THE USE OF MEDICINAL PLANTS BY THE YANOMAMI INDIANS OF BRAZIL, PART II[1]

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Milliken, W. *(Centre for Economic Botany, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, U.K.), and* **Albert, B.** *(ORSTOM, 213 rue La Fayette, 75480 Paris Cedex 10, France).* THE USE OF MEDICINAL PLANTS BY THE YANOMAMI INDIANS OF BRAZIL, PART II. *Economic Botany 51(3)264–278, 1997. The results of ethnobotanical fieldwork among two Yanomami communities are presented, and the knowledge of medicinal plants and fungi among those communities is discussed in the light of recent evidence that the Yanomami possess, contrary to previous assumptions, an extensive pharmacopoeia. In addition to the 113 species already known to be used by the group, a further 85 species are documented. Twenty-three species are named and discussed in detail. Considerable overlap is found between the uses of medicinal species by the upland Yanomami and those of the lowland Yanomami, but considerable differences are also apparent. The new data raise the currently recorded total to a level comparable with or greater than that recorded among other Amazonian indigenous peoples. Many of these plants are used in the same way by other indigenous and non-indigenous groups, supporting the hypothesis that their use is based on pharmacological activity. The origins and significance of this knowledge are discussed, with particular reference to the use of plants in the treatment of malaria.*

Uso de plantas medicinais pelos Índios Yanomami do Brasil, II. *Apresentam-se os resultados da pesquisa de campo sobre etnobotânica entre duas comunidades yanomami. Descreve-se o conhecimento de plantas e fungos medicinais dessas comunidades à luz de dados recentes segundo os quais os Yanomami, ao contrário do que se supunha, possuem uma vasta farmacopéia. Além das 113 espécies que já se sabia serem utilizadas pelo grupo, foram documentadas mais 85. Vinte e três espécies são identificadas pelo nome e discutidas em detalhe. Há uma grande sobreposição na maneira como as espécies medicinais são usadas pelos Yanomami da serra e pelos da planície, mas também existem diferenças significativas. Os novos dados elevam o total registrado a um nível comparável ou maior do que o documentado para outros povos indígenas da Amazônia. Muitas dessas plantas são usadas do mesmo modo que outros grupos indígenas e não indígenas, o que vem dar suporte à hipótese de que sua utilização se baseia numa atividade farmacológica. Discutem-se as origens e o significado desse conhecimento, com especial atenção para o uso de plantas no tratamento de malária.*

Key Words: Yanomami; medicinal plants; Amazônia; phytotherapy; Brazil; malaria.

Between 1993 and 1994 an ethnobotanical study was carried out among the Watoriki tʰeri pë (Yanomami inhabitants of the village of Watoriki) in the State of Amazonas, Brazil. The primary aim of the study was to conduct an inventory of the medicinal plants used by the group, the results of which have since been published (Milliken and Albert 1996). A total of 113 species of medicinal plants and fungi were collected, from a broad spectrum of taxonomic groups (92 genera and 50 families), and it was evident that in the past there had been a considerably greater knowledge of this subject among the group than exists today. This was the first record of an extensive knowledge of medicinal plants among the Yanomami, who have tended previously to be regarded as relying almost entirely upon shamanism for their cures.

This belief continues to surface in ethnobotanical works dealing with the Yanomami. Plotkin (1993), for example, described the Venezuelan Yanomami as "lacking an ethnopharmaceutical tradition," and concluded that this was the result of a heavy reliance on "shamanistic contact with the spirit world for healing purposes." Plotkin expressed surprise that his young informant had told him that *Jacaranda copaia*

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(Aubl.) D. Don (Bignoniaceae), which he recorded as *shatabahre* (*xatapahre*), was not used for medicine, since many other Amazonian indigenous groups employ it for a variety of medicinal purposes. In fact, both at Watoriki (where it is known as *xitopari hi*) and at Xitei (where it is known as *xitopori hi*), it is used to treat snake bites, and conversations with older members of the village which he visited would almost certainly have yielded information similar to ours.

