ( $AK_{med}=1$ ); Chenopodiiflorae, Rosiflorae ( $AK_{med}=2$ ).

to be biologically active than are under-represented taxa. This hypothesis is not supported for the Apo Kayan medicinal flora, even when the data for significant outliers Commeliniflorae and Liliflorae are omitted (Table 5.4;  $P=.42$ ,  $r^2=.44$ ). Regression residuals (Fig. 5.18; App. 5.7) were not significantly correlated with biological activity in the Kenyah medicinal flora (Fig. 5.7). However, most of the highly active species used medicinally by the Kenyah are contained in over-represented taxa. For example, Annoniflorae includes the highly active families Piperaceae and Lauraceae (App. 5.12). Rutiflorae includes the highly active families Fabaceae, Meliaceae, and Sapindaceae (App. 5.12) as well as Rutaceae, which is known to contain biologically active constituents such as alkaloids, volatile oils, coumarins, and terpenoids (Evans 1989).

#### 5.4. Conclusions

From the examination of relationships between selection frequency, importance value, and biological activity reported here, a number of conclusions may be drawn concerning the chemical ecology of Kenyah use of the Apo Kayan flora in traditional remedies.

The Kenyah have not selected plant materials for use in traditional remedies at random from the available flora. The distribution of biological activity in the flora selected for medicinal use, as indicated by larvicidal, antifungal, and phototoxic activity, appears to emphasize antifungal activity in particular, and may indicate avoidance of some highly toxic materials, as indicated by larvicidal activity. Once a plant has been selected for medicinal use, the active part is preferred.

The results of this study reveal significant relationships between the frequency of biological activity in the medicinal flora, the frequency of selection, and the degree of consensus on use, as indicated by the medicinal importance value (IV). The relationship between medicinal importance value and biological activity is strongest at the level of plant part and species. These attributes are among those for which Kenyah plant nomenclature indicates a prominent role in the Kenyah view of the plant world, although symbolic and spiritual associations, availability, accessibility, and other factors likely influence selection and medicinal importance of plant materials.

Several additional relationships between the distribution of biological activity in the Apo Kayan flora and its selection for medicinal use by the Kenyah are suggested by the results of this study. Secondary forest species are highly active, and appear to be highly selected by the Kenyah for medicinal use. Common species are used in more remedies, but rare species appear to be more thoroughly examined and used for their biological activity. The high frequency of biological activity in transplanted and cultivated species used in traditional remedies suggests that the Kenyah manage these species to make important biologically active materials more readily available than are species collected wild.

A more thorough examination of these relationships will benefit from larger samples of the non-medicinal flora, replication of bioassays, and employment of tests for biological activity that are more specifically relevant to the ailment treated and the Kenyah understanding of its cause (ie., the examination of antiplasmodial activity of Kenyah malaria remedies, presented in Chapter 4). Variation in the nature and quantity of secondary metabolites in individual plants over time, and within plant species, were

not considered in the present study, but are likely to influence patterns of harvest for medicinal use.

The results presented in this chapter support the view that ethnomedicine is the result a continuous empirical process of experiment and discovery that can be corroborated by modern methods. Traditional knowledge of medicinal materials cannot be replicated or replaced by random samples, or by phylogenetic, morphological, or ecological associations with biological activity.

## CHAPTER 6

### GENERAL CONCLUSIONS AND DISCUSSION

#### 6.1 Main conclusions

This study is the first thorough investigation of the medicines used by an indigenous group in Borneo. A primary objective of an ethnobotanical study is to "identify what plants are significant" to the people of a particular culture (Ford 1978:44). This study has attempted to answer this fundamental question concerning Kenyah knowledge and use of plants in traditional remedies by addressing several subsidiary questions that are relevant to current issues in ethnobotany. These questions included: (1) Which remedies are most important to the Kenyah? (2) How is remedy importance related to the Kenyah view of health and illness? (3) What is the relationship between remedy importance, biological activity, and potential efficacy? and (4) What is the relationship between indicators of human preference and biological activity?

A new tool was developed to address the latter set of questions quantitatively, and to facilitate the examination of falsifiable hypotheses. A simple consensus index, the remedy importance value ( $IV_{\text{remedy}}$ ) was derived from ethnobotanical survey data (Chapter 3) to measure the relative degree of consensus and local geographic extent of knowledge among the Kenyah concerning individual remedies (unique species/tissue-medicinal use combinations, *sensu* Johns et al. 1994). This index differs from other proposed measures of consensus (eg., Trotter and Logan 1986; Johns, Kokwaro and Kimanani 1990; Phillips and Gentry 1993a, 1993b) in its simplicity, its application to data obtained from interviews with groups as well as individuals, and its

flexibility in quantifying relative importance of larger units of interest, such as remedy categories (Chapter 3), plant taxa, and groups defined by ecological variables (Chapter 5).

Ethnobotanical survey results showed that the Kenyah have a far more extensive knowledge of remedies derived from the Apo Kayan flora and fauna than had previously been noted (Elshout 1923; Nieuwenhuis 1929; Tillema [1938] 1989; Conley 1973; Whittier 1973), confirming preliminary results of other researchers (Soedjito 1982; Sangat-Roemantyo 1982). Remedies recorded during this study comprise 199 plant species and 5 animal species, and represent a broad range of taxa (Chapter 3, Chapter 5). Kenyah consultants described 438 unique remedies to treat 66 different ailments. Remedies for prominent local health problems, such as dermatological and gastrointestinal ailments, are most numerous, but materials used as poisons, as synergists with other remedies, and remedies for dental and pediatric ailments are most important.

An approximation of the relationship between importance and therapeutic efficacy was derived using an *in vitro* human malaria assay (*Plasmodium falciparum*) to evaluate the activity of Kenyah malaria remedies and non-malaria remedy controls (Chapter 4; Leaman et al. 1995). Plants with a high importance value as malaria remedies ( $IV_{mal}$ ) produced extracts that inhibited cultured *Plasmodium falciparum* more effectively than extracts of remedies with low  $IV_{mal}$  and control plants. These results provide a more use-specific test of the correlation between consensus and general biological activity demonstrated by Trotter and Logan (1986).

The nature of the relationships between importance and general biological activity of the medicinal and non-

medicinal flora was evaluated using three assay models adapted for the field situation (Chapter 5). Significant relationships were demonstrated between medicinal importance value of plant parts and species and the sum of their larvicidal, antifungal, and phototoxic activities (sum  $f$ ), as well as between selection frequency of superorders and sum  $f$ .

This study is unique in demonstrating that healers and herbalists select for biological activity in the medicinally used flora with respect to the available flora (Chapter 5). Previous studies have demonstrated that ethnomedical data can lead to more efficient isolation of anticancer agents in plant extracts than alternate collection strategies, such as random sampling, chemo-taxonomic relationships, and ecological distributions of biological activity (eg., Spjut and Perdue 1976; Spjut 1985; Cordell, Beecher, and Pezzuto 1991). The present study demonstrates that a high level of ethnomedical consensus is a good predictor of biological activity.

Frequencies of biological activity in plant tissues selected for medicinal use are significantly higher than in tissues not used in remedies. These results strongly suggest that selection of plant materials for use in remedies by the Kenyah is based on empirical examination of individual species and plant parts in the treatment of ailments. Higher levels of biological activity in transplanted and cultivated species suggest that the Kenyah manipulate plant species to enhance the availability of biologically active materials.

Overall, this research supports the premise that human knowledge and use of plants as medicines is a dynamic product of empirical investigation of the therapeutic properties of available materials. Such knowledge includes

the special knowledge of healers, the more generalized knowledge of herbalists, and community knowledge of household remedies. The relative importance of traditional remedies to the Kenyah communities surveyed appears to reflect not only the relative significance of the pathogens and other risks to health and life to which a particular ethnic community is exposed, but also the relative therapeutic efficacy of materials available for use as medicines.

## **6.2 Implications of this study for health, conservation, and management of biodiversity**

The Kenyah rely on traditional remedies for most of their health care, as does an estimated 80% of the world's population (Farnsworth et al. 1985). This study was motivated principally by immediate and practical concerns of the Kenyah, which encompass the efficacy, safety, and accessibility of medicines; cultural and environmental integrity; and conservation, not only of plant and animal resources, but also of their knowledge of how to use these wisely (Leaman, Yusuf, and Sangat-Roemantyo 1991; Leaman et al. in press). These concerns are shared by many communities of indigenous people who rely on an intimate knowledge and careful use of the surrounding flora and fauna for their survival (eg., Coordinating Body for Indigenous People's Organizations of the Amazon Basin 1995).

Most (62%) species used medicinally by the Kenyah are collected wild from secondary forest habitats (Chapter 5). The Kenyah consider 29% of all medicinal species to be rare (difficult to find). Although the impact of shifting cultivation by the Kenyah on forest succession and species composition in the Apo Kayan is small at current population levels (Mackie 1986), immigration, changes in agricultural practices, and commercial logging could affect the

availability of many medicinal species, either directly through over-harvesting, or indirectly through the reduction of primary and mature secondary forest habitats.

Kenyah women have significantly greater knowledge of remedies than do men, but important remedies are known equally to both genders (Chapter 3). Although traditional remedies are still in common use in the Apo Kayan, knowledge of the plant and animal sources and methods of use is held only by a few individuals in each community. These healers and herbalists, almost without exception, are community elders. Elderly Kenyah healers and herbalists lament the lack of interest in their skills among younger people, and forecast the disappearance of their medicinal knowledge.

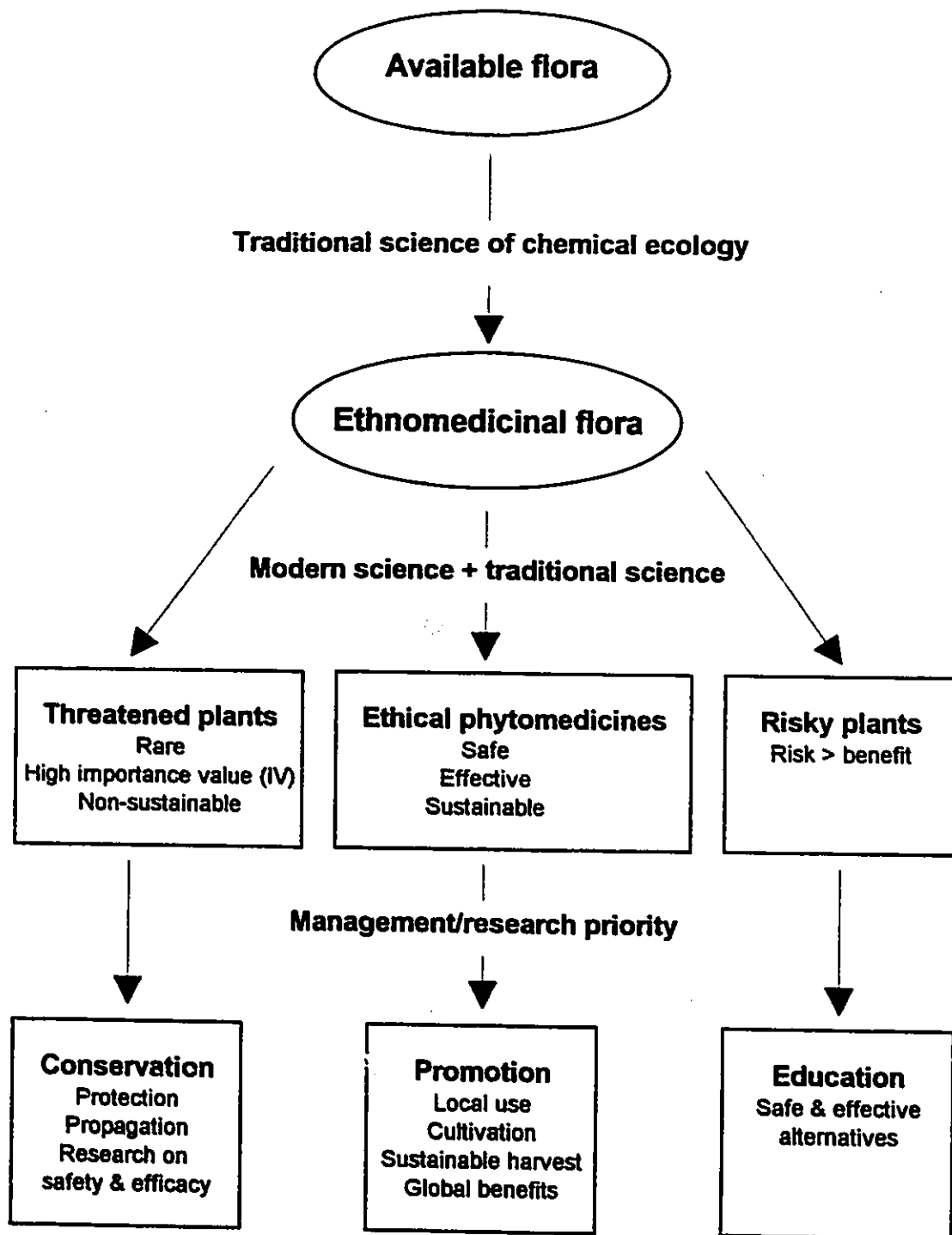
There is increasing interest in the application of ethnomedical survey results to the search for novel pharmaceuticals and in the conservation of the cultural and biotic diversity upon which these surveys depend (Cordell, Beecher, and Pezzuto 1991; Reid et al. 1993; Chadwick and Marsh 1994). Direct benefits to the communities involved are limited by a number of factors, however, including: the focus of pharmaceutical research on patentable drugs and diseases of primary concern to developed countries (Baker et al. 1995); the inaccessibility of commercial drugs and other products to rural peoples; relatively little research on the safety and efficacy of traditional remedies (De Smet 1991; but see Caceres 1987, 1991); concerns about the community vis-à-vis the national interest in intellectual property rights (Baker et al. 1995); and the threat of over-harvest of wild-collected species with international market value (Jenkins and Oldfield 1992; World Health Organization, World Conservation Union, and World Wide Fund for Nature 1993).

### 6.3. Priorities for future research

A model is proposed (Fig. 6.1) for using traditional knowledge more effectively to identify priorities for research and management directed toward conservation of rare or threatened medicinal species and rational use of traditional remedies. The principal contributions of ethnobotanical research include: identification of important remedies and species using consensus methods; identification of important medicinal species that are considered rare by healers and herbalists; and preliminary identification of potentially effective or toxic remedies through biological assays and literature reviews.

These priorities are supported by a number of international research and development efforts. Two current efforts are the TRAMIL (Scientific Investigation and Popular Use of Medicinal Plants in the Caribbean) project (Robineau 1991, 1995); and the People and Plants Initiative (Hamilton 1995) sponsored by the World Wide Fund for Nature (WWF), the United Nations Educational, Scientific and Cultural Organisation (UNESCO), and the Royal Botanic Gardens, Kew.

Applying this model to the present study, 79 remedies, involving 66 species of plants or animals, are highly valued among the Apo Kayan Kenyah communities (Chapter 3). Of these locally important species, 22 (33%) are biologically active; the Kenyah consider 23 (35%) of these rare (Chapter 5). There are species that are important, biologically active, and possibly rare; these warrant research directed toward conservation and protection. *Aquilaria beccariana* van Tiegh. (*gaharu*, or incense wood), a valuable product for commercial trade, has been proposed as a conservation priority (Peluso 1983).



**Figure 6.1. Contribution of traditional science and modern science to management and research priorities for conservation and sustainable use of medicinal plants.**

While the field bioassays provide only a rough indicator of potential efficacy of traditional remedies, the present study identified two important Kenyah malaria remedies with antiplasmodial activity (Chapter 4). One species, *Aglaia dookoo* Griff. (cf., *Lansium domesticum* Corr. Serr.) is widely used, common, and transplanted to homegardens, allowing for the possibility of cultivation. This is an example of a remedy that warrants further research directed toward standardization of a safe, effective, and locally accessible remedy for an ailment with significant local health effects.

Few ethnobotanical surveys have been undertaken among indigenous peoples of Kalimantan. Given the diversity and the unexplored nature of the Kalimantan flora, such surveys are likely to reveal a wealth of previously undocumented medicinal species. If other isolated communities are discontinuing the practice of traditional medicine as quickly as are the Kenyah, much of this knowledge of useful medicinal species may be gone within a few years.

A number of aspects of Kenyah ethnobotany to which this thesis alludes have not been analyzed fully here. Among these are Kenyah taxonomy of medicinal plants and of the ailments they treat; and a detailed assessment of the biological activity-use relationships of remedies other than those for malaria. Work on the former will require a better understanding of Kenyah linguistics and concepts of health than is possible for an outsider to achieve in a few months of research, but is likely to reveal much about the cultural and biological basis for selection and use of plants as remedies. The latter will require bioassay models that are relevant to the biological basis and the cultural understanding of the ailments treated.

### Appendix 3.1. Field data collected for a survey of Kenyah plant medicines

#### I. Botanical Data

Date, collector, collection number  
Local name/folk taxonomy  
Family/scientific name (if known)  
Location of collection  
Habitat type (e.g., succession age-class)  
Life form (e.g., tree, herb)  
Height  
Biological factors affecting distribution  
Evidence of herbivore or pathogen damage  
Type of material/tissue collected  
Flower/fruit colour and characters (if sterile, when likely to flower/fruit)

#### II. Ethnobotanical Data

Consultant's name, age, gender, occupation, etc.  
Date and location of interview  
Etymology of vernacular name  
Other sources of material: season, time, local  
Indication (ailment treated, symptoms)  
Preparation and application (part used, dosage, age of patient, etc.)  
Expected results  
Problems/constraints affecting use  
History of use/current status of use  
Other (non-medicinal) uses

Appendix 3.2. Kenyah taxonomy of medicinally used flora and fauna

Kenyah name <sup>a</sup>	English translation	Scientific name	Family	VN <sup>b</sup>
abung	left	<i>Ficus cf., uncinulata</i> King Becc.	Moraceae	73
aka Bakung	Bakung vine	<i>Rhaphidophora montana</i> Schott	Araceae	235
aka balet		<i>Piper arborescens</i> Miq.	Piperaceae	39
aka Belan	Belan's vine	<i>Merremia umbellata</i> (L.) Hallier f.	Convolvulaceae	136
aka bo' Ulu' (1)	old man Ulu's vine	<i>Daibergia velutina</i> Benth.	Fabaceae	142
aka bo' Ulu' (2)	old man Ulu's vine	<i>Daibergia pinnata</i> (Lour.) Prain	Fabaceae	203
aka kedatung tura	trip up vine	<i>Merremia borneensis</i> Merr.	Convolvulaceae	68
aka kelawit	hook vine	<i>Uncaria cordata</i> (Lour.) Merr.	Rubiaceae	47
aka keleput laso'	blowpipe vine for bums	<i>Cissus simplex</i> Blanco	Vitaceae	31
aka kelese'		<i>Spatholobus ferrugineus</i> Benth.	Fabaceae	22
aka kuwik		<i>Trichosanthes bracteata</i> Vogl	Cucurbitaceae	107
aka lepet	twisting vine	<i>Aeschynanthus obconica</i> C.B. Clarke	Gesneriaceae	145
aka letien	maggot vine	<i>Pandorea pandorana</i> v. Steenis	Bigoniaceae	138
aka lundok demah	clear sleep vine	<i>Breymia cf., rhamnoidea</i> (Retz.) Muell.-Arg.	Euphorbiaceae	202
aka malung	Alung's vine	<i>Pothos ovatifolius</i> Engl.	Araceae	149
aka pebejek	sprain vine	<i>Aeschynanthus elongata</i> C.B. Clarke	Gesneriaceae	198
aka pelandu	mousedeer vine	<i>Maesa ramentacea</i> (Roxb.) A. DC.	Myrsinaceae	210
aka pelian	measles vine	<i>Kadsura scandens</i> Bl. (var. 2)	Schisandraceae	71
aka pelian apui	measles vine	<i>Kadsura scandens</i> Bl. (var. 2)	Schisandraceae	71
aka pere'	sanding vine	<i>Tetracera scandens</i> Merr.	Dilleniaceae	131
aka pulut		<i>Merremia borneensis</i> Merr.	Convolvulaceae	68
aka sekileng		<i>Embellia ribes</i> Bum.f.	Myrsinaceae	82
aka sekiput luit	shin closing vine	<i>Hedyotis cf., sumatrana</i> Merr.	Rubiaceae	95
aka silu sing	cats' claw vine	<i>Zizyphus borneensis</i> Merr.	Rhamnaceae	186
aka tepilik sulau	tossed coin vine	<i>Mussaenda laxiflora</i> Merr.	Rubiaceae	69
aka tisp lanak	ulcer sucker	<i>Kadsura scandens</i> Bl. (var. 1)	Schisandraceae	55
aka umeng	lone vine	<i>Hoya coronaria</i> Bl.	Asclepiadaceae	200
aka unga	necklace vine	<i>Piper arborescens</i> Miq.	Piperaceae	39
aka unga kalong	push away	<i>Piper sp.</i>	Piperaceae	148
ata'		<i>Smilax odoratissima</i> Bl.	Smilacaceae	130

## Appendix 3.2. continued

Kenyah name <sup>a</sup>	English translation	Scientific name	Family	VN <sup>b</sup>
<i>atiu Kenyah</i>		<i>Eurycoma longifolia</i> Jack	Simarubaceae	93
<i>baa'</i>		<i>Oryza sativa</i> L.	Poaceae	300
<i>balang</i>	proud	<i>Piper peltatum</i> L.	Piperaceae	52
<i>balang ulet</i>	proud caterpillar	<i>Piper arborescens</i> Miq.	Piperaceae	39
<i>bele sa'ai</i>	shy flower	<i>Amomum ligulatum</i> R.M. Smith	Zingiberaceae	85
<i>beleng la'</i>		<i>Litsea cubeba</i> (Lour.) Pers.	Lauraceae	16
<i>beruang</i>	sunbear	<i>Helarctos malayanus</i>	Ursidae	252
<i>befe'</i>	good	<i>Dianella nemorosa</i> Lam.	Liliaceae	110
<i>beting</i>		<i>Tacca cf., cristata</i> Jack	Taccaceae	239
<i>bia' kalong</i>	necklace arrow leaf	<i>Alocasia longiloba</i> Miq.	Araceae	103
<i>buah abung</i>		<i>Nepenthes cf., cuspidatum</i> Bl.	Sapindaceae	88
<i>buah acheng (1)</i>	bird fruit	<i>Loranthus constrictus</i> Danser	Loranthaceae	125
<i>buah acheng (2)</i>	bird fruit	<i>Loranthus fuscus</i> Bl.	Loranthaceae	128
<i>buah aka pun</i>	fruit of treeshrew vine	<i>Rhizanthes</i> sp.	Rafflesiaceae	245
<i>buah mali</i>	difficult fruit	<i>Litsea noronhae</i> Bl.	Lauraceae	99
<i>buah tlo</i>	egg fruit	<i>Nepenthes crotchalum</i>	Sapindaceae	109
<i>bulo lan</i>	true bamboo	<i>Schizostachyum latifolium</i> Gamble	Poaceae	208
<i>bunga alo'</i>	foreign flower	<i>Chrysanthemum</i> sp.	Asteraceae	254
<i>burak</i>		<i>Eriodendron anfractuosum</i> DC.	Bombacaceae	183
<i>bute' baa'</i>	husked rice	<i>Callicarpa longifolia</i> Lam.	Verbenaceae	72
<i>daun Bakung</i>	Bakung leaf	<i>Aglaonema</i> sp.	Araceae	288
<i>dian belede'</i>	Dutch durian	<i>Annona muricata</i> L.	Annonaceae	65
<i>dian tapen</i>	boat durian	<i>Annona muricata</i> L.	Annonaceae	65
<i>duling</i>	spine	<i>Cratogeomum sumatranum</i> (Jack) Bl.	Clusiaceae	14
<i>durle</i>	aster vine	<i>Casuarina borneensis</i> Merr.	Flacourtiaceae	34
<i>embeng</i>		<i>Emilia sonchifolia</i> (L.) DC.	Asteraceae	167
<i>embeng aka</i>		<i>Blumea pubigera</i> (L.) Merr. (var. 2)	Asteraceae	262
<i>embeng kesa'</i>	loo daisy	<i>Elephantopus scaber</i> L.	Asteraceae	256
<i>embeng pasa pen</i>		<i>Blumea balsamifera</i> (L.) DC.	Asteraceae	51
<i>enep</i>		<i>Albizia chinensis</i> (Osbeck) Merr.	Fabaceae	108
<i>geaf</i>		<i>Pinanga coronata</i> Bl.	Araceae	220

## Appendix 3.2. continued

Kenyah name <sup>a</sup>	English translation	Scientific name	Family	VN <sup>b</sup>
gaharu		<i>Aquilaria beccariana</i> van Tiegh.	Thymelaeaceae	112
iyeng		<i>Miscanthus floridulus</i> (Labiil.)	Poaceae	215
jako Kenyah	Kenyah tobacco	<i>Nicotiana tabacum</i> L.	Solanaceae	221
jangkang iyap	chicken toes	<i>Schefflera</i> cf., <i>oblongifolia</i> Merr.	Araliaceae	182
jela bung-bung	spotted tongue	<i>Macaranga gigantea</i> Muell.-Arg.	Euphorbiaceae	118
jefe'fatung; pakat jalei		<i>Coxi lacryma-jobi</i> L.	Poaceae	89
jelmutin empak'	primary forest jelemutin	<i>Astronia macrophylla</i> Bl. Bujdr.	Melastomataceae	146
jelmutin; jemutin		<i>Melastoma malabathricum</i> L.	Melastomataceae	20
kayu a'io'		<i>Scyphostegia borneensis</i> Stapf	Scyphostegiaceae	98
kayu aplek		<i>Aglala</i> sp.	Meliaceae	187
kayu ba'o lung		<i>Cinnamomum</i> sp. 2	Lauraceae	290
kayu batu	stone wood	<i>Fagraea racemosa</i> Jack (ex Wall.)	Loganiaceae	7
kayu be'kua		<i>Justicia gendarussa</i> Burm.f.	Acanthaceae	119
kayu besuk		<i>Syzygium</i> cf., <i>confertum</i> (Korth.) Merr. & Perry	Myrtaceae	10
kayu beta		<i>Parkia speciosa</i> Roxb.	Fabaceae	133
kayu betao'		<i>Calophyllum biflorum</i> M.L. Henderson & Wyatt-Smith	Clusiaceae	144
kayu bisit; bichit		<i>Drimys piperita</i> Hook.f.	Winteraceae	90
kayu buah ale'		<i>Saraca declinata</i> (Jack) Miq.	Fabaceae	196
kayu juping		<i>Garuga</i> sp.	Burseraceae	236
Kayu kelele lan	true kelele tree	<i>Trigonopleura malayana</i> Hook.f.	Euphorbiaceae	139
kayu kelelingan	oily water wood	<i>Diospyros borneensis</i> Hiern	Ebenaceae	121
kayu luk		<i>Aglala</i> sp.	Meliaceae	187
kayu nyelubang		<i>Leea</i> cf., <i>indica</i> (Burm.f.) Merr.	Leeaceae	180
kayu pela'	hollow tree	<i>Homalanthus populneus</i> (Geisel.) Pax	Euphorbiaceae	33
kayu pute'	white wood	<i>Palaquium calophyllum</i> (Tesyms.)	Sapotaceae	143
kayu sa'ong	hat tree	<i>Neonauclea calycina</i> (Bartl. ex DC.)	Rubiaceae	42
kayu sekau		<i>Aquilaria beccariana</i> van Tiegh.	Thymelaeaceae	112
kayu te pa'ei		<i>Leucosyke alba</i> Zoll. & Mor.	Urticaceae	102
kayu te'pakun		<i>Garcinia</i> sp.	Clusiaceae	164
kayu tengat	taboo tree	<i>Helicopsis artocarpoides</i> Elm.	Proteaceae	77
kayu tuwe'		<i>Calophyllum spectabile</i> Willd.	Clusiaceae	140

## Appendix 3.2. continued

Kenyah name <sup>a</sup>	English translation	Scientific name	Family	VN <sup>b</sup>
kayu ujan	rain tree	<i>Ananas comosus</i> (L.) Merr.	Bromeliaceae	243
keladi	coconut	<i>Colocasia esculenta</i> (L.) Schott	Araceae	94
kelapa	forest kelembunyo	<i>Cocos nucifera</i> L.	Araceae	249
kelembunyo bai'	tens (of fruit)	<i>Melodorum</i> aff. <i>kenfilii</i> Hook f. & Thoms.	Annonaceae	184
kelepulo'	moon eggplant	<i>Medinilla crassifolia</i> (Bl.) Bl.	Melastomataceae	19
kelungaung bulan	forest kerapat	<i>Solanum</i> cf., <i>melongena</i> L.	Solanaceae	207
kepfung	arrow leaf	undetermined (land crab)	Crustacean	255
kerapat bai	tears	<i>Alpinia mutica</i> Roxb.	Zingiberaceae	179
kupel	thick-spined porcupine	<i>Leersia hexandra</i> Swartz	Poaceae	122
la'lung		<i>Colocasia esculenta</i> (L.) Schott	Araceae	94
labu		<i>Cucumis</i> cf., <i>sativa</i> L.	Cucurbitaceae	301
lamel		<i>Etilingera</i> sp. 1	Zingiberaceae	1
landa'		<i>Thecurus crassispinis</i>	Hystrioidae	246
lempa' pisa'		<i>Curculigo</i> sp.	Liliaceae	46
lemulang		<i>Cinnamomum</i> sp. 1	Lauraceae	211
lengeset		<i>Aglaia dookoo</i> Griff.	Meliaceae	30
lengiden		<i>Ilex</i> sp.	Aquifoliaceae	83
lesayat		<i>Sesamum indicum</i> L.	Pedaliaceae	278
lia afok	foreign spice	<i>Capsicum frutescens</i> L.	Solanaceae	205
lia buke' borak	fermented rice spice	<i>Alpinia galanga</i> (L.) Sw.	Zingiberaceae	61
lia bukei salok		<i>Zingiber cassumunar</i> Rosc.	Zingiberaceae	219
lia bunglei	Lei's ginger	<i>Hedychium</i> sp.	Zingiberaceae	62
lia mit pute'	yellow and white spice	<i>Curcuma longa</i> L.	Zingiberaceae	60
lia mit tuning	yellow rubbing ginger	<i>Etilingera</i> sp. 4	Zingiberaceae	63
lia nyalau	nyalau Spicer	<i>Kaempferia galanga</i> L.	Zingiberaceae	57
lia sukeng	repellant ginger	<i>Zingiber officinale</i> Rosc.	Zingiberaceae	64
lia ubat	medicine spice	Undetermined sp.	Zingiberaceae	59
limau	aromatic arrow-leaf	<i>Citrus</i> cf., <i>aurantium</i> L.	Rutaceae	248
lung adek	red arrow-leaf	<i>Homalomena humilis</i> (Jack) Hook.f.	Araceae	150
lung balu	green arrow-leaf	<i>Homalomena rubra</i> Hassk. (var. 1)	Araceae	43
lung bileng		<i>Homalomena rubra</i> Hassk. (var. 2)	Araceae	251

## Appendix 3.2. continued

Kenyah name <sup>a</sup>	English translation	Scientific name	Family	VN <sup>b</sup>
mali		<i>Litsea aff. robusta</i> Bl.	Lauraceae	224
manjan	papaya	<i>Carica papaya</i> L.	Caricaceae	185
namam lan	irue branching fem	<i>Dicranopteris linearis</i> (Burm.f.) Underw.	Gleicheniaceae	12
njau lutung	dried njau	<i>Alstonia scholaris</i> (L.) R.Br.	Apocynaceae	188
nyending		<i>Ellingera eliator</i> (Jack) R.M. Smith	Zingiberaceae	40
padi		<i>Smilax barbata</i> Wall.	Smilacaceae	92
pakat jalei		<i>Coix lacryma-jobi</i> L.	Poaceae	89
paku denum	follower fem	<i>Diplazium</i> sp.	Thelypteridaceae	28
paku julut	bitter fem	<i>Nephrolepis biserrata</i> Schott	Polyodiaceae	25
paku pahit	barking deer fem	<i>Thelypteris unita</i>	Thelypteridaceae	27
paku telao	tiger steam	<i>Blechnum orientale</i> L.	Polyodiaceae	87
panyap lenjau	teras (seasoning) wood	<i>Dysophylla auricularia</i> Bl.	Lamiaceae	127
payang kayu	grandparent Luan	<i>Macaranga</i> sp.	Euphorbiaceae	147
pe Luan		<i>Costus speciosus</i> (Koenig) Smith	Zingiberaceae	104
pei		<i>Dendrocnide stimulans</i> (L.f.) Chew	Urticaceae	11
penaggeng		<i>Sida rhombifolia</i> L.	Malvaceae	17
penganen langau	weeping herb	<i>Lycopodium cernuum</i> L.	Lycopodiaceae	80
petee	banana	<i>Musa</i> spp.	Musaceae	244
pidang pelaki	hawk raspberry	<i>Rubus moluccanus</i> L.	Rosaceae	3
pidang tanjung	cape raspberry	<i>Passiflora foetida</i> L.	Passifloraceae	216
puang		<i>Schefflera</i> cf. <i>oblongifolia</i> Merr.	Araliaceae	182
punyang	white pig	<i>Musa borneensis</i> Becc.	Musaceae	53
puto babui	giant squirrel	<i>Palaquium calophyllum</i> (Tesy.)	Sapotaceae	143
saniangan	spine	<i>Ratufa affinis</i>	Sciuridae	247
safa		<i>Casearia borneensis</i> Merr.	Flacourtiaceae	34
sawan	snail	<i>Musa borneensis</i> Becc.	Musaceae	53
seh	forest sekiput	undetermined (snail)	Unknown	299
sekipui bai	wrapped hand	<i>Alpinia mutica</i> Roxb.	Zingiberaceae	179
semangkak	sprints' red dye	<i>Impatiens balsamina</i> L.	Balsaminaceae	217
semangkak bai		<i>Ludwigia hyssopifolia</i> (G. Don.f.) Exell	Onagraceae	111
simo		<i>Psidium guajava</i> L.	Myrtaceae	32

## Appendix 3.2. continued

Kenyah name <sup>a</sup>	English translation	Scientific name	Family	VN <sup>b</sup>
siput Kenyah	snail	undetermined (snail)	Unknown	299
suling julut (1)	follower flute	<i>Glochidion arborescens</i> Bl.	Euphorbiaceae	38
suling julut (2)	follower flute	<i>Glochidion</i> sp.	Euphorbiaceae	75
taban sakit ulu	medicine for headache	<i>Kalanchoe pinnata</i> (Lam.) Pers.	Crassulaceae	74
tampu	sugar root	<i>Cleistocalyx operculatus</i> (Roxb.) Merr. & Perry	Myrtaceae	191
tekaleng bekan	fallow noose poison	<i>Buddleja asiatica</i> Lour.	Loganiaceae	134
tekorak lalaut	tobacco	<i>Zingiber longipedunculatum</i> Ridley	Zingiberaceae	49
tembakau	river edge	<i>Nicotiana tabacum</i> L.	Solanaceae	221
tembalut bai		<i>Nauclea purpurascens</i> Korth.	Rubiaceae	100
tepo	(sugar cane)	<i>Homstedtia havilandii</i> (K.Schum.) K.Schum.	Zingiberaceae	5
tepu	crazy poison	<i>Saccharum officinarum</i> L.	Poaceae	298
tiking	true ginger	<i>Polygonum barbatum</i> L.	Polygonaceae	116
tite' lan		<i>Elilingera</i> cf. <i>punicea</i> Roxb.	Zingiberaceae	48
titei' telejan		<i>Homstedtia</i> sp.	Zingiberaceae	123
tuba abeng	rotting poison	<i>Croton tiglium</i> L.	Euphorbiaceae	18
tuba aka	poison vine	<i>Derris elliptica</i> (Wallich) Benth.	Fabaceae	91
tuba beriking	crazy poison	<i>Polygonum barbatum</i> L.	Polygonaceae	116
tuba jek	quick poison	<i>Pongamia pinnata</i> (L.) Merr.	Fabaceae	124
tuba kule'	tiger-spot poison	<i>Croton tiglium</i> L.	Euphorbiaceae	18
tuba palang bekan	fallow noose poison	<i>Buddleja asiatica</i> Lour.	Loganiaceae	134
tuba selabung bekan	fallow noose poison	<i>Buddleja asiatica</i> Lour.	Loganiaceae	134
tuba tuleng	earlobe poison	<i>Hydrocotyle javanica</i> Thunb.	Aptaceae	105
tuba urong	earlobe poison	<i>Hydrocotyle javanica</i> Thunb.	Aptaceae	105
tuban	epiphyte	<i>Drynaria sparsisora</i> Moore	Polypodiaceae	9
tubo bala	red tended one	<i>Globba atrosanguinea</i> T.&B.	Zingiberaceae	257
tubn sakai	welcome guest	<i>Hedychium cylindricum</i> Ridley	Zingiberaceae	29
tubo saleng	black stalk	<i>Globba</i> sp.	Zingiberaceae	135
tung noh (kayu noh)	Noh's leaf	<i>Timonius</i> sp.	Rubiaceae	37
uba tepu	sugar root	<i>Cleistocalyx operculatus</i> (Roxb.) Merr. & Perry	Myrtaceae	191
ubi abo'		<i>Manihot esculenta</i> Crantz	Euphorbiaceae	250
ubi rambat		<i>Manihot esculenta</i> Crantz	Euphorbiaceae	250