According to the older Watoriki t^{h}eri pë, medicine of this type (phytotherapy) had largely been practiced by the older women in the past, whereas shamanic medicine had been (and is) practiced by the men. It was apparently these older women who had been the most knowledgeable about medicinal plants, although this was no longer the case at Watoriki at the time of study. There, all of the older women had died, mainly in the epidemics suffered by the group in 1973 and in 1977, and the majority of the surviving knowledge was that which the oldest men of the community had acquired from their mothers and grandmothers before they died. This probably represents only a proportion of what was originally known to them. The current availability of "Western" industrial medicine close to Watoriki has had a significant effect on the attitude of the Watoriki t^{h}eri pë towards healthcare, and consequently the traditional knowledge of medicinal plants has been devaluated, particularly amongst the younger generations. This is likely to lead to the loss of a substantial proportion of the remaining knowledge of medicinal plants within the relatively near future.

One of the main questions which this initial study raised was whether this rich knowledge of medicinal plants is also to be found among other Yanomami communities, and has simply been overlooked by previous researchers, or whether it is a phenomenon particular to the Watoriki t^{h}eri pë. In order to investigate this, and to document further the medicinal plants used by the Yanomami, additional studies were conducted in 1995 among Yanomami communities which were selected for their different environments (Xitei) or different linguistic-cultural contexts (Balawaú), and which were known to have entered a regular contact situation recently. The results of these investigations are presented and discussed here. Another of the questions which was raised in the earlier study, and which is discussed and to some extent resolved here, is the origin of the substantial knowledge of anti-malarial plant medicine which was recorded among the communities studied.

The Study Area

The research was conducted at two locations in northern Amazonian Brazil, in the States of Roraima and Amazonas. Both of these lie within the territory of the Yanomami Indians, which spans the border between Brazil and Venezuela, and between the Amazon and Orinoco basins (Fig. 1). The first site, Xitei, lies in the upland part of their lands, in the headwaters of the Parima river. At Xitei there is now an airstrip (2°36′40″N, 63°52′28″W, alt, 620 m a.s.l.), a small Catholic mission, and a FUNAI (Fundação Nacional de Índio) post, all of which opened in 1990–1992 after a massive invasion of wildcat gold miners (*garimpeiros*) in 1987–1989. There is one Yanomami community (Watatasi) nearby, where the majority of the data were collected. In the surrounding area there are another 19 Yanomami communities (total 672 people), at one of which (Kuai u) fieldwork was also carried out. The second site, Balawaú, lies in the lowlands to the north-west of Watoriki (where the initial fieldwork had been conducted). At Balawaú a health post was established by the Commissão Pró-Yanomami (CCPY) between 1992 and 1993, with an airstrip (1°48′13″N, 63°47′55″W, alt. 160 m a.s.l.), close to two Yanomami communities among the nine (total 263 people) in the vicinity.

Both of these sites are in dense evergreen tropical rainforest. The forest is diverse and mixed, showing a fairly typical composition for the region, with tree species typical of both the Amazon and the Guianas strongly represented. The vegetation at Balawaú is similar to that at Watoriki, although there are elements of the vegetation there (e.g., *Piper francovilleanum* C.DC, Piperaceae and *Tabernaemontana macrocalyx* Müll. Arg., Apocynaceae) which are absent at Watoriki but common in the upland forests. The vegetation in the Xitei region is typical of the submontane *terra firme* forests of the Serra Parima, which have been described in detail by Huber et al. (1984). Huber et al. set the 600m contour as the approximate lower level of these submontane forests, and recognised them as distinct from the forests at lower altitudes. How-