## Appendix 3.2. continued

Kenyah name <sup>a</sup>	English translation	Scientific name	Family	VN <sup>b</sup>
ubuf bele'sua	pith of thorn	<i>Zingiber longipedunculatum</i> Ridley	Zingiberaceae	49
ubuf lalyei	sharp pith	<i>Etiligera</i> sp. 3	Zingiberaceae	35
udu aka anye'	white/not white vine	<i>Anisomeles</i> sp.	Lamiaceae	229
udu aka pute' ndak	foreigner herb	<i>Ampelocissus imperialis</i> (Miq.) Bl.	Vitaceae	44
udu alok	widower's stick herb	<i>Paspalum conjugatum</i> Bergius	Poaceae	101
udu amban lumpung (1)	widower's stick herb	<i>Hyptis capitata</i> Jacq.	Lamiaceae	208
udu ampan lumbang (2)	widower's stick herb	<i>Hyptis rhomboidea</i> Mart & Gal.	Lamiaceae	8
udu bawing		undetermined	Poaceae	253
udu beluk		<i>Drymaria cordata</i> Willd.	Caryophyllaceae	86
udu berau		<i>Erigeron linifolius</i> Willd.	Asteraceae	231
udu beta'		<i>Phyllanthus niruri</i> L.	Euphorbiaceae	28
udu biak pibang	petei bean herb	<i>Alocasia longiloba</i> Miq.	Araceae	103
udu bulu pak nyao	twin-stalked arrow-leaf	<i>Orthosiphon caudatus</i>	Lamiaceae	58
udu daun telinga	cats' whisker herb	<i>Hydrocotyle javanica</i> Thunb.	Apiaceae	105
udu jela'an	earlobe leaf herb	<i>Elaphoglossum</i> sp.	Asplenaceae	45
udu kalong aka	white tongue herb	<i>Polyalthia</i> (?) sp.	Annonaceae	240
udu kedapet (1)	necklace vine herb	<i>Cyathula prostrata</i> (L.) Bl.	Amaranthaceae	66
udu kedapet (2)	love charm herb	<i>Lophatherum gracile</i> Brongn.	Poaceae	120
udu kep	stick-tight herb	<i>Cassia alata</i> L.	Fabaceae	70
udu langau	ringworm herb	<i>Oidemia verticillata</i> Korth.	Rubiaceae	98
udu langau	mosquito weed	<i>Plectranthus scutellaroides</i> (L.) R.Br.	Lamiaceae	6
udu lekahan	mosquito herb	<i>Premna glandulosa</i> Merr. (var. 1)	Verbenaceae	23
udu lekahan		<i>Premna glandulosa</i> Merr. (var. 2)	Verbenaceae	36
udu lurun		<i>Emilia sonchifolia</i> (L.) DC.	Asteraceae	167
udu mudung bio'	big mountain herb	<i>Labisia pumila</i> Benth. & Hook.f.	Myrsinaceae	78
udu ngeau	cat herb	<i>Plectranthus scutellaroides</i> (L.) R.Br.	Lamiaceae	6
udu njeu lupang		<i>Urena lobata</i> L.	Malvaceae	24
udu nyalau		<i>Aneilema herbaceum</i> (Roxb.) Wall.	Commelinaceae	132
udu pebelek	sprain herb	<i>Crinum asiaticum</i> L.	Liliaceae	97
udu peñan' (2)	pox herb	<i>Spermacoce laevis</i> Lam.	Rubiaceae	108
udu peñan' (1)	pox herb	<i>Oldenlandia diffusa</i> Roxb.	Rubiaceae	50

## Appendix 3.2. continued

Kenyah name <sup>a</sup>	English translation	Scientific name	Family	VN <sup>b</sup>
udu pelien bule'	stop fever herb	<i>Desmodium</i> cf., <i>triflorum</i> (L.) DC.	Fabaceae	222
udu pendeng kayeng	snake herb	<i>Clerodendrum</i> sp.	Verbenaceae	238
udu penganen	Fairy bluebird nest herb	<i>Lycopodium</i> sp.	Lycopodiaceae	117
udu salapunei	shin-bone closing herb	<i>Cyrtandra mammillata</i> Hallier f.	Gesneriaceae	137
udu sekiput lulut (1)	shin-bone closing herb	<i>Blumea pubigera</i> (L.) Merr. (var. 1)	Asteraceae	141
udu sekiput lulut (2)	shin-bone closing herb	<i>Ampelocissus pilipes</i> Planch.	Vitaceae	41
udu selaput	sucking herb	<i>Lygodium microphyllum</i> (Willd.) Alston	Schizaeaceae	21
udu sepak		<i>Piper belfe</i> L.	Piperaceae	114
udu si'ik	new wound medicine	<i>Scleria sumatrensis</i> Retz.	Cyperaceae	129
udu taban sua	dung weed	<i>Hedyotis</i> cf., <i>sumatrana</i> Merr.	Rubiaceae	95
udu tai	white dung herb	<i>Adenostemma lavenia</i> Kuntze o.k.	Asteraceae	67
udu pute' bua	white dung herb	<i>Ageratum conyzoides</i> L.	Asteraceae	2
udu tai pute	chicken dung herb	<i>Ageratum conyzoides</i> L.	Asteraceae	2
udu tai yap	Aji's father's herb	<i>Spermacoce ocymoides</i> Burm.f.	Rubiaceae	199
udu Taman Aji	weeping herb	<i>Rourea mimosoides</i> (Vahl) Planch	Connaraceae	13
udu tange	ginger leaf herb	<i>Lycopodium cernuum</i> L.	Lycopodiaceae	80
udu tika	rattan seringan	<i>Cyperus kyllingia</i> Endl.	Cyperaceae	113
udu tung lia	rattan semule'	<i>Peristrophe bivalvis</i> (L.) Merr.	Acanthaceae	223
ulem		<i>Solanum torvum</i> Sw.	Solanaceae	214
uwaj seringan		<i>Daemonorops hallerianus</i> Becc.	Areaceae	115
uwel semule'		<i>Daemonorops periacanthus</i> Miq.	Areaceae	285
name unknown		<i>Myrmeconauclea strigosa</i> (Korth.) Merr.	Rubiaceae	204

<sup>a</sup> Major Kenyah categories of plants: aka = vine; kayu = tree, wood; tabu = cucurbit; lia = ginger (but see *Capsicum*); lung = aroid; paku = fern; tuba = poison; udu = small herb; uwai = rattan; embeng = aster. Subcategories: bunga = flower; buah = fruit; tung/daun = leaf; ube/ubi = root.

<sup>b</sup> VN=voucher number Leaman 89-

Appendix 3.3. Kenyah remedies and remedy importance values ( $IV_{remedy}$ ) by major medicinal use categories and locally defined indications

Category	Indication	Scientific name	Family	$IV_{remedy}$
1.	Gastrointestinal remedies (GI)			
	1.1. Stomachache	<i>Ageratum conyzoides</i> L.	Asteraceae	1
		<i>Alpinia galanga</i> (L.) Sw.	Zingiberaceae	2
		<i>Amomum ligulatum</i> R.M. Smith	Zingiberaceae	1
		<i>Annona muricata</i> L.	Annonaceae	1
		<i>Aquilaria beccariana</i> van Tiegh.	Thymelaeaceae	1
		<i>Astronia macrophylla</i> Bl. Blijdr.	Melastomataceae	1
		<i>Casearia borneensis</i> Merr.	Flacourtiaceae	2
		<i>Chrysanthemum</i> sp.	Asteraceae	2
		<i>Cinnamomum</i> sp. 1	Lauraceae	1
		<i>Cinnamomum</i> sp. 2	Lauraceae	1
		<i>Citrus cf., aurantium</i> L.	Rutaceae	3
		<i>Cleistocalyx operculatus</i> (Roxb.) Merr. & Pemy	Myrtaceae	1
		<i>Coix lacryma-jobi</i> L.	Poaceae	1
		<i>Etilingera</i> sp. 4	Zingiberaceae	2
		<i>Etilingera</i> sp. 1	Zingiberaceae	1
		<i>Eurycoma longifolia</i> Jack	Simarubaceae	1
		<i>Globba</i> sp.	Zingiberaceae	1
		<i>Hedychium</i> sp.	Zingiberaceae	2
		<i>Homalomena humilis</i> (Jack) Hook.f.	Araceae	1
		<i>Kadsura scandens</i> Bl. (var. 1)	Schisandraceae	1
		<i>Leucosyke alba</i> Zoll. & Mor.	Urticaceae	1
		<i>Litsea noronhae</i> Bl.	Lauraceae	1
		<i>Loranthus constrictus</i> Danser	Loranthaceae	2
		<i>Loranthus fuscus</i> Bl.	Loranthaceae	2
		<i>Melastoma malabathricum</i> L.	Melastomataceae	1
		<i>Melodorum aff. kentii</i> Hook.f. & Thoms.	Annonaceae	1
		<i>Mussaenda laxiflora</i> Merr.	Rubiaceae	1
		<i>Nicotiana tabacum</i> L.	Solanaceae	1
		<i>Oryza sativa</i> L.	Poaceae	3

Appendix 3.3. continued  
Category

Indication	Scientific name	Family	IV <sub>remedy</sub>	
Stomachache (continued)	<i>Piper arborescens</i> Miq.	Piperaceae	1	
	<i>Piper betle</i> L.	Piperaceae	1	
	<i>Piper</i> sp.	Piperaceae	1	
	<i>Piper peitatum</i> L.	Piperaceae	2	
	<i>Rhizanthus</i> sp.	Rafflesiaceae	2	
	<i>Rubus moluccanus</i> L.	Rosaceae	2	
	<i>Saraca declinata</i> (Jack) Miq.	Fabaceae	1	
	<i>Sida rhombifolia</i> L.	Malvaceae	2	
	<i>Solanum</i> cf., <i>melongena</i> L.	Solanaceae	1	
	<i>Syzygium</i> cf., <i>confertum</i> (Korth.) Merr. & Perry	Myrtaceae	2	
	<i>Thecurus crassispinis</i>	Hystriidae	4	
	undetermined (snail)	unknown	1	
	<i>Zingiber longipedunculatum</i> Ridley	Zingiberaceae	1	
	1.2. Diarrhea	<i>Amomum ligulatum</i> R.M. Smith	Zingiberaceae	1
		<i>Annona muricata</i> L.	Annonaceae	1
		<i>Astronia macrophylla</i> Bl. Bijdr.	Melastomataceae	1
		<i>Callicarpa longifolia</i> Lam.	Verbenaceae	1
		<i>Casearia borneensis</i> Merr.	Flacourtiaceae	1
		<i>Cinnamomum</i> sp. 2	Lauraceae	1
		<i>Costus speciosus</i> (Koenig) Smith	Zingiberaceae	1
<i>Ellingera</i> sp. 4		Zingiberaceae	1	
<i>Ficus</i> cf., <i>uncinulata</i> King Becc.		Moraceae	1	
<i>Homalomena rubra</i> Hassk. (var. 1)		Araceae	3	
<i>Kadsura scandens</i> Bl. (var. 1)		Schisandraceae	1	
<i>Leucosyke alba</i> Zoll. & Mor.		Urticaceae	1	
<i>Loranthus constrictus</i> Danser		Loranthaceae	2	
<i>Loranthus fuscus</i> Bl.		Loranthaceae	2	
<i>Naucllea purpurascens</i> Korth.		Rubiaceae	1	
<i>Oryza sativa</i> L.		Poaceae	1	
<i>Phyllanthus niruri</i> L.		Euphorbiaceae	2	
<i>Piper arborescens</i> Miq.		Piperaceae	1	
<i>Piper</i> sp.		Piperaceae	1	

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>
	Diarrhea (continued)	<i>Psidium guajava</i> L.	Myrtaceae	2
		<i>Saraca declinata</i> (Jack) Miq.	Fabaceae	1
		<i>Syzygium</i> cf., <i>confertum</i> (Korth.) Merr. & Perry	Myrtaceae	1
1.3.	Intestinal worms	<i>Ananas comosus</i> (L.) Merr.	Bromeliaceae	1
		<i>Carica papaya</i> L.	Caricaceae	1
		<i>Citrus</i> cf., <i>aurantium</i> L.	Rutaceae	1
		<i>Coix lacryma-jobi</i> L.	Poaceae	1
		<i>Drynaria sparsisora</i> Moore	Polypodiaceae	2
		<i>Etilingera eliator</i> (Jack) R.M. Smith	Zingiberaceae	1
		<i>Etilingera</i> sp. 3	Zingiberaceae	1
		<i>Globba</i> sp.	Zingiberaceae	1
		<i>Hornstedtia havilandii</i> (K.Schum.) K.Schum.	Zingiberaceae	4
		<i>Manihot esculenta</i> Crantz	Euphorbiaceae	3
		<i>Pinanga coronata</i> Bl.	Arecaceae	1
		<i>Piper peltatum</i> L.	Piperaceae	2
		<i>Premna glandulosa</i> Merr. (var. 1)	Verbenaceae	1
		<i>Premna glandulosa</i> Merr. (var. 2)	Verbenaceae	1
		<i>Scleria sumatrensis</i> Reiz.	Cyperaceae	1
		undetermined (snail)	Unknown	1
1.4.	Vomiting	<i>Cinnamomum</i> sp. 2	Lauraceae	1
		<i>Citrus</i> cf., <i>aurantium</i> L.	Rutaceae	1
		<i>Coix lacryma-jobi</i> L.	Poaceae	1
		<i>Oryza sativa</i> L.	Poaceae	1
		<i>Sida rhombifolia</i> L.	Malvaceae	1
		<i>Solanum</i> cf., <i>melongena</i> L.	Solanaceae	1
1.5.	Cholera	<i>Annona muricata</i> L.	Annonaceae	1
		<i>Citrus</i> cf., <i>aurantium</i> L.	Rutaceae	3
		<i>Litsea noronhae</i> Bl.	Lauraceae	3
		<i>Oryza sativa</i> L.	Poaceae	3

Appendix 3.3. continued  
Category

Indication	Scientific name	Family	IV <sub>remedy</sub>
1.6. Bloody stools	<i>Alpinia mutica</i> Roxb.	Zingiberaceae	4
	<i>Naucllea purpurascens</i> Korth.	Rubiaceae	1
	<i>Rhizanthus</i> sp.	Rafflesiaceae	2
	<i>Zingiber longipedunculatum</i> Ridley	Zingiberaceae	2
1.7. Heartburn	<i>Alpinia galanga</i> (L.) Sw.	Zingiberaceae	2
	<i>Coix lacryma-jobi</i> L.	Poaceae	1
	<i>Etilingera</i> sp. 1	Zingiberaceae	1
	<i>Piper</i> sp.	Piperaceae	1
	<i>Alpinia galanga</i> (L.) Sw.	Zingiberaceae	1
1.8. Constipation	<i>Premna glandulosa</i> Merr. (var. 1)	Verbenaceae	1
	<i>Premna glandulosa</i> Merr. (var. 2)	Verbenaceae	1
	<i>Etilingera</i> sp. 1	Zingiberaceae	1
1.9. Stimulate appetite	<i>Litsea cubeba</i> (Lour.) Pers.	Lauraceae	1
	<i>Oryza sativa</i> L.	Poaceae	1
	<i>Etilingera</i> sp. 1	Zingiberaceae	1
1.10. Jaundice	<i>Etilingera</i> sp. 3	Zingiberaceae	1
	<i>Piper</i> sp.	Piperaceae	1
1.12. Food poisoning	<i>Daemonorops hallierianus</i> Becc.	Araceae	1
	<i>Musa</i> spp.	Musaceae	1
1.13. Blood in vomit	<i>Adenostemma lavenia</i> Kuntze o.k.	Asteraceae	1
	<i>Blechnum orientale</i> L.	Polypodiaceae	2
2. Dermatological remedies (DER)	<i>Blumea pubigera</i> (L.) Merr. (var. 1)	Asteraceae	1
	<i>Blumea pubigera</i> (L.) Merr. (var. 2)	Asteraceae	1

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>
	Old wounds (continued)	<i>Capsicum frutescens</i> L.	Solanaceae	1
		<i>Cissus simplex</i> Blanco	Vitaceae	4
		<i>Curculigo</i> sp.	Liliaceae	4
		<i>Dendrocnide stimulans</i> (L.f.) Chew	Jurassicaceae	2
		<i>Elephantopus scaber</i> L.	Asteraceae	1
		<i>Erigeron linifolius</i> Willd.	Asteraceae	1
		<i>Ellingera</i> sp. 4	Zingiberaceae	1
		<i>Fagraea racemosa</i> Jack (ex Wall.)	Loganiaceae	1
		<i>Hedychium cylindricum</i> Ridley	Zingiberaceae	2
		<i>Helarctos malayanus</i>	Ursidae	1
		<i>Homalomena rubra</i> Hassk. (var. 2)	Araceae	2
		<i>Hypis rhomboidea</i> Mart & Gal.	Lamiaceae	3
		<i>Kadsura scandens</i> Bl. (var. 1)	Schisandraceae	1
		<i>Litsea noronhae</i> Bl.	Lauraceae	1
		<i>Ludwigia hyssopifolia</i> (G. Don.f.) Exell	Onagraceae	3
		<i>Melastoma malabathricum</i> L.	Melastomataceae	1
		<i>Merremia umbellata</i> (L.) Hallier f.	Convolvulaceae	1
		<i>Naucllea purpurascens</i> Korth.	Rubiaceae	1
		<i>Oldenlandia verticillata</i> Korth.	Rubiaceae	2
		<i>Peristrophe bivalvis</i> (L.) Merr.	Acanthaceae	1
		<i>Piper batle</i> L.	Piperaceae	1
		<i>Plectranthus scutellaroides</i> (L.) R.Br.	Lamiaceae	2
		<i>Saccharum officinarum</i> L.	Poaceae	1
		<i>Tacca</i> cf. <i>cristata</i> Jack	Taccaceae	1
		<i>Trichosanthes bracteata</i> Voigt	Cucurbitaceae	4
		<i>Urena lobata</i> L.	Malvaceae	2
2.2.	New wounds	<i>Ampelocissus imperialis</i> (Miq.) Bl.	Vitaceae	4
		<i>Ampelocissus pilipes</i> Planch.	Vitaceae	2
		<i>Anisomeles</i> sp.	Lamiaceae	1
		<i>Blumea pubigera</i> (L.) Merr. (var. 1)	Asteraceae	4
		<i>Blumea pubigera</i> (L.) Merr. (var. 2)	Asteraceae	4
		<i>Capsicum frutescens</i> L.	Solanaceae	3

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>
	New wounds (continued)	<i>Citrus cf., aurantium</i> L.	Rutaceae	3
		<i>Colocasia esculenta</i> (L.) Schott	Araceae	4
		<i>Dalbergia pinnata</i> (Lour.) Prain	Fabaceae	1
		<i>Dalbergia velutina</i> Benth.	Fabaceae	1
		<i>Erigeron linifolius</i> Willd.	Asteraceae	1
		<i>Ficus cf., uncinulata</i> King Becc.	Moraceae	2
		<i>Hedyotis cf., sumatrana</i> Merr.	Rubiaceae	1
		<i>Impatiens balsamina</i> L.	Balsaminaceae	4
		<i>Leea cf., indica</i> (Burm.f.) Merr.	Leeaceae	1
		<i>Lycopodium</i> sp.	Lycopodiaceae	1
		<i>Medinilla crassifolia</i> (Bl.) Bl.	Melastomataceae	3
		<i>Merremia borniensis</i> Merr.	Convolvulaceae	4
		<i>Paspalum conjugatum</i> Bergius	Poaceae	3
		<i>Plectranthus scutellaroides</i> (L.) R.Br.	Lamiaceae	1
		<i>Rourea mimosoides</i> (Vahl) Planch.	Connaraceae	2
		<i>Spermacoce ocymoides</i> Burm.f.	Rubiaceae	1
		<i>Aglaonema</i> sp.	Araceae	1
		<i>Alocasia longiloba</i> Miq.	Araceae	1
		<i>Colocasia esculenta</i> (L.) Schott	Araceae	1
		<i>Curculigo</i> sp.	Liliaceae	1
		<i>Etlingera eliator</i> (Jack) R.M. Smith	Zingiberaceae	1
		<i>Garuga</i> sp.	Burseraceae	1
		<i>Globba atrosanguinea</i> T.&B.	Zingiberaceae	1
		<i>Hedychlorum cylindricum</i> Ridley	Zingiberaceae	2
		<i>Ilex</i> sp.	Aquifoliaceae	2
		<i>Melastoma malabathricum</i> L.	Melastomataceae	1
		<i>Musa borneensis</i> Becc.	Musaceae	1
		<i>Musa</i> spp.	Musaceae	2
		<i>Pandorea pandorana</i> v. Steenis	Bignoniaceae	1
		<i>Piper arborescens</i> Miq.	Piperaceae	2
		<i>Rhaphidophora montana</i> Schott	Araceae	1
		<i>Scleria sumatrensis</i> Retz.	Cyperaceae	1
2.3.	Bites, stings			