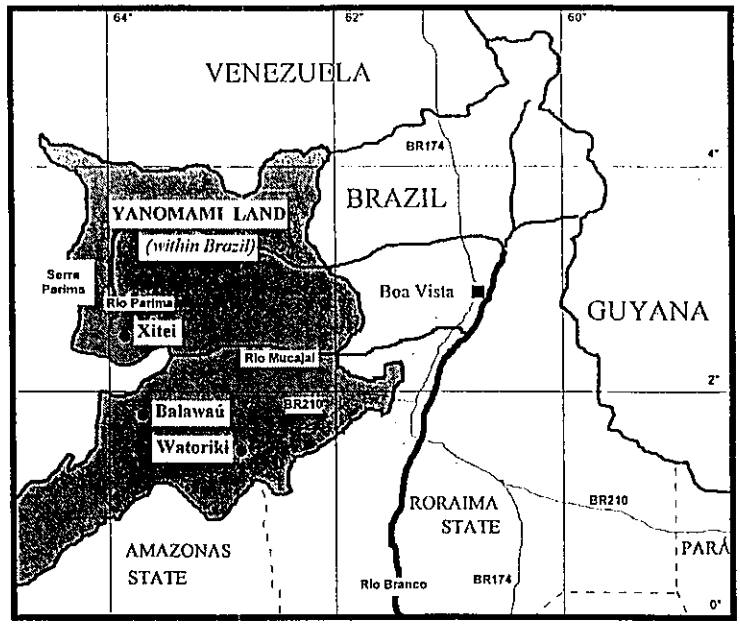

Fig. 1. Location of the study areas.

ever, although there are noticeable differences between these submontane forests and the forests in the Watoriki region, including a greater richness in the epiphyte flora, a slightly lower canopy, and the inclusion of species typical of the Guayana Highland (e.g., *Psammisia guianensis* Klotzsch, Ericaceae), they also include many elements of the flora of the neighboring lowlands.

Methods

Fieldwork was conducted between June and July 1995, during a three-week visit to the Xitei area and a one-week visit to Balawaú. Collection of specimens and preliminary data was carried out in the forest with Yanomami informants, and subsequently plant identifications and usage data were checked by consensus in the village. Identification of plant species was only recorded when a consensus agreement was reached. All conversations were recorded, and subsequently transcribed for checking of ethnobotanical data and orthography. Both men and women were interviewed.

The names of plants were recorded using the current standard orthography for Yanomami language in Brazil (see Albert and Goodwin Gomez 1997). In almost all cases (except where the species was identifiable without doubt), ethnobotanical data were supported by herbarium voucher specimens, initially preserved in 70% ethanol (Schweinfurth technique). These were either collected simultaneously with the recording of the data, or subsequently. Incomplete collections (fertile specimens) have been lodged at the herbaria of the Instituto Nacional de Pesquisas da Amazônia in Manaus (INPA), the Museu Integrado de Roraima in Boa Vista (MIRR) and the New York Botanical Garden (NY), and a full set (including sterile voucher specimens) is maintained at the Royal Botanic Gardens, Kew (K).

The number of people with whom the data were initially checked varied from two to several, depending upon availability. On the rare occasions when uncorroborated data were specifically denied by others, they were rejected. However, due to the threatened state of medicinal plant knowledge among the Brazilian Yanomami, and the need to record surviving information, uncorroborated data which were not specifically denied were generally not rejected.

Results

In the Xitei region, 109 medicinal plants and fungi were recorded, including 76 'new' species (i.e., not previously recorded at Watoriki). Of