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>		
	Bites, stings (continued)	<i>Spatholobus ferrugineus</i> Benth.	Fabaceae	4		
		<i>Trichosanthes bracteata</i> Volgt	Cucurbitaceae	1		
2.4.	Rashes	<i>Adenostemma laevnia</i> Kunize o.k.	Asteraceae	1		
		<i>Alpinia galanga</i> (L.) Sw.	Zingiberaceae	1		
		<i>Blumea pubigera</i> (L.) Merr. (var. 1)	Asteraceae	1		
		<i>Blumea pubigera</i> (L.) Merr. (var. 2)	Asteraceae	1		
		<i>Cassia alata</i> L.	Fabaceae	4		
		<i>Crafoxyllum sumatranum</i> (Jack) Bl.	Clusiaceae	1		
		<i>Daibergia pinnata</i> (Lour.) Prain	Fabaceae	1		
		<i>Ellingera</i> sp. 4	Zingiberaceae	1		
		<i>Ellingera</i> sp. 1	Zingiberaceae	1		
		<i>Helicopsis artocropoides</i> Elm.	Proteaceae	1		
		<i>Plectranthus scutellaroides</i> (L.) R.Br.	Lamiaceae	2		
		<i>Timonius</i> sp.	Rubiaceae	3		
		<i>Trigonopleura malayana</i> Hook.f.	Euphorbiaceae	1		
		2.5.	Dog mange	<i>Cassia alata</i> L.	Fabaceae	4
				<i>Ellingera eliator</i> (Jack) R.M. Smith	Zingiberaceae	1
				<i>Hoya coronaria</i> Bl.	Asclepiadaceae	2
<i>Polygonum barbatum</i> L.	Polygonaceae			1		
<i>Scyphostegia borneensis</i> Stapf	Scyphostegiaceae			4		
<i>Trigonopleura malayana</i> Hook.f.	Euphorbiaceae			1		
<i>Zingiber longipedunculatum</i> Ridley	Zingiberaceae			2		
2.7.	Burns			<i>Anellema herbaceum</i> (Roxb.) Wall.	Commelinaceae	1
		<i>Cissus simplex</i> Blanco	Vitaceae	1		
		<i>Parkia speciosa</i> Roxb.	Fabaceae	2		
		<i>Polyalthia</i> (?) sp.	Annonaceae	1		
		<i>Smilax odoratissima</i> Bl.	Smilacaceae	1		

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>			
2.8.	Dog wounds	<i>Alocasia longiloba</i> Miq.	Araceae	1			
		<i>Etilingera ellator</i> (Jack) R.M. Smith	Zingiberaceae	1			
		<i>Garcinia</i> sp.	Clusiaceae	1			
		<i>Schizostachyum latifolium</i> Gamble	Poaceae	1			
2.9.	Vitiligo	<i>Alpinia galanga</i> (L.) Sw.	Zingiberaceae	4			
		<i>Cassia alata</i> L.	Fabaceae	4			
		<i>Homalanthus populneus</i> (Gelsel.) Pax	Euphorbiaceae	4			
		<i>Hoya coronaria</i> Bl.	Asclepiadaceae	2			
		<i>Cassia alata</i> L.	Fabaceae	4			
2.10.	Ringworm	<i>Hoya coronaria</i> Bl.	Asclepiadaceae	2			
		<i>Croton tiglium</i> L.	Euphorbiaceae	1			
3.	Gynecological remedies	3.1. Postpartum weakness					
					<i>Etilingera</i> sp. 4	Zingiberaceae	1
					<i>Helarctos malayanus</i>	Ursidae	1
					<i>Homstedtia havilandii</i> (K.Schum.) K.Schum.	Zingiberaceae	4
					<i>Musa borneensis</i> Becc.	Musaceae	1
					<i>Nephrolepis biserrata</i> Schott	Polypodiaceae	3
					<i>Thelypteris unita</i>	Thelypteridaceae	3
					undetermined (land crab)	Crustacean	1
					<i>Cocos nucifera</i> L.	Areaceae	1
					<i>Pinanga coronata</i> Bl.	Areaceae	1
					<i>Zingiber cassumunar</i> Roxb.	Zingiberaceae	2
					<i>Piper arthorescens</i> Miq.	Piperaceae	1
					<i>Piper</i> sp.	Piperaceae	1
<i>Zingiber cassumunar</i> Roxb.	Zingiberaceae	2					
3.2.	Late menses, induce miscarriage						
3.3.	Labour pain						

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV remedy	
3.4.	Induce labour, deliver placenta	<i>Fagraea racemosa</i> Jack (ex Wall.)	Loganiaceae	3	
		<i>Manihot esculenta</i> Cranz	Euphorbiaceae	3	
4.	Cardio-pulmonary remedies (CAR-PUL)	4.1. Cough	<i>Adenostemma lavenia</i> Kuntze o.k.	Asteraceae	4
			<i>Costus speciosus</i> (Koenig) Smith	Zingiberaceae	1
		<i>Cyperus kyllingia</i> Endl.	Cyperaceae	4	
		<i>Impatiens balsamina</i> L.	Balsaminaceae	1	
		<i>Leersia hexandra</i> Swartz	Poaceae	4	
		<i>Oldenlandia diffusa</i> Roxb.	Rubiaceae	1	
		<i>Zingiber officinale</i> Rosc.	Zingiberaceae	1	
		4.2. Chest pain	<i>Drymaria cordata</i> Willd.	Caryophyllaceae	1
			<i>Zingiber officinale</i> Rosc.	Zingiberaceae	1
		4.3. Tuberculosis	<i>Curcuma longa</i> L.	Zingiberaceae	1
			<i>Melastoma malabathricum</i> L.	Melastomataceae	1
		4.4. Asthma	<i>Impatiens balsamina</i> L.	Balsaminaceae	1
		4.5. High blood pressure	<i>Pinanga coronata</i> Bl.	Areaceae	1
<i>Piper betle</i> L.	Piperaceae		1		
4.6. Nosebleed	<i>Callicarpa longifolia</i> Lam.	Verbenaceae	1		
	<i>Casearia borneensis</i> Merr.	Flacourtiaceae	2		
5.	Dental remedies (DEN)	5.1. Toothache	<i>Euphorbia</i>	Euphorbiaceae	1
			<i>Urtica</i>	Urticaceae	1
		<i>Asplenium</i>	Aspleniaceae	1	
		<i>Piper</i>	Piperaceae	2	

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>	
5.2.	Breath cleanser	<i>Nephrolepis biserrata</i> Schott	Polypodiaceae	1	
		<i>Piper peitatum</i> L.	Piperaceae	1	
5.3.	Tooth extraction	<i>Craoxylum sumatranum</i> (Jack) Bl.	Clusiaceae	3	
		<i>Nephtelium</i> cf. <i>cuspidatum</i> Bl.	Sapindaceae	2	
5.4.	Strengthen gums, teeth	<i>Piper betle</i> L.	Piperaceae	4	
		undetermined (snail)	Unknown	4	
5.5.	White tongue	<i>Macaranga gigantea</i> Muell.-Arg.	Euphorbiaceae	1	
5.6.	Mouth sores	<i>Elaphoglossum</i> sp.	Aspleniaceae	1	
6.	Eye remedies (EYE)	6.1. Human eye infections	<i>Adenostemma lavenia</i> Kuntze o.k.	Asteraceae	1
			<i>Coix lacryma-jobi</i> L.	Poaceae	1
			<i>Eclingera eliator</i> (Jack) R.M. Smith	Zingiberaceae	1
			<i>Hedychium cylindricum</i> Ridley	Zingiberaceae	2
			<i>Tetracera scandens</i> Merr.	Dilleniaceae	1
			6.2. Poultry eye infections	<i>Adenostemma lavenia</i> Kuntze o.k.	Asteraceae
	<i>Cyathula prostrata</i> (L.) Bl.	Amaranthaceae	2		
6.3.	Eye injuries	<i>Dicranopteris linearis</i> (Burm.f.) Underw.	Gleicheniaceae	2	
		<i>Tetracera scandens</i> Merr.	Dilleniaceae	1	
7.	Tonics (GEN)	7.1. Tiredness, weakness	<i>Blumea balsamifera</i> (L.) DC.	Asteraceae	2
			<i>Casearia borneensis</i> Merr.	Flacourtiaceae	2
			<i>Curcuma longa</i> L.	Zingiberaceae	1

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>
	Tiredness, weakness (continued)	<i>Hedychium</i> sp.	Zingiberaceae	2
		<i>Leucosyke alba</i> Zoll. & Mor.	Urticaceae	1
		<i>Litsea cubeba</i> (Lour.) Pers.	Lauraceae	1
		<i>Maesa ramentacea</i> (Roxb.) A. DC.	Myrsinaceae	1
		<i>Miscanthus floridulus</i> (Labill.)	Poaceae	3
		<i>Nephtrolepis biserrata</i> Schott	Polypodiaceae	1
		<i>Piper peltatum</i> L.	Piperaceae	2
		<i>Thelypteris unita</i>	Thelypteridaceae	3
		<i>Zingiber officinale</i> Rosc.	Zingiberaceae	2
7.2.	Maintain youth	<i>Loranthus constrictus</i> Danser	Loranthaceae	1
		<i>Loranthus fuscus</i> Bl.	Loranthaceae	1
8.	Neurological/orthopedic (NEU/ORT)			
8.1.	Soreness, pain	<i>Alocasia longiloba</i> Miq.	Araceae	1
		<i>Ellingera</i> sp. 4	Zingiberaceae	1
		<i>Hedychium</i> sp.	Zingiberaceae	2
		<i>Helarctos malayanus</i>	Ursidae	1
		<i>Hornstedtia</i> sp.	Zingiberaceae	4
		<i>Litsea</i> aff. <i>robusta</i> Bl.	Lauraceae	1
		<i>Litsea noronhae</i> Bl.	Lauraceae	1
		<i>Orthosiphon caudatus</i>	Lamiaceae	1
		undetermined sp.	Poaceae	1
		<i>Zingiber officinale</i> Rosc.	Zingiberaceae	3
8.2.	Stimulant	<i>Daemonorops periacanthus</i> Miq.	Araceae	2
		<i>Helarctos malayanus</i>	Ursidae	1
		<i>Nicotiana tabacum</i> L.	Solanaceae	4
		<i>Pinanga coronata</i> Bl.	Areaceae	4
		<i>Piper betle</i> L.	Piperaceae	4
		<i>Trigonoptera malayana</i> Hook.f.	Euphorbiaceae	4
		undetermined (snail)	Unknown	4

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>		
8.3.	Bruises, swelling	<i>Aeschynanthus elongata</i> C.B. Clarke	Gesneriaceae	2		
		<i>Crinum asiaticum</i> L.	Liliaceae	1		
		<i>Drynaria sparsisora</i> Moore	Polypodiaceae	2		
		<i>Fagraea racemosa</i> Jack (ex Wall.)	Loganiaceae	1		
		<i>Litsea</i> aff. <i>robusta</i> Bl.	Lauraceae	1		
8.4.	Rheumatism	<i>Aeschynanthus obconica</i> C.B. Clarke	Gesneriaceae	1		
		<i>Costus speciosus</i> (Koenig) Smith	Zingiberaceae	1		
		<i>Fagraea racemosa</i> Jack (ex Wall.)	Loganiaceae	1		
		<i>Melastoma malabathricum</i> L.	Melastomataceae	2		
		<i>Curcuma longa</i> L.	Zingiberaceae	1		
8.5.	Headache	<i>Kalanchoe pinnata</i> (Lam.) Pers.	Crassulaceae	3		
9.	Cosmetic remedies (COS)					
		9.1.	Hair, skin cleanser	<i>Elingera eliator</i> (Jack) R.M. Smith	Zingiberaceae	1
				<i>Helicopsis artocarpoides</i> Elm.	Proteaceae	1
9.2.	Air freshener	<i>Citrus</i> cf., <i>aurantium</i> L.	Rutaceae	3		
10.	Urinary remedies (URI)					
		10.1	Yellow urine	<i>Emilia sonchifolia</i> (L.) DC.	Asteraceae	1
				<i>Elingera</i> sp. 3	Zingiberaceae	2
10.2	Diuretic	<i>Elingera</i> cf., <i>punicea</i> Roxb.	Zingiberaceae	1		
11.	Metabolic (MET)					
		11.1.	Berberi	<i>Alpinia galanga</i> (L.) Sw.	Zingiberaceae	1
				<i>Fagraea racemosa</i> Jack (ex Wall.)	Loganiaceae	1
		<i>Glochidion arborescens</i> Bl.	Euphorbiaceae	2		

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>
	Beriberi (continued)	<i>Glochidion</i> sp.	Euphorbiaceae	1
		<i>Neonauclea calycina</i> (Bartl. ex DC.)	Rubiaceae	2
		<i>Oryza sativa</i> L.	Poaceae	1
		<i>Pinanga coronata</i> Bl.	Arecaceae	2
11.2.	Vitamins	<i>Etlingera</i> cf., <i>punicea</i> Roxb.	Zingiberaceae	1
		<i>Uncaria cordata</i> (Lour.) Merr.	Rubiaceae	2
		<i>Zingiber longipedunculatum</i> Ridley	Zingiberaceae	1
11.3.	Diabetes	<i>Phyllanthus niruri</i> L.	Euphorbiaceae	2
11.4.	Weight gain	<i>Solanum torvum</i> Sw.	Solanaceae	2
12.	Systemic remedies (SYS)			
12.1.	Fevers	<i>Ageratum conyzoides</i> L.	Asteraceae	3
		<i>Astronia macrophylla</i> Bl. Bijdr.	Melastomataceae	1
		<i>Eriodendron anfractuosum</i> DC.	Bombacaceae	4
		<i>Clerodendrum</i> sp.	Verbenaceae	1
		<i>Cyrtandra mammillata</i> Hallier f.	Gesneriaceae	1
		<i>Diosphylla auricularia</i> Bl.	Lamiaceae	1
		<i>Elephantopus scaber</i> L.	Asteraceae	1
		<i>Eurycoma longifolia</i> Jack	Simarubaceae	1
		<i>Hydrocotyle javanica</i> Thunb.	Apiaceae	1
		<i>Kaempferia galanga</i> L.	Zingiberaceae	2
		<i>Litsea cubeba</i> (Lour.) Pers.	Lauraceae	4
		<i>Lophatherum gracile</i> Brongn.	Poaceae	1
		<i>Lygodium microphyllum</i> (Willd.) Alston	Schizaeaceae	3
		<i>Maesa ramentacea</i> (Roxb.) A. DC.	Myrsinaceae	1
		<i>Nauclea purpurascens</i> Korth.	Rubiaceae	1
		<i>Phyllanthus niruri</i> L.	Euphorbiaceae	1
		<i>Piper betle</i> L.	Piperaceae	1
		<i>Schefflera</i> cf., <i>oblongifolia</i> Merr.	Araliaceae	4

Appendix 3.3. continued  
Category

Indication	Scientific name	Family	IV <sub>remedy</sub>	
Fevers (continued)	undetermined sp.	Zingiberaceae	1	
	undetermined sp. (Leaman 89-X)	unknown	4	
	<i>Zingiber officinale</i> Rosc.	Zingiberaceae	3	
12.2. Malarial fever	<i>Aglaia dookoo</i> Griff.	Meilaceae	4	
	<i>Astonia scholaris</i> (L.) R.Br.	Apocynaceae	1	
	<i>Annona muricata</i> L.	Annonaceae	1	
	<i>Carica papaya</i> L.	Caricaceae	1	
	<i>Hedychium cylindricum</i> Ridley	Zingiberaceae	1	
	<i>Piper arborescens</i> Miq.	Piperaceae	2	
	<i>Piper betle</i> L.	Piperaceae	1	
	<i>Schefflera</i> cf., <i>oblongifolia</i> Merr.	Araliaceae	1	
	undetermined sp.	Zingiberaceae	1	
	undetermined sp. (Leaman 89-X)	unknown	4	
	12.3. Poxes	<i>Cyrtandra mammillata</i> Hallier f.	Gesneriaceae	1
		<i>Desmodium</i> cf., <i>triflorum</i> (L.) DC.	Fabaceae	2
		<i>Diplazium</i> sp.	Thelypteridaceae	3
		<i>Glochidion</i> sp.	Euphorbiaceae	2
<i>Homalomena humilis</i> (Jack) Hook.f.		Araceae	1	
<i>Hydrocotyle javanica</i> Thunb.		Apiaceae	2	
<i>Kadsura scandens</i> Bl. (var. 2)		Schisandraceae	4	
<i>Litsea cubeba</i> (Lour.) Pers.		Lauraceae	4	
<i>Miscanfrus floridulus</i> (Labill.)		Poaceae	3	
<i>Musa</i> spp.		Musaceae	2	
<i>Oldenlandia diffusa</i> Roxb.		Rubiaceae	2	
<i>Passiflora foetida</i> L.		Passifloraceae	1	
<i>Spermacoce laevis</i> Lam.		Rubiaceae	1	
undetermined sp. (Leaman 89-X)		unknown	4	
12.4. Enlarged spleen		<i>Blumea pubigera</i> (L.) Merr. (var. 1)	Asteraceae	1
		<i>Fagraea racemosa</i> Jack (ex Wall.)	Loganiaceae	2
		<i>Homalomena rubra</i> Hassk. (var. 1)	Araceae	1

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>
	Enlarged spleen (continued)	<i>Pothos ovatifolius</i> Engl.	Araceae	1
		<i>Premna glandulosa</i> Merr. (var. 1)	Verbenaceae	2
		<i>Premna glandulosa</i> Merr. (var. 2)	Verbenaceae	2
12.5.	Cold, chills	<i>Aquilaria beccariana</i> van Tiegh.	Thymelaeaceae	1
		<i>Eriodendron anfractuosum</i> DC.	Bombacaceae	1
		<i>Cyathula prostrata</i> (L.) Bl.	Amaranthaceae	1
		<i>Hyptis capitata</i> Jacq.	Lamiaceae	1
		<i>Lophatherum gracile</i> Brongn.	Poaceae	1
12.6.	Complex ailments	<i>Breynia</i> cf., <i>rhamnoides</i> (Retz.) Muell.-Arg.	Euphorbiaceae	1
		<i>Dalbergia pinnata</i> (Lour.) Prain	Fabaceae	1
		<i>Etiligera</i> sp. 1	Zingiberaceae	1
		<i>Myrmeconaucllea strigosa</i> (Korfh.) Merr.	Rubiaceae	1
13.	Ritual remedies (RIT)			
13.1.	Charms, amulets	<i>Aneilema herbaceum</i> (Roxb.) Wall.	Commelinaceae	1
		<i>Capsicum frutescens</i> L.	Solanaceae	1
		<i>Cinnamomum</i> sp. 1	Lauraceae	1
		<i>Helicopsis arctocarpoides</i> Elm.	Proteaceae	2
		<i>Homalomena rubra</i> Hassk. (var. 2)	Araceae	4
		<i>Labisia pumila</i> Benth. & Hook.f.	Myrsinaceae	2
		<i>Loranthus fuscus</i> Bl.	Loranthaceae	1
		<i>Mussaenda laxiflora</i> Merr.	Rubiaceae	1
		<i>Ratufa affinis</i>	Sciuridae	2
		<i>Smilax odoratissima</i> Bl.	Smilacaceae	1
13.2.	Ritual healing	<i>Aquilaria beccoriana</i> van Tiegh.	Thymelaeaceae	4
		<i>Cucumis</i> cf., <i>sativa</i> L.	Cucurbitaceae	4
		<i>Derris elliptica</i> (Wallich) Benth.	Fabaceae	4
		<i>Homalomena rubra</i> Hassk. (var. 1)	Araceae	4
		<i>Litsea cubeba</i> (Lour.) Pers.	Lauraceae	4