TABLE 1. PRINCIPAL MEDICINAL PLANT FAMILIES RECORDED AMONG THE YANOMAMI.*

Overall (all study sites)		Xitei region (present study)		Watoriki (Milliken & Albert 1996)	
Family	No. spp. (No. genera)	Family	No. spp. (No. genera)	Family	No. spp. (No. genera)
Leguminosae	13 (12)	Leguminosae	9 (9)	Leguminosae	9 (9)
Piperaceae	13 (12)	Piperaceae	8 (3)	Piperaceae	8 (2)
Araceae	11 (5)	Gesneriaceae	6 (3)	Araceae	6 (4)
Moraceae	9 (6)	Moraceae	5 (5)	Moraceae	6 (5)
Rubiaceae	9 (6)	Araceae	4 (4)	Rubiaceae	6 (6)
Guttiferae	7 (4)	Guttiferae	4 (4)	Zingiberaceae**	4 (3)
Annonaceae	6 (4)	Melastomataceae	4 (2)	Annonaceae	4 (4)
Gesneriaceae	6 (3)	Zingiberaceae**	4 (3)	Apocynaceae	4 (2)
Zingiberaceae**	6 (3)	Acanthaceae	3 (3)	Guttiferae	4 (3)
Apocynaceae	5 (2)	Burseraceae	3 (1)	Bignoniaceae	3 (3)
Menispermaceae	5 (3)	Myrtaceae	3 (2)	Monimiaceae	3 (2)
Burseraceae	4 (1)	Orchidaceae	3 (1)	Palmae	3 (3)
Melastomataceae	4 (2)	Rubiaceae	3 (3)		
Palmae	4 (4)	Solanaceae	3 (3)		
Polygonaceae	4 (1)				
Acanthaceae	3 (3)				
Bignoniaceae	3 (3)				
Euphorbiaceae	3 (3)				
Monimiaceae	3 (2)				
Myrtaceae	3 (2)				
Orchidaceae	3 (1)				
Rutaceae	3 (2)				
Solanaceae	3 (3)				

* Families represented by three or more species.
** Including Costaceae.

the 33 species which had already been collected, 11 were attributed the same medicinal properties as they had been at Watoriki, 19 were attributed new (different) medicinal properties, and three were attributed both new properties *and* the properties which had been attributed to them at Watoriki. At Balawaú, 22 medicinal species were recorded, including eight new species. In addition, four previously recorded species were attributed new medicinal properties there, and ten were attributed the same properties as had been recorded previously. One new medicinal species was recorded during a further brief visit to the Watoriki tʰeri pë. As a result of the 1995 fieldwork, the total number of species of medicinal plants and fungi recorded amongst the Brazilian Yanomami thus rose from 113 to 198, the total number of genera from 92 to 141, and the total number of families from 50 to 77. Analyses of the medicinal plants and fungi by family, habit and use, are presented in Tables 1–3.

TABLE 2. CATEGORIES OF MEDICINAL PLANTS AND FUNGI RECORDED AMONG THE YANOMAMI.

Category	Species	Genera
Plant habit		
Trees	70	56
Herbs (terrestrial)	41	34
Shrubs	26	17
Vines/lianas/stranglers (large, woody)	24	16
Epiphytes (including climbing araceous epiphytes)	22	11
Vines (small, non-woody)	9	9
Other		
Fungi	6	6
Ferns	8	7
Cultivated species	16	16

In the first paper on the medicinal plants of the Yanomami (Milliken and Albert 1996) an attempt was made to protect their intellectual property rights by temporary control of parts of the data set. The same policy will be followed here, for at present there seems to be no sure way of combining scientific publication with the protection of those rights and the guarantee of

TABLE 3. DIVERSITY OF PLANTS AND FUNGI USED IN YANOMAMI MEDICINAL TREATMENTS.*

Treatment	Species	Genera	Families	Spp./Gen.	Spp./Fam.
Fevers	60	46	32	1.30	1.88
Stomach/intestinal pains	35	26	21	1.35	1.67
Malaria (external application)	24	21	17	1.14	1.41
Diarrhea	23	20	15	1.15	1.53
Infectious epidemic diseases	15	13	11	1.15	1.36
Malaria (internal application)	14	10	9	1.40	1.56
Coughs	13	10	9	1.30	1.44
Eye infections	13	13	9	1.00	1.44
Toothache	13	13	12	1.00	1.08
Headache	11	8	8	1.38	1.38
Snake bite	11	7	7	1.60	1.57
Itching	10	10	9	1.00	1.11
Worms (intestinal)	10	8	6	1.25	1.67
Congestion	9	8	8	1.13	1.13
Respiratory infections	9	5	4	1.80	2.25
Body pains (localized)	8	6	6	1.33	1.33
Thrush (oral)	8	8	6	1.00	1.33
Ponerine ant stings	8	8	6	1.00	1.33

* Medicinal applications for which eight or more species are used.

returning benefits from potentially ensuing profits. Species whose (corresponding) uses are already published elsewhere, or whose properties are widely recognized and can thus be regarded as having entered the public domain, are discussed at species level here. In other cases the plants' properties appear to be known at present only to the Yanomami, no other records of their uses having been found in the literature. These plants are not discussed by species name in the present paper. However, voucher numbers corresponding to specimens held in a special collection at the Royal Botanic Gardens Kew (K) have been cited in Appendix 1, and the full data will become available in a later publication when ongoing studies have been completed and copyright problems overcome.