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>
	Ritual healing (continued)	<i>Lycopodium cernuum</i> L.	Lycopodiaceae	1
		<i>Ratufa affinis</i>	Sciuridae	4
		<i>Sesamum orientale</i> L.	Pedaliaceae	4
13.3.	Omens, augury	<i>Dendrocnide stimulans</i> (L.f.) Chew	Urticaceae	1
		<i>Dianella nemorosa</i> Lam.	Liliaceae	1
		<i>Etilingera eliator</i> (Jack) R.M. Smith	Zingiberaceae	1
		<i>Justicia gendarussa</i> Burm.f.	Acanthaceae	1
14.	Poisons (POI)			
14.1.	Piscicides (fish poisons)	<i>Aglaia</i> sp.	Meliaceae	4
		<i>Albizia chinensis</i> (Osbeck) Merr.	Fabaceae	4
		<i>Buddleja asiatica</i> Lour.	Loganiaceae	4
		<i>Calophyllum biflorum</i> M.L. Henderson & Wyatt-	Clusiaceae	4
		<i>Calophyllum soulattri</i> Burm.f.	Clusiaceae	1
		<i>Croton tiglium</i> L.	Euphorbiaceae	4
		<i>Derris elliptica</i> (Wallich) Benth.	Fabaceae	4
		<i>Diospyros borneensis</i> Hiem	Ebenaceae	4
		<i>Drimys piperita</i> Hook.f.	Winteraceae	4
		<i>Embellia ribes</i> Burm.f.	Myrsinaceae	4
		<i>Hydrocotyle javanica</i> Thunb.	Apiaceae	4
		<i>Macaranga</i> sp.	Euphorbiaceae	1
		<i>Nepenthes cripetalum</i>	Sapindaceae	1
		<i>Palaquium calophyllum</i> (Tesy.)	Sapotaceae	2
		<i>Polygonum barbatum</i> L.	Polygonaceae	4
		<i>Pongamia pinnata</i> (L.) Merr.	Fabaceae	3
		<i>Smilax barbata</i> Wail.	Smilacaceae	4
		<i>Zizyphus borneensis</i> Merr.	Rhamnaceae	1
14.2.	Repellents, insecticides	<i>Aquilaria beccariana</i> van Tiegh.	Thymelaeaceae	1
		<i>Embellia ribes</i> Burm.f.	Myrsinaceae	3
		<i>Eurycoma longifolia</i> Jack	Simarubaceae	1

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>
	Repellents, insecticides (continued)	<i>Macaranga</i> sp. <i>Nicotiana tabacum</i> L. <i>Schizostachyum latifolium</i> Gamble	Euphorbiaceae Solanaceae Poaceae	1 4 1
14.3.	Suicide	<i>Derris elliptica</i> (Wallich) Benth. <i>Pongamia pinnata</i> (L.) Merr.	Fabaceae Fabaceae	1 1
15.	Antidotes (ANT)			
15.1.	Blow-dart poison	<i>Ellingera eliator</i> (Jack) R.M. Smith <i>Parkia speciosa</i> Roxb.	Zingiberaceae Fabaceae	1 2
15.2.	Snakebite	<i>Musa</i> spp.	Musaceae	2
16.	Veterinary remedies (VET)*			
16.1.	Dog mange	<i>Cassia alata</i> L. <i>Ellingera eliator</i> (Jack) R.M. Smith <i>Hoya coronaria</i> Bl. <i>Polygonum barbatum</i> L. <i>Scyphostegia borneensis</i> Stapf <i>Trigonopleura malayana</i> Hook.f. <i>Zingiber longipedunculatum</i> Ridley	Fabaceae Zingiberaceae Asclepiadaceae Polygonaceae Scyphostegiaceae Euphorbiaceae Zingiberaceae	4 1 2 1 4 1 2
16.2.	Dog wounds	<i>Alocasia longiloba</i> Miq. <i>Ellingera eliator</i> (Jack) R.M. Smith <i>Garcinia</i> sp. <i>Schizostachyum latifolium</i> Gamble	Araceae Zingiberaceae Clusiaceae Poaceae	1 1 1 1
16.3.	Repellants	<i>Eurycoma longifolia</i> Jack <i>Macaranga</i> sp. <i>Schizostachyum latifolium</i> Gamble	Simarubaceae Euphorbiaceae Poaceae	1 1 1

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>
16.4.	Poultry eye infection	<i>Adenostemma laevifolia</i> Kuntze o.k.	Asteraceae	2
		<i>Cyathula prostrata</i> (L.) Bl.	Amaranthaceae	2
17. Pediatric remedies (PED)*	17.1. Skin rashes	<i>Etilingera</i> sp. 4	Zingiberaceae	1
		<i>Piper peltatum</i> L.	Piperaceae	2
	17.2. Stomachache	<i>Ananas comosus</i> (L.) Merr.	Bromeliaceae	1
		<i>Etilingera</i> sp. 3	Zingiberaceae	1
		<i>Piper peltatum</i> L.	Piperaceae	2
		<i>Premna glandulosa</i> Merr. (var. 1)	Verbenaceae	1
		<i>Premna glandulosa</i> Merr. (var. 2)	Verbenaceae	1
	17.3. Intestinal worms	<i>Premna glandulosa</i> Merr. (var. 1)	Verbenaceae	1
		<i>Premna glandulosa</i> Merr. (var. 2)	Verbenaceae	1
	17.4. Constipation	<i>Etilingera</i> sp. 3	Zingiberaceae	1
		<i>Clerodendrum</i> sp.	Verbenaceae	1
	17.5. Jaundice	<i>Cyrtandra mammillata</i> Hallier f.	Gesneriaceae	1
		<i>Kaempferia galanga</i> L.	Zingiberaceae	2
		<i>Litsea cubeba</i> (Lour.) Pers.	Lauraceae	4
		<i>Phyllanthus niruri</i> L.	Euphorbiaceae	1
		undetermined sp. (Leaman 89-X)	unknown	4
	17.6. Fever	<i>Hedyctium cylindricum</i> Ridley	Zingiberaceae	1
undetermined sp. (Leaman 89-X)		unknown	4	
17.7. Malarial fever	<i>Spermacoce laevis</i> Lam.	Rubiaceae	1	
	<i>Cyrtandra mammillata</i> Hallier f.	Gesneriaceae	1	
	<i>Desmodium</i> cf., <i>triflorum</i> (L.) DC.	Fabaceae	2	

Appendix 3.3. continued  
Category

Indication	Scientific name	Family	IV <sub>remedy</sub>	
Poxes (continued)	<i>Diplazium</i> sp.	Thelypteridaceae	3	
	<i>Glochidion</i> sp.	Euphorbiaceae	2	
	<i>Homalomena humilis</i> (Jack) Hook.f.	Araceae	1	
	<i>Hydrocotyle javanica</i> Thunb.	Apiaceae	2	
	<i>Kadsura scandens</i> Bl. (var. 2)	Schisandraceae	4	
	<i>Litsea cubeba</i> (Lour.) Pers.	Lauraceae	4	
	<i>Miscanthus floridulus</i> (Labill.)	Poaceae	3	
	<i>Musa</i> spp.	Musaceae	2	
	<i>Oldenlandia diffusa</i> Roxb.	Rubiaceae	2	
	<i>Passiflora foetida</i> L.	Passifloraceae	1	
	undetermined sp. (Leaman 89-X)	unknown	4	
	17.9. Enlarged spleen	<i>Homalomena rubra</i> Hassk. (var. 1)	Araceae	1
	17.10. Charms, amulets	<i>Helicopsis artocropoides</i> Elm.	Proteaceae	2
		<i>Homalomena rubra</i> Hassk. (var. 2)	Araceae	4
17.11. Ritual healing	<i>Lycopodium cernuum</i> L.	Lycopodiaceae	1	
17.12. Tuberculosis	<i>Curcuma longa</i> L.	Zingiberaceae	1	
	<i>Elingera</i> sp. 3	Zingiberaceae	2	
18. Synergistic remedies (SYN)*	18.1. Stomachache	<i>Mussaenda laxiflora</i> Merr.	1	
		<i>Oryza sativa</i> L.	3	
	18.2. Diarrhea	<i>Oryza sativa</i> L.	Poaceae	1
	18.3. Intestinal worms	<i>Elingera elliflor</i> (Jack) R.M. Smith	Zingiberaceae	1
18.4. Vomiting	<i>Oryza sativa</i> L.	Poaceae	1	

Appendix 3.3. continued

Category	Indication	Scientific name	Family	IV <sub>remedy</sub>
	18.5. Cholera	<i>Oryza sativa</i> L.	Poaceae	3
	18.6. Stimulate appetite	<i>Oryza sativa</i> L.	Poaceae	1
	18.7. Enlarged spleen	<i>Premna glandulosa</i> Merr. (var. 1) <i>Premna glandulosa</i> Merr. (var. 2)	Verbenaceae Verbenaceae	2 2
	18.8. Beriberi	<i>Oryza sativa</i> L.	Poaceae	1

#### Appendix 3.4. Account of a Kenyah healing ceremony

The current status of use of traditional remedies among the Kenyah today is illustrated by the following example. A man about 25 years old at the time of the study, Taman K, became ill while on a hunting expedition to the forests near the site of a former Uma' Tukung Kenyah village at Sungai Jemahang. The principal symptoms were an incapacitating headache, partial loss of vision, and loss of appetite. There had been no obvious event while in the forest to precipitate these symptoms, thus some members of the hunting party were immediately concerned that there had been some offense given to an ancestral spirit lurking around the old village site, that had breached a taboo, or even that some sort of curse had been laid, as Taman K's social standing in the community often put him in situations of settling scores between family units. Taman K's friends carried him back to Long Sungai Barang by boat on a stretcher fabricated on the spot from bamboo poles and a plastic tarpaulin. Upon arriving at home, Taman K took aspirin tablets and went to bed. He repeated this treatment for two days, with no improvement. On the third day, he consulted the mantri obat, who had no medicine but wanted to charge him a small fee for the house call. He was refused. After 5 days, Taman K himself began to suspect some extraordinary cause (a suggestion he had resisted since, because of his social position and the high standing of his family, a demonstration of belief in adat lama would have been a poor example for the community). A strong and energetic young man, a few days of his illness had made him look weak, pale, and many years older. His family sent for two spirit healers from Lidung Payau, a husband and wife team, both about 60 years old. Meanwhile, Taman K requested, and received from me a tablet of a prescription migraine remedy (cafergot), which I had offered to him a few days earlier. After swallowing the tablet, Taman K told me that the

healers were coming and invited me to observe their treatment.

The healers arrived in the late afternoon and ate with the family, except for Taman K, who remained in bed. In the evening, a lay brother from the Catholic church arrived, along with a few of the village elders, and they sat in the main room of the house conversing quietly until dark. At dark the shutters of the main room were closed as usual, and an oil lamp lit and placed in the centre of the room. In the adjoining bedroom, family members helped Taman K rise from his bed, seated him on a low stool, and wrapped him in a blanket. The female healer took a packet from her *banyet* (a woven rattan sack carried on the back), unwrapped nine small parcels containing seeds, bark, and other materials as follows:

Rhizome of *lung bala* (*Homalomena rubra* Hassk. var. 1, Araceae); seeds of two undetermined species of *labu* (*Cucurbita* spp., Cucurbitaceae) cultivated for food; bark of *tuba aka* (*Derris elliptica* (Wallich) Benth., Fabaceae); dried fruits of *beleng la'* (*Litsea cubeba* (Lour.) Pers., Lauraceae); seeds of *lesayat* (*Sesamum indicum* L., Pedaliaceae); diseased heartwood of *kayu sekau/gaharu* (*Aquilaria beccariana* van Tiegh., Thymelaeaceae); fur of *sanangan* (*Ratufa affinis*, Sciuridae); and resin from an unidentified species of tree.

The healer arranged small amounts from each parcel on a small tray. The lay brother extracted a plastic bottle in the shape of the Virgin Mary from his jacket pocket, and sprinkled holy water from it onto the tray. The female healer then placed the oil lamp below Taman K's stool, and dropped pinches of the material on the tray into the flame, allowing the smoke (*siap*) to rise into the blanket. Taman K perspired heavily under the blanket. When the material on

the tray had all been burnt, Taman K's wife helped him back into bed.

While the herbs were being burnt, the rest of us sat in the darkened main room. The elders chatted with the healer and the lay brother about various events of interest in Long Sungai Barang. When Taman K had returned to bed, the healer began a long chant; simultaneously the lay brother said a long Catholic prayer aloud, and others in the room participated in one or the other or both, or continued chatting about unrelated events. After about 15 minutes, everyone was silent, then said goodnight and went home. The healer collected their banyet and went to sleep in the house of a relative in the village. In the morning, Taman K's headache was gone, and he looked extremely well.

**Appendix 4.1. Non-malaria remedy extracts used as controls in *Plasmodium falciparum* and human epidermoid carcinoma (KB) assays**

The following remedies used for ailments other than malaria by the Kenyah of the Apo Kayan were sampled for comparison with malaria remedies in the *Plasmodium falciparum* and KB cell assays. The format here is: scientific name/family/Kenyah name/herbarium specimens/part used: medicinal or other use.

*Ageratum conyzoides* L./Asteraceae/udu tai/JTA & RY 92-6  
UO/leaves, stems: fever, stomachache, wounds.

*Albizia chinensis* (Osbeck) Merr./Fabaceae/enep/JTA & RY 92-6  
UO/ bark: fish poison.

*Dianella nemorosa* Lam. (cf. *D. ensifolia* L.  
Redouté)/Liliaceae/ bete'/JTA & RY 92-7 UO/whole plant:  
ritual.

*Diospyros borneensis* Hiern/Ebenaceae/kayu kelelingan/HS &  
DJL 92-8 UO/leaves: fish poison.

*Etilingera eliator* (Jack) R.M. Smith (formerly *Nicolaia eliator* (Jack) Rosc.; *N. speciosa*  
Horan)/Zingiberaceae/nyanding/HS & DJL 92-9 UO/fruit:  
insect stings, dog mange, dart poison antidote,  
anthelmintic; stalk: eye infections, ritual.

*Etilingera* sp. 1/Zingiberaceae/lamei/HS & DJL 92-10 UO/buds:  
stomachache, heartburn, appetite stimulant, insect  
stings, and as tonic to treat a condition (ya'a tudep,  
"very difficult") the symptoms of which are paleness  
and jaundice; stalk: not used.

*Homalomena pendula* (Bl.) Bakh.f./Araceae/JTA & RY 92-8  
UO/not used by Kenyah.

*Leucosyke alba* Zoll. & Mor./Urticaceae/kayu te pa'ei/HS &  
DJL 92-11 UO/leaves, bark: fatigue, stomachache,  
diarrhea.

*Parkia speciosa* Hassk. (cf. *roxburghii*)/Fabaceae/kayu  
beta/JTA & RY 92-9 UO/bark: burns; leaves: dart poison  
antidote.

*Plectranthus scutellaroides* (L.) R. Br./Lamiaceae/udu  
langau, udu ngeau/JTA & RY 92-10 UO/leaves: rashes,  
wounds.

*Pongamia pinnata* (L.) Merr./Fabaceae/tuba jek/JTA & RY 92-11  
UO/roots: fish poison; stem: not used by Kenyah.

*Smilax barbata* Wall./Smilacaceae/padi/HS & DJL 92-12  
UO/rhizome: fish poison.

Appendix 5.1. Selection frequency and remedy importance value ( $IV_{remedy}$ ) of plant parts used in Kenyah remedies

Plant part	No. spp.	Sel. Freq. <sup>a</sup>	No. remedies	Sel. Freq. <sup>b</sup>	Mean $IV_{remedy}$ <sup>c</sup>	+ S.E. <sup>d</sup>
Leaf	124	0.61	229	0.54	3.2	+ 0.2
Stem	58	0.29	100	0.23	2.8	+ 0.2
Bark	25	0.12	40	0.09	3.1	+ 0.4
Wood	5	0.02	10	0.02	3.2	+ 0.9
Sap	12	0.06	14	0.03	1.8	+ 0.3
Fruit	15	0.07	34	0.08	3.8	+ 1.0
Flower	5	0.02	10	0.02	2.8	+ 0.7
Seed	9	0.04	21	0.05	4.4	+ 0.8
Root	22	0.11	37	0.09	2.0	+ 0.2
Rhizome	24	0.12	60	0.14	4.1	+ 0.5
All aerial parts	13	0.06	16	0.04	2.3	+ 0.4

<sup>a</sup> Total number of medicinal species = 203.

<sup>b</sup> Total number of remedies = 438. Mean  $IV_{remedy}$  for some plant parts exceeds maximum  $IV_{remedy}$  (=4) because some remedies require more than one part.

<sup>c</sup> Mean of remedy importance values for parts used medicinally.

<sup>d</sup> Standard error of the mean.

Appendix 5.2. Biological activity according to plant parts in the medicinally used and non-medicinal Apo Kayan flora

Plant part	Larvicidal				Biological activity*				Phototoxic	
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
<i>I. Medicinal - part used active</i>										
leaf	29	85	0.34	9	89	0.10	1	72	0.01	
stem	4	29	0.14	3	31	0.10	0	30	0.00	
bark	9	21	0.43	3	20	0.15	0	18	0.00	
wood	0	2	0.00	1	3	0.33	1	3	0.33	
sap	1	2	0.50	0	1	0.00	0	1	0.00	
fruit	6	9	0.67	1	7	0.14	0	7	0.00	
flower	0	4	0.00	2	6	0.33	1	3	0.33	
seed	1	1	1.00	0	1	0.00	0	1	0.00	
root	2	9	0.22	1	10	0.10	0	9	0.00	
rhizome	2	18	0.11	4	18	0.22	0	14	0.00	
<i>II. Medicinal - part active not used</i>										
leaf	9	47	0.19	2	43	0.05	1	37	0.03	
stem	8	43	0.19	5	48	0.10	2	42	0.05	
bark	7	21	0.33	4	20	0.20	2	17	0.12	
wood	0	2	0.00	1	2	0.50	0	2	0.00	
sap	0	0	nt	0	0	nt	0	0	nt	
fruit	7	12	0.58	2	13	0.15	0	12	0.00	
flower	9	36	0.25	1	48	0.02	3	46	0.07	
seed	0	1	0.00	1	2	0.50	0	2	0.00	
root	4	46	0.09	5	59	0.08	0	54	0.00	
rhizome	2	8	0.25	0	8	0.00	0	7	0.00	

Appendix 5.2. continued

Plant part	Larvicidal			Biological activity <sup>a</sup>			Phototoxic		
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
<b>III. Non-medicinal controls</b>									
leaf	14	32	0.44	1	35	0.03	0	25	0.00
stem	0	2	0.00	1	6	0.17	0	6	0.00
bark	13	25	0.52	0	25	0.00	0	17	0.00
wood	1	2	0.50	0	2	0.00	0	1	0.00
sap	0	0	nt	0	0	nt	0	0	nt
fruit	0	0	nt	0	3	0.00	0	2	0.00
flower	1	4	0.25	0	8	0.00	0	8	0.00
seed	0	0	nt	0	0	nt	0	0	nt
root	0	4	0.00	0	7	0.00	0	6	0.00
rhizome	0	1	1.00	0	1	0.00	1	1	1.00

<sup>a</sup> Larvicidal=toxicity to brine shrimp (*Artemia salina* Leach) nauplii, LD<sub>50</sub> < 10<sup>4</sup> ppm. Antifungal=inhibition of brewer's yeast (*Saccharomyces cerevisiae*). Phototoxic=light-activated inhibition of brewer's yeast. nt=not tested.

Appendix 5.3. Selection frequency and species importance value ( $IV_{\text{species}}$ ) of plant life forms used in Kenyah remedies

Plant life form	No. spp.	Sel. Freq. <sup>a</sup>	Mean $IV_{\text{species}}$ <sup>b</sup> ± S.E. <sup>c</sup>
Herb	79	0.39	3.6 ± 0.3
Epiphyte/ parasite	5	0.02	5.2 ± 0.6
Vine	45	0.22	3.4 ± 0.4
Shrub	18	0.09	4.1 ± 0.9
Tree	56	0.28	3.6 ± 0.4

<sup>a</sup> Total number of medicinal species = 203.

<sup>b</sup> Species importance value = sum of remedy importance values for each species.

<sup>c</sup> Standard error of the mean.

Appendix 5.4. Biological activity according to life form in the medicinally used and non-medicinal Apo Kayan flora

Plant life form	Larvicidal <sup>a</sup>			Biological activity			Phototoxic <sup>c</sup>		
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
<b>I. Medicinal - part used active</b>									
Herb	8	53	0.15	7	49	0.14	0	44	0.00
Epiphyte/ parasite	0	5	0.00	1	5	0.20	0	4	0.00
Vine	16	28	0.57	5	24	0.21	1	23	0.04
Shrub	7	10	0.70	0	9	0.00	2	7	0.29
Tree	25	42	0.60	6	36	0.17	1	31	0.03
<b>II. Medicinal - part active not used</b>									
Herb	7	53	0.13	2	49	0.04	1	44	0.02
Epiphyte/ parasite	0	5	0.00	0	5	0.00	0	4	0.00
Vine	1	28	0.04	0	24	0.00	0	23	0.00
Shrub	1	10	0.10	0	9	0.00	1	7	0.14
Tree	1	42	0.02	2	36	0.06	2	31	0.06
<b>III. Non-medicinal controls</b>									
Herb	0	6	0.00	1	6	0.17	1	6	0.17
Epiphyte/ parasite	0	0	nt	0	0	nt	0	0	nt
Vine	1	1	1.00	0	1	0.00	0	0	nt
Shrub	1	1	1.00	0	1	0.00	0	1	0.00
Tree	18	27	0.67	1	27	0.04	0	17	0.00

<sup>a</sup> Toxicity to brine shrimp (*Artemia salina* Leach) nauplii, LD<sub>50</sub> < 10<sup>4</sup> ppm.

<sup>b</sup> Inhibition of brewer's yeast (*Saccharomyces cerevisiae*).

<sup>c</sup> Light-activated inhibition of brewer's yeast.

Appendix 5.5. Selection frequency and medicinal importance value (mean  $IV_{species}$ ) of habitats in the Apo Kayan flora

Habitat <sup>a</sup>	Kenyah	Age class (years)	No. spp.	Sel. Freq. <sup>b</sup>	Mean $IV_{species}$ <sup>c</sup> ± S.E. <sup>d</sup>
Disturbed site/old field (DS)	bekan	0-4	43	0.21	3.0 ± 0.4
Disturbed site/young secondary forest (DS/YSF)	-	0-25	7	0.03	3.6 ± 0.6
Young secondary forest/open thicket (YSF)	jekau metan	5-25	38	0.19	4.3 ± 0.5
Young and mature secondary forest (YSF/MSF)	jekau lan	5-50	1	<0.01	2.0 ± 0.0
Mature secondary forest (MSF)	jekau bele'	25-50	57	0.28	3.2 ± 0.3
Mature secondary forest/primary forest (MSF/PF)	-	25-50+	28	0.14	3.9 ± 0.4
Primary forest/old forest (PF)	empa'	50+	2	0.01	4.0 ± 0.0
Ubiquitous (DS-PF)	-	0-50+	2	0.01	1.5 ± 0.5

<sup>a</sup> Habitat age classes based on Kenyah definitions of forest type.

<sup>b</sup> Total number of medicinal species = 203

<sup>c</sup> Species importance value = sum of remedy importance values for each species.

<sup>d</sup> Standard error of the mean.

Appendix 5.6. Biological activity according to habitat (age class) in the medicinally used and non-medicinal Apo Kayan flora

Habitat age class (yrs) <sup>a</sup>	Larvicidal			Antifungal			Phototoxic		
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
<b>I. Medicinal - part used active</b>									
DS (0-4)	2	29	0.07	4	27	0.00	1	27	0.04
DS/YSF (0-25)	3	7	0.43	0	6	0.00	0	5	0.00
YSF (5-24)	10	30	0.33	2	29	0.07	0	25	0.00
YSF/MSF (5-50)	0	1	0.00	0	1	0.00	0	0	nt
MSF (25-50)	21	34	0.62	5	27	0.19	0	24	0.00
MSF/PF (25-50+)	13	24	0.54	4	22	0.18	0	19	0.00
PF (50+)	2	2	1.00	1	2	0.50	1	2	0.50
DS-PF (0-50+)	1	1	1.00	0	1	0.00	0	1	0.00
<b>II. Medicinal - part active not used</b>									
DS (0-4)	5	29	0.17	0	27	0.00	0	27	0.00
DS/YSF (0-25)	1	7	0.14	0	6	0.00	1	5	0.20
YSF (5-24)	3	30	0.10	2	29	0.07	0	25	0.00
YSF/MSF (5-50)	0	1	0.00	0	1	0.00	0	0	nt
MSF (25-50)	1	34	0.03	2	27	0.07	2	24	0.08
MSF/PF (25-50+)	0	24	0.00	0	22	0.00	0	19	0.00
PF (50+)	0	2	0.00	0	2	0.00	1	2	0.50
DS-PF (0-50+)	0	1	0.00	0	1	0.00	0	1	0.00

Appendix 5.6. continued

Habitat age class (yrs) <sup>a</sup>	Larvicidal			Antifungal			Phototoxic		
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
<b>III. Non-medicinal controls</b>									
DS (0-4)	1	6	0.17	1	6	0.17	0	6	0.00
DS/YSF (0-25)	0	0	nt	0	0	nt	0	0	nt
YSF (5-24)	5	7	0.71	1	7	0.14	1	7	0.14
YSF/MSF (5-50)	0	0	nt	0	0	nt	0	0	nt
MSF (25-50)	5	8	0.63	0	8	0.00	0	7	0.00
MSF/PF (25-50+)	1	1	1.00	0	1	0.00	0	1	0.00
PF (50+)	7	10	0.70	0	10	0.00	0	1	0.00
DS-PF (0-50+)	1	3	0.33	0	3	0.00	0	2	0.00

<sup>a</sup> DS = disturbed site (*bekan*); DS/YSF = disturbed site/young secondary forest; YSF = young secondary forest/open thicket (*jekau metan*); YSF/MSF = young secondary forest/mature secondary forest (*jekau lan*); MSF = mature secondary forest (*jekau bele*); MSF/PF = mature secondary forest/primary forest; PF = primary forest/old forest (*empa*); DS-PF = ubiquitous.

<sup>b</sup> Larvicidal = toxicity to brine shrimp (*Artemia salina* Leach) nauplii, LD<sub>50</sub> < 104 ppm. Antifungal = inhibition of brewer's yeast (*Saccharomyces cerevisiae*). Phototoxic = light-activated inhibition of brewer's yeast. nt = not tested.

Appendix 5.7. Selection frequency and medicinal importance value (mean  $IV_{species}$ ) of superorders in the Apo Kayan medicinal flora compared with the estimated available flora of Borneo

Division Class Superorder <sup>a</sup>	Kenyah medicinal flora				Borneo flora		
	No. +D48 <sup>b</sup>	Sel. Freq. <sup>c</sup>	$IV_{species}$	Mean $\pm$ S.E. <sup>d</sup>	Est. no. spp. <sup>e</sup>	Regression Residual <sup>f</sup>	
Lycophyta (clubmosses)	2	0.01	1.0	$\pm$ 0.0	?		
Pterophyta (ferns)	8	0.04	3.4	$\pm$ 0.5	700	-9.4455 (-)*	
Pinophyta (gymnosperms)	0	0.00	0.0	$\pm$ 0.0	26	-0.7223 (-)	
Anthophyta (angiosperms)							
Dicotyledonae							
Annoniflorae	15	0.07	5.2	$\pm$ 1.1	261	7.7496 (+)*	
Nymphaeiflorae	0	0.00	0.0	$\pm$ 0.0	3	-0.0833 (-)	
Rafflesiflorae	1	<0.01	4.0	$\pm$ 0.0	6	0.8333 (+)	
Theiflorae	11	0.05	3.1	$\pm$ 0.5	499	-2.8618	
Violiflorae	6	0.03	3.8	$\pm$ 0.8	100	3.2221 (+)	
Malviflorae	18	0.09	3.4	$\pm$ 0.4	602	1.2769	
Santaliflorae	2	0.01	5.5	$\pm$ 0.4	78	-0.1668	
Geraniiflorae	1	<0.01	6.0	$\pm$ 0.0	52	-0.4445 (-)	
Chenopodiiflorae	2	0.01	2.0	$\pm$ 0.7	12	1.6666 (+)	
Hamamelidiflorae	0	0.00	0.0	$\pm$ 0.0	51	-1.4167 (-)	
Proteiflorae	1	<0.01	4.0	$\pm$ 0.0	1	0.9722 (+)	
Rutiflorae	18	0.09	4.4	$\pm$ 1.0	372	7.6661 (+)*	
Posiflorae	2	0.01	2.5	$\pm$ 0.4	38	0.9444 (+)	
Myrtiflorae	7	0.03	3.1	$\pm$ 0.5	304	-1.4449	
Gentianiflorae	22	0.11	2.5	$\pm$ 0.4	709	2.3045	
Solaniflorae	6	0.03	4.0	$\pm$ 1.0	44	4.7777 (+)	
Corniflorae	7	0.03	3.7	$\pm$ 0.8	105	4.0832 (+)	
Lamiiflorae	10	0.05	2.3	$\pm$ 0.5	69	8.0832 (+)*	
Asteriflorae	9	0.04	4.1	$\pm$ 0.8	38	7.9444 (+)*	
Monocotyledonae							
Liliiflorae	7	0.03	2.4	$\pm$ 0.6	767	-14.307 (-)*	
Triuridiflorae	0	0.00	0.0	$\pm$ 0.0	5	-0.1389 (-)	
Alismatiflorae	0	0.00	0.0	$\pm$ 0.0	8	-0.2222 (-)	
Ariflorae	8	0.04	3.4	$\pm$ 0.9	195	2.5831 (+)	
Areciflorae	4	0.02	3.5	$\pm$ 1.7	212	-1.8892 (-)	
Commeliniflorae	36	0.18	4.3	$\pm$ 0.5	428	24.1100 (+)*	

<sup>a</sup> Superorders follow Thorne (1981).

<sup>b</sup> Number of species used medicinally by the Kenyah.

<sup>c</sup> Frequency of superorder in the medicinal flora. Total number of medicinally used species = 203.

<sup>d</sup> Species importance value = sum of remedy importance values for each species. S.E. = standard error of the mean.

(continued on next page)

Appendix 5.7 continued

<sup>e</sup> Number of Borneo species in each superorder was estimated from Merrill (1921) for angiosperms and gymnosperms; from Copeland (1917) for pteridophytes. More recent reports of individual taxonomic groups suggest that these sources underestimate the total number of species in the Borneo flora by 40-50 % (Merrill 1921; Kiew 1984; Mat-Salleh, Beach, and Beaman 1990).

<sup>f</sup> Residual values were derived from an unweighted, least-squares linear regression of the number of Apo Kayan species used medicinally by the Kenyah against the estimated number of Borneo species per superorder ( $P=0$ ;  $r^2=0.640$ ). Residuals above or below 95% confidence intervals are over-represented (+) or under-represented (-) in the Apo Kayan medicinal flora; significant outliers (\*) exceed the standard error of the regression estimate ( $\pm 6.82$ ).

Appendix 5.8. Selection frequency and medicinal importance value (mean  $IV_{species}$ ) of families in the Apo Kayan medicinal flora compared with the estimated available flora of Borneo

Division	Class	Superorder <sup>a</sup>	Order	Family	No. spp. <sup>b</sup>	Kenyah medicinal flora Sel. Freq. <sup>c</sup>	Borneo flora Mean $IV_{species}$ ± S.E. <sup>d</sup>	Borneo flora Est. no. spp. <sup>e</sup>	Regression Residual <sup>f</sup>
Lycophyta (clubmosses)									
Lycopsidea									
Lycopodiaceae									
					2	0.010	1.0 ± 0.0	?	
Selaginellaceae									
					0	0.000	0.0 ± 0.0	?	
Pterophyta (ferns)									
Filicopsida									
Adiantaceae									
					0	0.000	0.0 ± 0.0	?	
Aspleniaceae									
					1	0.005	2.0 ± 0.0	?	
Blechnaceae									
					0	0.000	0.0 ± 0.0	?	
Davalliaceae									
					0	0.000	0.0 ± 0.0	?	
Dennstaedtiaceae									
					0	0.000	0.0 ± 0.0	?	
Gleicheniaceae									
					1	0.005	2.0 ± 0.0	10	
Polypodiaceae									
					3	0.015	3.7 ± 0.7	587	
Schizaeaceae									
					1	0.005	3.0 ± 0.0	8	
Thelypteridaceae									
					2	0.010	4.5 ± 1.1	?	
Gymnosperms									
Cycadopsida									
Cycadaceae									
					0	0.000	0.0 ± 0.0	1	-0.0188 (-)
Gnetopsida									
Gnetaceae									
					0	0.000	0.0 ± 0.0	8	-0.1508 (-)
Pinopsida									
Pinaceae									
					0	0.000	0.0 ± 0.0	6	-0.1131 (-)
Taxopsida									
Taxaceae									
					0	0.000	0.0 ± 0.0	11	-0.2073 (-)
Anthophyta (angiosperms)									
Dicotyledonae									
Annoniflorae									
Annonales									
Annonaceae									
					3	0.015	2.0 ± 0.8	54	1.9822 (+)
Aristolochiaceae									
					0	0.000	0.0 ± 0.0	6	-0.1131 (-)
Chloranthaceae									
					0	0.000	0.0 ± 0.0	2	-0.0377 (-)
Hernandiaceae									
					0	0.000	0.0 ± 0.0	1	-0.0188 (-)
Lauraceae									
					5	0.025	5.4 ± 2.0	74	3.8053 (+)*
Magnoliaceae									
					0	0.000	0.0 ± 0.0	7	-0.1319 (-)
Monimiaceae									
					0	0.000	0.0 ± 0.0	4	-0.0754 (-)
Myristicaceae									
					0	0.000	0.0 ± 0.0	37	-0.6974 (-)
Piperaceae									
					4	0.020	8.5 ± 1.9	36	3.3215 (+)*
Schisandraceae									
					2	0.010	3.5 ± 0.4	2	0.9812 (+)
Winteraceae									
					1	0.005	4.0 ± 0.0	1	0.9812 (+)

## Appendix 5.8. continued

Division							
Class							
Superorder <sup>a</sup>	Kenyah medicinal flora			Borneo flora		Regression	
Order	No.	Sel.	Mean	Est. no.	Regression		
Family	spp. <sup>b</sup>	Freq. <sup>c</sup>	$IV_{species} \pm S.E.^d$	spp. <sup>e</sup>	Residual <sup>f</sup>		
Berberidales							
Menispermaceae	0	0.000	0.0 $\pm$ 0.0	26	-0.4900 (-)		
Ranunculaceae	0	0.000	0.0 $\pm$ 0.0	4	-0.0754 (-)		
Nymphaeiflorae							
Nymphaeales							
Nymphaeaceae	0	0.000	0.0 $\pm$ 0.0	3	-0.0565 (-)		
Rafflesiflorae							
Rafflesiales							
Rafflesiaceae	1	0.005	4.0 $\pm$ 0.0	6	0.8869 (+)		
Theiflorae							
Ebenales							
Ebenaceae	1	0.005	4.0 $\pm$ 0.0	29	0.4534 (+)		
Sapotaceae	1	0.005	2.0 $\pm$ 0.0	57	-0.0743 (-)		
Styraceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)		
Ericales							
Epacridaceae	0	0.000	0.0 $\pm$ 0.0	4	-0.0754 (-)		
Ericaceae	0	0.000	0.0 $\pm$ 0.0	70	-1.3193 (-)		
Polygonales							
Polygonaceae	1	0.005	5.0 $\pm$ 0.0	7	0.8681 (+)		
Primulales							
Myrsinaceae	3	0.015	3.7 $\pm$ 1.4	81	1.4733 (+)		
Theales							
Aquifoliaceae	1	0.005	2.0 $\pm$ 0.0	16	0.6984 (+)		
Clethraceae	0	0.000	0.0 $\pm$ 0.0	2	-0.0377 (-)		
Clusiaceae	4	0.020	2.5 $\pm$ 0.8	54	2.9822 (+)*		
Dilleniaceae	1	0.005	2.0 $\pm$ 0.0	57	-0.0743		
Icacinaceae	0	0.000	0.0 $\pm$ 0.0	18	-0.3393 (-)		
Lecythidaceae	0	0.000	0.0 $\pm$ 0.0	11	-0.2073 (-)		
Nepenthaceae	0	0.000	0.0 $\pm$ 0.0	26	-0.4900 (-)		
Ochnaceae	0	0.000	0.0 $\pm$ 0.0	19	-0.3581 (-)		
Symplocaceae	0	0.000	0.0 $\pm$ 0.0	24	-0.4523 (-)		
Theaceae	0	0.000	0.0 $\pm$ 0.0	23	-0.4335 (-)		
Violiflorae							
Capparales							
Capparaceae	0	0.000	0.0 $\pm$ 0.0	5	-0.0942 (-)		
Violales							
Loganiaceae	0	0.000	0.0 $\pm$ 0.0	26	-0.4900 (-)		
Caricaceae	1	0.005	2.0 $\pm$ 0.0	1	0.9812 (+)		
Cucurbitaceae	2	0.010	4.5 $\pm$ 0.4	28	1.4723 (+)		
Datisceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)		
Flacourtiaceae	1	0.005	7.0 $\pm$ 0.0	22	0.5853 (+)		