Yanomami medicinal plant data, selected on these criteria, are presented below, together with comparative data from the literature (relevant to the species or their congeners). A number of the species discussed are attributed multiple medicinal uses of which some have been omitted. Not all of the species discussed here were recorded for the first time in 1995. Some had previously been recorded as medicinal plants at Watoriki, but were not published in the earlier paper (Milliken and Albert 1996) because of the property rights issues outlined above. However, new corroborative data from further literature studies have now satisfied the criteria necessary for their publication.

SOME MEDICINAL PLANT SPECIES USED BY THE YANOMAMI

N.B. The *x* used in the Yanomami orthography currently accepted in Brazil (and employed here) corresponds to the *sh* used in many other publications (e.g., in Venezuela). The barred *i* corresponds to the *i* in some previous publications.

Anacardium giganteum Hancock ex Engl. [Milliken 1761, K]

Anacardiaceae

Yanomami name: *oru xihi* (Watoriki), *wito hi* (Balawaú)

Remedy for diarrhea and stomach ache (Watoriki). Pieces of the inner bark are kneaded in cold water and the extract is drunk.

This species is used in the same way in Guyana (Fanshawe 1948; Lachman-White, Adams, and Trotz 1987). There are numerous references to the use of the bark of the cultivated *A. occidentale* L. for treating diarrhea (Grenand, Moretti, and Jacquemin 1987; La Rotta 1988; Schultes and Raffauf 1990).

Capsicum frutescens L. [Milliken 1755, K]

Solanaceae

Yanomami name: *prika aki*

Remedy for serious eye infection (imminent blindness) attributed to sorcery (Watoriki), and for respiratory (lung) infections (Xitei).

A small piece of the fruit is crushed in cold water and the extract is used as an eye-wash. For respiratory infections, an infusion of the fruits is drunk.

The Caribs of Dominica traditionally used the juice of the fruits as eye-drops for ophthalmia (Hodge and Taylor 1957), and in Guyana the use of red pepper juice for ophthalmia has also been reported (Roth 1924). In Mexico an extract of the leaves is used to treat eye disorders (Salas and Peraza 1993). In Trinidad, a decoction of the leaves is drunk to relieve chest colds, coughs and asthma, and in Jamaica a decoction of the fruits is gargled to relieve sore throats (Morton 1981). The Shipibo-Conibo of Peru also drink a decoction of the fruits as a cough remedy (Arévalo Valera 1994). In Guyana an infusion of the leaves and green fruits is drunk for coughs and colds (Lachman-White, Adams, and Trotz 1987).

Cecropia aff. *peltata* L. [Milliken 2345, K]

Moraceae

Yanomami name: *tokori hanaki*

Remedy for carbuncles and abscesses (Xitei).

The fallen bracts of the leaf-buds, which release a sticky jelly-like substance when crushed, are applied locally to draw out the pus and "refresh" the abscess.

In Argentina and Brazil the sap of *C. peltata* is applied to external ulcers, cancers and sores (Di Stasi et al. 1989; Morton 1981). The Island Caribs of Dominica pounded the unopened leaves, mixed them with salt and applied the poultice to wounds and sores (Hodge and Taylor 1957), and the Tikuna apply the gummy exudate from *C. latifolia* Miq. to bleeding gums. In Guyana, a hot poultice prepared from the young shoots of *Cecropia* spp. is used to dress ulcers and bush sores. The slimy sap of the young *Cecropia* shoots is used to treat fresh cuts (Fanshawe 1948), and the crushed dried leaves may be applied to leishmaniasis lesions in French Guiana (Grenand, Moretti, and Jacquemin 1987).