## Appendix 5.8. continued

Division							
Class							
Superorder <sup>a</sup>							
Order	No.	Kenyah medicinal flora			Borneo flora		Regression
Family	spp. <sup>b</sup>	Sel. Freq. <sup>c</sup>	Mean IV <sub>species</sub>	± S.E. <sup>d</sup>	Est. no. spp. <sup>e</sup>	Residual <sup>f</sup>	
Passifloraceae	1	0.005	1.0	± 0.0	6	0.8869 (+)	
Scyphostegiaceae	1	0.005	4.0	± 0.0	1	0.9812 (+)	
Tumeraceae	0	0.000	0.0	± 0.0	1	-0.0188 (-)	
Violaceae	0	0.000	0.0	± 0.0	9	-0.1696 (-)	
Malviflorae							
Euphorbiales							
Dichapetalaceae	0	0.000	0.0	± 0.0	2	-0.0377 (-)	
Euphorbiaceae	10	0.040	3.6	± 0.6	195	6.3247 (+)*	
Malvales							
Bixaceae	0	0.000	0.0	± 0.0	1	-0.0188 (-)	
Bombacaceae	1	0.005	5.0	± 0.0	23	0.5665 (+)	
Dipterocarpaceae	0	0.000	0.0	± 0.0	103	-1.9413 (-)	
Elaeocarpaceae	0	0.000	0.0	± 0.0	22	-0.4147 (-)	
Malvaceae	2	0.010	2.5	± 0.4	12	1.7738 (+)	
Sterculiaceae	0	0.000	0.0	± 0.0	37	-0.6974 (-)	
Thymelaeaceae	1	0.005	7.0	± 0.0	14	0.7361 (+)	
Tiliaceae	0	0.000	0.0	± 0.0	19	-0.3581 (-)	
Rhamnales							
Rhamnaceae	1	0.005	1.0	± 0.0	5	0.9058 (+)	
Urticales							
Moraceae	1	0.005	3.0	± 0.0	116	-1.1863 (-)	
Ulmaceae	0	0.000	0.0	± 0.0	7	-0.1319 (-)	
Urticaceae	2	0.010	3.5	± 0.4	46	1.1330 (+)	
Santaliflorae							
Balanophorales							
Balanophoraceae	0	0.000	0.0	± 0.0	4	-0.0754 (-)	
Celastrales							
Celastraceae	0	0.000	0.0	± 0.0	14	-0.2639 (-)	
Santalales							
Loranthaceae	2	0.010	5.5	± 0.4	47	1.1142 (+)	
Oleaceae	0	0.000	0.0	± 0.0	7	-0.1319 (-)	
Santalaceae	0	0.000	0.0	± 0.0	6	-0.1131 (-)	
Geraniiflorae							
Geraniales							
Balsaminaceae	1	0.005	6.0	± 0.0	6	0.8869 (+)	
Erythroxylaceae	0	0.000	0.0	± 0.0	2	-0.0377 (-)	
Linaceae	0	0.000	0.0	± 0.0	5	-0.0942 (-)	
Malpighiaceae	0	0.000	0.0	± 0.0	4	-0.0754 (-)	
Oxalidaceae	0	0.000	0.0	± 0.0	10	-0.1885 (-)	
Polygalaceae	0	0.000	0.0	± 0.0	25	-0.4712 (-)	

## Appendix 5.8. continued

Division	Kenyah medicinal flora		Borneo flora		Regression
Class	No.	Sel.	Mean	Est. no.	Residual <sup>f</sup>
Superorder <sup>a</sup>	spp. <sup>b</sup>	Freq. <sup>c</sup>	$IV_{species} \pm S.E.d$	spp. <sup>e</sup>	
Order					
Family					
Chenopodiiflorae					
Chenopodiales					
Aizoaceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)
Amaranthaceae	1	0.005	3.0 $\pm$ 0.0	10	0.8115 (+)
Caryophyllaceae	1	0.005	1.0 $\pm$ 0.0	0	1.0000 (+)
Portulacaceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)
Hamamelidiflorae					
Casuarinales					
Casuarinaceae	0	0.000	0.0 $\pm$ 0.0	3	-0.0565 (-)
Fagales					
Fagaceae	0	0.000	0.0 $\pm$ 0.0	48	-0.9047 (-)
Proteiflorae					
Proteales					
Proteaceae	1	0.005	4.0 $\pm$ 0.0	1	0.9812 (+)
Rutiflorae					
Rutales					
Anacardiaceae	0	0.000	0.0 $\pm$ 0.0	34	-0.6408 (-)
Burseraceae	1	0.005	1.0 $\pm$ 0.0	24	0.5477 (+)
Connaraceae	1	0.005	2.0 $\pm$ 0.0	14	0.7361 (+)
Fabaceae	10	0.049	4.8 $\pm$ 1.3	174	6.7205 (+)*
Juglandaceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)
Meliaceae	2	0.010	4.0 $\pm$ 0.0	52	1.0199 (+)
Myricaceae	0	0.000	0.0 $\pm$ 0.0	2	-0.0377 (-)
Rutaceae	1	0.005	14.0 $\pm$ 0.0	19	0.6419 (+)
Sabiaceae	0	0.000	0.0 $\pm$ 0.0	8	-0.1508 (-)
Sapindaceae	2	0.010	1.5 $\pm$ 0.4	49	1.0765 (+)
Simaroubaceae	1	0.005	3.0 $\pm$ 0.0	3	0.9435 (+)
Rosiflorae					
Pittosporales					
Pittosporaceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)
Rosales					
Crassulaceae	1	0.005	3.0 $\pm$ 0.0	1	0.9812 (+)
Cunoniaceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)
Droseraceae	0	0.000	0.0 $\pm$ 0.0	3	-0.0565 (-)
Rosaceae	1	0.005	2.0 $\pm$ 0.0	24	0.5477 (+)
Saxifragaceae	0	0.000	0.0 $\pm$ 0.0	7	-0.1319 (-)
Staphyleaceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)
Myrtiflorae					
Myrtales					
Combretaceae	0	0.000	0.0 $\pm$ 0.0	11	-0.2073 (-)
Lythraceae	0	0.000	0.0 $\pm$ 0.0	4	-0.0754 (-)

## Appendix 5.8. continued

Division	Class	Superorder <sup>a</sup>	Order	Family	No. spp. <sup>b</sup>	Kenyah medicinal flora			Borneo flora	
						Sel. Freq. <sup>c</sup>	Mean IV <sub>species</sub>	Mean $\pm$ S.E. <sup>d</sup>	Est. no. spp. <sup>e</sup>	Regression Residual <sup>f</sup>
				Melastomataceae	3	0.015	4.0	$\pm$ 0.8	171	-0.2230
				Myrtaceae	3	0.015	2.3	$\pm$ 0.5	111	0.9079 (+)
				Onagraceae	1	0.005	3.0	$\pm$ 0.0	4	0.9246 (+)
				Punicaceae	0	0.000	0.0	$\pm$ 0.0	1	-0.0188 (-)
				Sonneratiaceae	0	0.000	0.0	$\pm$ 0.0	2	-0.0377 (-)
			Gentianiflorae							
			Bignoniales							
				Acanthaceae	2	0.010	1.0	$\pm$ 0.0	51	1.0388 (+)
				Bignoniaceae	1	0.005	1.0	$\pm$ 0.0	3	0.9435 (+)
				Gesneriaceae	3	0.015	1.7	$\pm$ 0.3	112	0.8890 (+)
				Lentibulariaceae	0	0.000	0.0	$\pm$ 0.0	7	-0.1319 (-)
				Orobanchaceae	0	0.000	0.0	$\pm$ 0.0	1	-0.0188 (-)
				Pedaliaceae	1	0.005	4.0	$\pm$ 0.0	1	0.9812 (+)
				Plantaginaceae	0	0.000	0.0	$\pm$ 0.0	1	-0.0188 (-)
				Scrophulariaceae	0	0.000	0.0	$\pm$ 0.0	26	-0.4900 (-)
			Gentianales							
				Apocynaceae	1	0.005	1.0	$\pm$ 0.0	71	-0.3382
				Asclepiadaceae	1	0.005	6.0	$\pm$ 0.0	48	0.0953
				Gentianaceae	0	0.000	0.0	$\pm$ 0.0	5	-0.0942 (-)
				Loganiaceae	2	0.010	6.5	$\pm$ 1.8	30	1.4346 (+)
				Rubiaceae	11	0.054	2.0	$\pm$ 0.3	333	4.7237 (+)*
			Oleales							
				Oleaceae	0	0.000	0.0	$\pm$ 0.0	20	-0.3770 (-)
			Solaniflorae							
			Campanulales							
				Campanulaceae	0	0.000	0.0	$\pm$ 0.0	5	-0.0942 (-)
				Goodeniaceae	0	0.000	0.0	$\pm$ 0.0	2	-0.0377 (-)
			Solanales							
				Convolvulaceae	2	0.010	3.0	$\pm$ 0.7	26	1.5100 (+)
				Solanaceae	4	0.020	4.5	$\pm$ 1.5	11	3.7927 (+)*
			Corniflorae							
			Aralliales							
				Apiaceae	1	0.005	7.0	$\pm$ 0.0	5	0.9058 (+)
				Araliaceae	1	0.005	5.0	$\pm$ 0.0	22	0.5853 (+)
			Cornales							
				Cornaceae (Aralidiacea)	0	0.000	0.0	$\pm$ 0.0	7	-0.1319 (-)
				Haloragidaceae	0	0.000	0.0	$\pm$ 0.0	2	-0.0377 (-)
				Leeaceae	1	0.005	1.0	$\pm$ 0.0	7	0.8881 (+)
				Rhizophoraceae	0	0.000	0.0	$\pm$ 0.0	20	-0.3770 (-)
				Vitaceae	3	0.015	3.7	$\pm$ 0.7	38	2.2838 (+)

## Appendix 5.8. continued

Division							
Class							
Superorder <sup>a</sup>			Kenyah medicinal flora			Borneo flora	
Order	No.	Sel.	Mean	Est. no.	Regression		
Family	spp. <sup>b</sup>	Freq. <sup>c</sup>	$IV_{\text{species}} \pm S.E.^d$	spp. <sup>e</sup>	Residual <sup>f</sup>		
Dipsacales							
Caprifoliaceae	0	0.000	0.0 $\pm$ 0.0	4	-0.0754 (-)		
Lamiiflorae							
Boraginales							
Boraginaceae	0	0.000	0.0 $\pm$ 0.0	3	-0.0565 (-)		
Lamiales							
Lamiaceae	6	0.030	2.0 $\pm$ 0.6	19	5.6419 (+)*		
Verbenaceae	4	0.020	2.8 $\pm$ 0.7	47	3.1142 (+)*		
Asteriflorae							
Asterales							
Asteraceae	9	0.044	4.1 $\pm$ 0.9	38	7.2838 (+)*		
Monocotyledonae							
Liliflorae							
Liliales							
Burmanniaceae	0	0.000	0.0 $\pm$ 0.0	12	-0.2262 (-)		
Dioscoreaceae	0	0.000	0.0 $\pm$ 0.0	11	-0.2073 (-)		
Iridaceae	0	0.000	0.0 $\pm$ 0.0	2	-0.0377 (-)		
Liliaceae	4	0.020	4.0 $\pm$ 1.0	34	2.5477 (+)*		
Orchidaceae	0	0.000	0.0 $\pm$ 0.0	702	-15.8312 (-)*		
Pontederiaceae	0	0.000	0.0 $\pm$ 0.0	3	-0.0565 (-)		
Smilacaceae	2	0.010	3.0 $\pm$ 0.7	10	0.8115 (+)		
Taccaceae	1	0.005	1.0 $\pm$ 0.0	3	0.9435 (+)		
Triuridiflorae							
Triuridales							
Triuridaceae	0	0.000	0.0 $\pm$ 0.0	5	-0.0942 (-)		
Alismatiflorae							
Alismatales							
Butomaceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)		
Hydrocharitales							
Hydrocharitaceae	0	0.000	0.0 $\pm$ 0.0	5	-0.0942 (-)		
Najadales							
Najadaceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)		
Potamogetonaceae	0	0.000	0.0 $\pm$ 0.0	1	-0.0188 (-)		
Ariflorae							
Arales							
Araceae	8	0.039	3.4 $\pm$ 0.9	195	3.3247 (+)*		
Areciflorae							
Arecales							
Arecaceae	4	0.020	3.5 $\pm$ 1.7	179	0.6262 (+)		
Pandanales							
Pandanales	0	0.000	0.0 $\pm$ 0.0	33	-0.6220 (-)		

## Appendix 5.8. continued

Division	Kenyah medicinal flora		Borneo flora		Regression
Class	No.	Sel.	Mean	Est. no.	Residual <sup>f</sup>
Superorder <sup>a</sup>	spp. <sup>b</sup>	Freq. <sup>c</sup>	IV <sub>species</sub> ± S.E. <sup>d</sup>	spp. <sup>e</sup>	
Order					
Family					
Commeliniflorae					
Commelinales					
Bromeliaceae	1	0.005	1.0 ± 0.0	1	0.9812 (+)
Centrolepidaceae	0	0.000	0.0 ± 0.0	1	-0.0188 (-)
Commelinaceae	1	0.005	2.0 ± 0.0	21	0.6042 (+)
Cyperaceae	2	0.010	3.0 ± 0.7	126	-0.3748
Eriocaulaceae	0	0.000	0.0 ± 0.0	6	-0.1131 (-)
Flagellariaceae	0	0.000	0.0 ± 0.0	3	-0.0565 (-)
Poaceae	9	0.044	3.8 ± 0.9	131	6.5309 (+)*
Xyridaceae	0	0.000	0.0 ± 0.0	4	-0.0754 (-)
Zingiberales					
Cannaceae	0	0.000	0.0 ± 0.0	1	-0.0188 (-)
Marantaceae	0	0.000	0.0 ± 0.0	7	-0.1319 (-)
Musaceae	2	0.010	4.5 ± 1.8	9	1.8304 (+)
Zingiberaceae	21	0.103	4.8 ± 0.6	118	18.7760 (+)*

<sup>a</sup> Superorders and orders follow Thorne (1981). Families follow Mabberley (1987).

<sup>b</sup> Number of species used medicinally by the Kenyah (AK<sub>med</sub>).

<sup>c</sup> Frequency of superorder in the medicinal flora. Total number of medicinally used species = 203.

<sup>d</sup> Species importance value = sum of remedy importance values for each species. S.E. = standard error of the mean.

<sup>e</sup> Number of Borneo species (BO) in each family was estimated from Merrill (1921) for angiosperms and gymnosperms; from Copeland (1917) for pteridophytes. More recent reports of individual taxonomic groups suggest that these sources underestimate the total number of species in the Borneo flora by 40-50 % (Merrill 1921; Kiew 1984; Mat-Salleh, Beach, and Beaman 1990).

<sup>f</sup> Residual values were derived from an unweighted, least-squares linear regression of the number of Apo Kayan species used medicinally by the Kenyah against the estimated number of species in the Borneo flora ( $P=0$ ;  $r^2=.27$ ). Residuals above or below 95% confidence intervals are over-represented (+) or under-represented (-) in the Apo Kayan medicinal flora; significant outliers (\*) exceed the standard error ( $\pm 2.36$ ) of the estimated regression line:

$$AK_{med} = 0 + 0.0188 (BO).$$

Appendix 5.9. Biological activity according to taxonomic superorder in the Kenyah medicinal flora

Division Class Superorder <sup>a</sup>	Biological activity											
	Larvicidal <sup>b</sup>			Antifungal <sup>c</sup>			Antitumor <sup>d</sup>			Phototoxic <sup>d</sup>		
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
<i>I. Medicinal - part used active</i>												
Lycophyta (clubmosses)	0	1	0.00	0	1	0.00	0	1	0.00	0	1	0.00
Pterophyta (ferns)	0	8	0.00	2	8	0.25	0	8	0.00	0	8	0.00
Anthophyta (angiosperms)												
Dicotyledonae												
Annoniflorae	5	7	0.71	2	6	0.33	0	6	0.00	0	6	0.17
Rafflesiiflorae	0	1	0.00	0	1	0.00	0	1	0.00	0	1	nt
Theiflorae	5	10	0.50	3	9	0.33	0	7	0.00	0	7	0.00
Violiflorae	2	4	0.50	0	3	0.00	0	3	0.00	0	3	0.00
Malviflorae	5	14	0.36	1	11	0.09	2	11	0.18	2	11	0.18
Santaliflorae	0	2	0.00	0	2	0.00	0	2	0.00	0	2	0.00
Geraniiflorae	0	0	nt	0	0	nt	0	0	nt	0	0	nt
Chenopodiiflorae	0	2	0.00	0	1	0.00	0	1	0.00	0	1	0.00
Proteiflorae	1	1	1.00	0	1	0.00	0	1	0.00	0	1	nt
Rutiflorae	9	13	0.69	2	13	0.15	1	11	0.09	1	11	0.09
Rosiflorae	1	1	1.00	0	0	nt	0	0	nt	0	0	nt
Myrtiflorae	5	6	0.83	1	6	0.17	0	5	0.00	0	5	0.00
Gentianiflorae	6	13	0.46	1	11	0.09	0	11	0.00	0	11	0.00
Solaniflorae	0	2	0.00	0	2	0.00	0	2	0.00	0	2	0.00
Corniflorae	5	6	0.83	0	4	0.00	0	4	0.00	0	4	0.00
Lamiiflorae	1	7	0.14	1	7	0.14	1	7	0.14	0	5	0.00
Asteriflorae	1	6	0.17	0	6	0.00	0	6	0.00	0	6	0.00

Appendix 5.9 continued

Division Class Superorder <sup>a</sup>	Biological activity								
	Larvicidal <sup>b</sup>		Antifungal <sup>c</sup>		Phototoxic <sup>d</sup>				
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
Monocotyledonae									
Liliiflorae	2	5	0.40	2	5	0.40	0	5	0.00
Ariflorae	1	4	0.25	0	3	0.00	0	3	0.00
Areciflorae	0	1	0.00	0	1	0.00	0	1	0.00
Commeliniflorae	3	24	0.13	4	22	0.18	0	17	0.00
<i>II. Medicinal - part active not used</i>									
Lycophyta	0	1	0.00	0	1	0.00	0	1	0.00
Pterophyta	2	8	0.25	0	8	0.00	0	8	0.00
Anthophyta									
Dicotyledonae									
Annoniflorae	0	7	0.00	0	6	0.00	1	6	0.00
Rafflesiflorae	0	1	0.00	0	1	0.00	0	0	nt
Theiflorae	1	10	0.10	0	9	0.00	1	7	0.14
Violiflorae	0	4	0.00	1	3	0.33	0	3	0.00
Malviflorae	1	14	0.07	0	11	0.00	0	11	0.00
Santaliflorae	0	2	0.00	0	2	0.00	0	2	0.00
Geraniiflorae	0	0	nt	0	0	nt	0	0	nt
Chenopodiiflorae	0	2	0.00	0	1	0.00	0	1	0.00
Proteiflorae	0	1	0.00	0	1	0.00	0	0	nt
Rutiflorae	1	13	0.08	0	13	0.00	1	11	0.09
Rosiflorae	0	1	0.00	0	0	nt	0	0	nt
Myrtiflorae	0	6	0.00	0	6	0.00	0	5	0.00
Gentianiflorae	1	13	0.08	1	11	0.09	1	11	0.09

Appendix 5.9 continued

Division Class	Larvicidal <sup>b</sup>				Biological activity				Phototoxic <sup>d</sup>	
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
Superorder <sup>a</sup>										
Solaniflorae	0	2	0.00	0	2	0.00	0	2	0.00	0.00
Corniflorae	0	6	0.00	0	4	0.00	0	4	0.00	0.00
Lamiiflorae	1	7	0.14	0	7	0.00	1	5	0.20	0.20
Asteriflorae	1	6	0.17	0	6	0.00	0	6	0.00	0.00
Monocotyledonae										
Liliiflorae	1	5	0.20	0	5	0.00	0	5	0.00	0.00
Ariflorae	0	4	0.00	0	3	0.00	0	3	0.00	0.00
Areciflorae	0	1	0.00	0	1	0.00	0	1	0.00	0.00
Commeliniflorae	3	24	0.13	2	22	0.09	0	17	0.00	0.00

<sup>a</sup> Superorders follow Thorne (1981).

<sup>b</sup> Toxicity to brine shrimp (*Artemia salina* Leach) nauplii, LD<sub>50</sub> < 10<sup>4</sup> ppm.

<sup>c</sup> Inhibition of brewer's yeast (*Saccharomyces cerevisiae*).

<sup>d</sup> Light-activated inhibition of brewer's yeast.  
nt=not tested.

Appendix 5.10. Biological activity according to family in the Kenyah medicinally used flora

Division Class Superorder Order Family <sup>a</sup>	Larvicidal <sup>b</sup>		Biological activity Antifungal <sup>c</sup>		Phototoxic <sup>d</sup>	
	No. spp. active	No. spp. tested	No. spp. active	No. spp. tested	No. spp. active	No. spp. tested
<i>1. Medicinal - part used active</i>						
Lycophyta (clubmosses)						
Lycopsidea	0	1	0	1	0	1
Lycopodiaceae						
Pterophyta (fern)						
Fillcopsida						
Aspleniaceae	0	1	1	1	0	1
Gleicheniaceae	0	1	0	1	0	1
Polypodiaceae	0	3	1	3	0	3
Schizaeaceae	0	1	0	1	0	1
Thelypteridaceae	0	2	0	2	0	2
Anthophyta (angiosperms)						
Dicotyledonae						
Annoniflorae						
Annonales						
Annonaceae	0	0	0	0	0	0
Lauraceae	1	2	0	2	0	2
Piperaceae	2	3	1	3	0	3
Schisandraceae	1	1	0	0	0	0
Winteraceae	1	1	1	1	0	1
Rafflesiiflorae						
Rafflesiales						
Rafflesiaceae	0	1	0	1	0	0

Appendix 5.10. continued

Division	Class	Superorder	Order	Family <sup>a</sup>	Larvicidal <sup>b</sup>		Biological activity		Phototoxic <sup>d</sup>		
					No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active
Theiflorae	Ebenales	Ebenaceae	1	1	1.00	1	1	1.00	0	1	0.00
		Sapotaceae	0	1	0.00	0	1	0.00	0	0	nt
		Polygonales	1	1	1.00	1	1	1.00	0	1	0.00
		Primulales	2	2	1.00	1	2	0.50	0	2	0.00
		Theales	1	1	1.00	0	0	nt	0	0	nt
		Aquifoliaceae	1	4	0.25	0	3	0.00	0	2	0.00
		Ciusiaceae	0	1	0.00	0	1	0.00	0	1	0.00
		Dilleniaceae	0	1	0.00	0	1	0.00	0	1	0.00
		Violiflorae	0	1	0.00	0	0	nt	0	0	nt
		Violales	1	1	1.00	0	1	0.00	0	1	0.00
		Caricaceae	1	1	1.00	0	1	0.00	0	1	0.00
		Cucurbitaceae	1	1	1.00	0	1	0.00	0	1	0.00
		Flacourtiaceae	0	0	nt	0	0	nt	0	0	nt
		Passifloraceae	0	1	0.00	0	1	0.00	0	1	0.00
		Scyphostegiaceae	3	6	0.38	0	6	0.00	0	6	0.00
		Euphorbiales	0	0	0.00	0	0	0.00	0	0	0.00
		Euphorbiaceae	0	0	0.00	0	0	0.00	0	0	0.00

Appendix 5.10. continued

Division Class Superorder Order Family <sup>a</sup>	Larvicidal <sup>b</sup>		Biological activity Antifungal <sup>c</sup>		Phototoxic <sup>d</sup>	
	No. spp. active	No. spp. tested Freq. spp. active	No. spp. active	No. spp. tested Freq. spp. active	No. spp. active	No. spp. tested Freq. spp. active
Malvales						
Bombacaceae	0	0 nt	0	0 nt	0	0 nt
Malvaceae	1	2 0.50	0	2 0.00	2	2 1.00
Thymelaeaceae	0	1 0.00	1	1 1.00	0	1 0.00
Rhamnales						
Rhamnaceae	1	1 1.00	0	0 nt	0	0 nt
Urticales						
Moraceae	0	0 nt	0	0 nt	0	0 nt
Urticaceae	0	2 0.00	0	2 0.00	0	2 0.00
Santaliflorae						
Santalales						
Loranthaceae	0	2 0.00	0	2 0.00	0	2 0.00
Geraniiflorae						
Geraniales						
Balsaminaceae	0	0 nt	0	0 nt	0	0 nt
Chenopodiiflorae						
Chenopodiales	0	1 0.00	0	0 nt	0	0 nt
Amaranthaceae	0	1 0.00	0	1 0.00	0	1 0.00
Caryophyllaceae						
Proteiflorae						
Proteales						
Proteaceae	1	1 1.00	0	1 0.00	0	0 nt



Appendix 5.10. continued

Division Class Superorder Order Family <sup>a</sup>	Larvicidal <sup>b</sup>		Biological activity Antifungal <sup>c</sup>		Phototoxic <sup>d</sup>	
	No. spp.	Freq. spp.	No. spp.	Freq. spp.	No. spp.	Freq. spp.
	active	tested	active	tested	active	tested
Gentianales						
Apocynaceae	1	1	0	1	0	1
Asclepiadaceae	0	1	0	0	0	0
Loganiaceae	2	2	0	2	0	2
Rubiaceae	3	6	1	5	0	5
Solaniflorae						
Solanales						
Convulvulaceae	0	2	0	2	0	2
Solanaceae	0	0	0	0	0	0
Corniflorae						
Araliales						
Apiaceae	0	1	0	1	0	1
Araliaceae	1	1	0	0	0	0
Leeaceae	0	0	0	0	0	0
Vitaceae	3	3	0	3	0	3
Lamiflorae						
Lamiales						
Lamiaceae	0	4	0	4	0	3
Verbenaceae	1	3	1	3	0	2
Asteriflorae						
Asterales						
Asteraceae	1	6	0	6	0	6



Appendix 5.10. continued

Division	Class	Superorder	Larvicidal <sup>b</sup>		Biological activity		Phototoxic <sup>d</sup>				
			No. spp. active	No. spp. tested	No. spp. active	No. spp. tested	No. spp. active	No. spp. tested			
Order	Family <sup>a</sup>		Freq. spp. active	Freq. spp. tested	Antifungal <sup>c</sup>	Freq. spp. active	Freq. spp. tested	Freq. spp. active	Freq. spp. tested		
<i>ii. Medicinal - part active not used</i>											
Lycophyta (clubmosses)	Lycopsidea		0	1	0.00	0	1	0.00	0	1	0.00
Pterophyta (fern)	Polypodiaceae		0	1	0.00	0	1	0.00	0	1	0.00
	Aspleniaceae		1	1	1.00	0	1	0.00	0	1	0.00
	Gleicheniaceae		0	3	0.00	0	3	0.00	0	3	0.00
	Schizaeaceae		1	1	1.00	0	1	0.00	0	1	0.00
	Thelypteridaceae		0	2	0.00	0	2	0.00	0	2	0.00
Anthophyta	Dicotyledonae										
	Annoniflorae										
	Annones										
	Annonaceae		0	0	nt	0	0	nt	0	0	nt
	Lauraceae		0	2	0.00	0	2	0.00	0	2	0.00
	Piperaceae		0	3	0.00	0	3	0.00	1	3	0.33
	Schisandraceae		0	1	0.00	0	0	nt	0	0	nt
	Winteraceae		0	1	0.00	0	1	0.00	0	1	0.00
Rafflesiflorae	Rafflesiales										
	Rafflesiaceae		0	1	0.00	0	1	0.00	0	0	nt

Appendix 5.10. continued

Division	Class	Superorder	Order	Family <sup>a</sup>	Larvicidal <sup>b</sup>		Biological activity		Phototoxic <sup>d</sup>	
					No. spp. active	No. spp. tested	No. spp. active	No. spp. tested	No. spp. active	No. spp. tested
Theiflorae	Ebenales									
	Ebenaceae				0	1	0	1	1	1.00
	Sapotaceae				0	1	0	1	0	nt
	Polygonales									
	Polygonaceae				?	1	0	1	0	0.00
	Primulales									
	Myrsinaceae				0	2	0	2	0	0.00
	Theales									
	Aquifoliaceae				0	1	0	0	0	nt
	Clusiaceae				1	4	0	3	0	0.00
	Dilleniaceae				0	1	0	1	0	0.00
	Violiflorae									
	Violales									
	Caricaceae				0	1	0	0	0	nt
	Cucurbitaceae				0	1	0	1	0	0.00
	Flacourtiaceae				0	1	0	1	0	0.00
	Passifloraceae				0	0	0	0	0	nt
	Scyphostegiaceae				0	1	1	1	0	1.00
	Malviflorae									
	Euphorbiales				1	8	0	6	0	0.00
	Euphorbiaceae									





Appendix 5.10. continued

Division Class Superorder Order Family <sup>a</sup>	Larvicidal <sup>b</sup>		Biological activity		Phototoxic <sup>d</sup>	
	No. spp. active	No. spp. tested	No. spp. active	No. spp. tested	No. spp. active	No. spp. tested
Gentianales						
Apocynaceae	0	1	0	1	0	1
Asclepiadaceae	0	1	0	0	0	0
Loganiaceae	0	2	1	2	0	2
Rubiaceae	1	6	0	5	1	5
Solaniflorae						
Solanales						
Convulvulaceae	0	2	0	2	0	2
Solanaceae	0	0	0	0	0	0
Comiflorae						
Aralliales						
Apiaceae	0	1	0	1	0	1
Araliaceae	0	1	0	0	0	0
Leeaceae	0	0	0	0	0	0
Vitaceae	0	3	0	3	0	3
Lamiiflorae						
Lamiales						
Lamiaceae	1	4	0	4	1	3
Verbenaceae	0	3	0	3	0	2
Asteriflorae						
Asterales						
Asteraceae	1	6	0	6	0	6

Appendix 5.10. continued

Division	Class	Superorder	Order	Family <sup>a</sup>	Larvicidal <sup>b</sup>		Biological activity		Phototoxic <sup>d</sup>	
					No. spp. active	No. spp. tested	No. spp. active	No. spp. tested	No. spp. active	No. spp. tested
Monocotyledonae	Liliiflorae									
	Liliales									
	Liliaceae	1	3	0.33	0	3	0.00	0	3	0.00
	Smilacaceae	0	2	0.00	0	2	0.00	0	2	0.00
	Taccaceae	0	0	nt	0	0	nt	0	0	nt
	Ariflorae									
	Arcales									
	Araceae	0	4	0.00	0	3	0.00	0	3	0.00
	Areciflorae									
	Arecalis									
	Areaceae	0	1	0.00	0	1	0.00	0	1	0.00
	Commeliniflorae									
	Commelinales									
	Bromeliaceae	0	1	0.00	0	0	nt	0	0	nt
	Commelinaceae	0	1	0.00	0	1	0.00	0	1	0.00
	Cyperaceae	0	2	0.00	0	2	0.00	0	2	0.00
	Poaceae	0	3	0.00	0	3	0.00	0	3	0.00
	Zingiberales									
	Musaceae	0	0	nt	0	0	nt	0	0	nt
	Zingiberaceae	3	17	0.18	2	16	0.13	0	11	0.00

<sup>a</sup> Families following Mabberley (1987). Higher taxa following Thorne (1981).

<sup>b</sup> Toxicity to brine shrimp (*Artemia salina* Leach) nauplii, LD<sub>50</sub> < 10<sup>4</sup> ppm.

<sup>c</sup> Inhibition of brewer's yeast (*Saccharomyces cerevisiae*).

<sup>d</sup> Light-activated inhibition of brewer's yeast.  
nt=not tested.

**Appendix 5.11. Selection frequency and medicinal importance value (mean  $IV_{species}$ ) of Kenyah medicinal plants according to their availability**

<b>Availability<sup>a</sup></b>	<b>No. spp.</b>	<b>Sel. Freq.<sup>b</sup></b>	<b>Mean <math>IV_{species}</math><sup>c</sup> ± S.E.<sup>d</sup></b>
Common	120	0.59	3.9 ± 0.3
Rare	58	0.29	3.5 ± 0.3
Uncertain	25	0.12	2.2 ± 0.3

<sup>a</sup> Status based on consensus of survey participants.

<sup>b</sup> Total number of medicinal species = 203.

<sup>c</sup> Species importance value = sum of remedy importance values for each species.

<sup>d</sup> Standard error of the mean.

Appendix 5.12. Biological activity according to species availability in the Apo Kayan medicinal flora

Availability <sup>a</sup>	Larvicidal <sup>b</sup>			Biological activity			Phototoxic <sup>d</sup>		
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
<b>I. Medicinal - part used active</b>									
common	30	86	0.35	10	77	0.16	4	69	0.06
rare	22	43	0.51	8	40	0.20	0	34	0.00
uncertain	4	9	0.44	1	6	0.12	0	6	0.00
<b>II. Medicinal - part active not used</b>									
common	7	86	0.08	4	77	0.05	2	69	0.03
rare	3	43	0.07	0	40	0.00	2	34	0.06
uncertain	0	9	0.00	0	6	0.00	0	6	0.00
<b>III. Non-medicinal controls</b>									
common	17	32	0.53	2	32	0.06	0	22	0.00
rare	1	3	0.33	0	3	0.00	1	2	0.50
uncertain	0	0	nt	0	0	nt	0	0	nt

<sup>a</sup> Status based on consensus of survey participants.

<sup>b</sup> Toxicity to brine shrimp (*Artemia salina* Leach) nauplii, LD<sub>50</sub> < 10<sup>4</sup> ppm.

<sup>c</sup> Inhibition of brewer's yeast (*Saccharomyces cerevisiae*).

<sup>d</sup> Light-activated inhibition of brewer's yeast.

nt=not tested.

Appendix 5.13. Selection frequency and medicinal importance value (mean  $IV_{\text{species}}$ ) according to management strategies for Kenyah medicinal plants

Management strategy <sup>a</sup>	No. spp.	Sel. Freq. <sup>b</sup>	Mean $IV_{\text{species}}$ <sup>c</sup>	$\pm$ S.E. <sup>d</sup>
Wild	164	0.78	3.3	$\pm$ 0.19
Transplanted	10	0.05	5.1	$\pm$ 1.20
Cultivated and wild	14	0.07	5.9	$\pm$ 0.88
Cultivated	21	0.10	4.6	$\pm$ 0.81

<sup>a</sup> Defined by Kenyah treatment categories.

<sup>b</sup> Total number of medicinal species = 203.

<sup>c</sup> Species importance value = sum of remedy importance values for each species.

<sup>d</sup> Standard error of the mean.

Appendix 5.14. Biological activity according to Kenyah management strategies for the Apo Kayan medicinal flora

Management strategy	Larvicidal <sup>a</sup>				Biological activity				Phototoxic <sup>c</sup>	
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
<b>I. Medicinal - part used active</b>										
Wild	45	113	0.40	16	101	0.16	0	93	0.00	
Transplanted	6	9	0.67	0	8	0.00	1	7	0.14	
Cultivated and wild	2	8	0.25	0	8	0.00	2	6	0.33	
Cultivated	3	8	0.38	3	6	0.50	1	3	0.33	
<b>II. Medicinal - part active not used</b>										
Wild	9	113	0.08	4	101	0.04	3	93	0.03	
Transplanted	1	9	0.11	0	8	0.00	1	7	0.14	
Cultivated and wild	0	8	0.00	0	8	0.00	0	6	0.00	
Cultivated	0	8	0.00	0	6	0.00	0	3	0.00	
<b>III. Non-medicinal controls</b>										
Wild	20	35	0.57	2	35	0.06	1	21	0.05	
Transplanted	0	0	nt	0	0	nt	0	0	nt	
Cultivated and wild	0	0	nt	0	0	nt	0	0	nt	
Cultivated	0	0	nt	0	0	nt	0	0	nt	

<sup>a</sup> Toxicity to brine shrimp (*Artemia salina* Leach) nauplii, LD<sub>50</sub> < 10<sup>4</sup> ppm.

<sup>b</sup> Inhibition of brewer's yeast (*Saccharomyces cerevisiae*).

<sup>c</sup> Light-activated inhibition of brewer's yeast.  
nt=not tested.

Appendix 5.15. Frequency distribution by medicinal importance value ( $IV_{\text{species}}$ ) of the medicinally used Apo Kayan flora

$IV_{\text{species}}^a$	No. spp. <sup>b</sup>	Freq.
1	43	0.21
2	46	0.23
3	26	0.13
4	33	0.16
5	14	0.07
6	16	0.08
7	10	0.05
8	4	0.02
9	4	0.02
10	3	0.01
11	0	0.00
12	0	0.00
13	0	0.00
14	2	0.01
15	1	0.00
16	1	0.00

<sup>a</sup> Species importance value = sum of remedy importance values for each species.

<sup>b</sup> Total number of species = 203.

Appendix 5.16. Medicinal importance value (IV<sub>species</sub>) and biological activity of the medicinally used Apo Kayan flora

IV <sub>species</sub> <sup>a</sup>	Biological activity <sup>b</sup>											
	Larvicidal				Antifungal				Phototoxic			
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
1	5	20	0.25	2	17	0.12	0	15	0.00	0	15	0.00
2	7	30	0.23	2	26	0.08	1	20	0.05	1	20	0.05
3	8	18	0.44	3	13	0.23	1	12	0.08	1	12	0.08
4	14	27	0.52	5	26	0.19	1	23	0.04	1	23	0.04
5	5	10	0.50	2	9	0.22	0	9	0.00	0	9	0.00
6	3	13	0.23	0	12	0.00	0	11	0.00	0	11	0.00
7	3	9	0.33	3	9	0.33	0	8	0.00	0	8	0.00
8	2	4	0.50	0	4	0.00	0	4	0.00	0	4	0.00
9	1	2	0.50	0	2	0.00	0	2	0.00	0	2	0.00
10	1	2	0.50	1	2	0.50	0	2	0.00	0	2	0.00
11	0	0	nt	0	0	nt	0	0	nt	0	0	nt
12	0	0	nt	0	0	nt	0	0	nt	0	0	nt
13	0	0	nt	0	0	nt	0	0	nt	0	0	nt
14	1	1	1.00	0	1	0.00	0	1	0.00	0	1	0.00
15	1	1	1.00	1	1	1.00	0	1	1.00	0	1	0.00
16	1	1	1.00	0	1	0.00	0	1	0.00	0	1	0.00

I. Medicinal - part used active

Appendix 5.16. continued

IV <sub>species</sub> <sup>a</sup>	Biological activity <sup>b</sup>											
	Larvicidal				Antifungal				Phototoxic			
	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active	No. spp. active	No. spp. tested	Freq. spp. active
1	4	20	0.20	0	17	0.00	0	15	0.00	0	15	0.00
2	2	30	0.07	0	26	0.00	0	20	0.00	0	20	0.00
3	1	18	0.06	1	13	0.08	1	12	0.08	1	12	0.08
4	1	27	0.04	1	26	0.04	2	23	0.09	2	23	0.09
5	0	10	0.00	0	9	0.00	1	9	0.11	1	9	0.11
6	2	13	0.15	1	12	0.08	0	11	0.00	0	11	0.00
7	0	9	0.00	0	9	0.00	0	8	0.00	0	8	0.00
8	1	4	0.25	0	4	0.00	0	4	0.00	0	4	0.00
9	1	2	0.50	1	2	0.50	0	2	0.00	0	2	0.00
10	0	2	0.00	0	2	0.00	0	2	0.00	0	2	0.00
11	0	0	nt	0	0	nt	0	0	nt	0	0	nt
12	0	0	nt	0	0	nt	0	0	nt	0	0	nt
13	0	0	nt	0	0	nt	0	0	nt	0	0	nt
14	0	1	0.00	0	1	0.00	0	1	0.00	0	1	0.00
15	0	1	0.00	0	1	0.00	0	1	0.00	1	1	1.00
16	0	1	0.00	0	1	0.00	0	1	0.00	0	1	0.00

II. Non-medicinal controls

<sup>a</sup> Species importance value = sum of remedy importance values for each species.  
<sup>b</sup> Larvicidal=toxicity to brine shrimp (*Artemia salina* Leach) nauplii, LD<sub>50</sub><10<sup>4</sup> ppm. Antifungal=inhibition of brewer's yeast (*Saccharomyces cerevisiae*). Phototoxic=light-activated inhibition of brewer's yeast. nt=not tested.

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