Clusia spp. [Milliken 1737, 1982, 2355, K]

Guttiferae

Yanomami name: *poripori thorho, poripori thoxi*

Vermifuge (Balawaú).

For intestinal worms, an infusion of the young roots, washed and crushed, is drunk.

The Taiwanos of Colombia consider the dried bark of *C. spathulaefolia* Engl. as a vermifuge (Schultes and Raffauf 1990), and in Costa Rica the latex of *C. odora* Seem. is used as a drastic purgative (Morton 1981). In French Guiana and Colombia, *Clusia* spp. are also used as purgatives (García-Barriga 1992; Heckel 1897).

Costus guanaiensis Rusby var. *macrostrobilus* (K. Schum.) Maas [Milliken 2344, K]

Zingiberaceae

Yanomami name: *naxuruma aki, naxuruma hanaki* (Watoriki, Xitei), *pokunama a* (Balawaú)

Remedy for coughs and bronchial disorders (Xitei). The young stem is peeled (like sugar cane) and chewed, and the acid-tasting juice is swallowed. The juice may also be mixed with water and drunk.

This species is used in Peru for coughs, bronchitis, laryngitis, pharyngitis and tonsillitis (Arévalo Valera 1994; Duke and Vasquez 1994). In Guyana, a syrup produced from *Costus* stems is used to treat coughs (Fanshawe 1948). The Créoles of French Guiana drink the juice of the stem of *C. scaber* Ruiz & Pav. for cough, flu and whooping cough (Grenand, Moretti, and Jacquemin 1987), and it is employed similarly in Guyana (Lachman-White, Adams, and Trotz 1987).

Croton palanostigma Klotzsch vel aff. [Milliken 2301A, K]

Euphorbiaceae

Yanomami name: *kotopori sihi*

Remedy (analgesic) for fevers, headaches and stomach ache. Also for leg pains associated with fevers (Xitei).

Strips of the inner bark are moistened in cold water and tied around the forehead (for headaches/fevers) or the waist (for stomach ache) or the calves (for leg pains).

The sap of this species is applied to ulcers and boils to reduce pain in the vicinity of Manaus (Schultes and Raffauf 1990). The bark of *C. lanjouwensis* Jabl. is used externally for fevers and headaches by the Waimiri Atroari (Milliken et al. 1992). The use of *Croton* spp. for treating fevers and malaria (generally internally) is very widespread and common in Latin America (Ayensu 1981; Berg and Silva 1988a; Brandão, Botelho, and Krettli 1985; Di Stasi et al. 1994; García-Barriga 1992; Lachman-White, Adams, and Trotz 1987; Morton 1981).

Cymbopogon citratus (Nees) Stapf. [Milliken 1775, K]

Gramineae

Yanomami name: *makiyuma hanaki, waihi hanaki,* (Watoriki), *makiyuma xiki* (Xitei)

Analgesic for muscular pain and other localized internal pains (Watoriki), and remedy for intestinal pain, diarrhea and headache (Xitei).

The leaves are crushed in the hands and rubbed on the body for pain. For intestinal pains and diarrhea, the root is crushed in cold water, and applied externally as a bath. A little of the extract may also be drunk. For headache, the crushed plant is tied around the forehead.

This species is commonly cultivated for its medicinal properties. In Bolivia it is considered a rubefacient, and the crushed leaves are rubbed on the body to relieve articular and muscular pains by activating the circulation (Lovati and Castellani 1991). An infusion of the leaves is drunk for stomach ache by the Siona

(Schultes and Raffauf 1990) and by "caboclos" in the Brazilian Amazon (Frechione, Posey, and Silva 1989), and for headache, fevers and influenza by the Tikunas, Palikur and Wayãpi (Grenand, Moretti, and Jacquemin 1987; Schultes and Raffauf 1990). In Venezuela it is taken as a digestive (Delascio Chitty 1985).

Dieffenbachia bolivarana G. S. Bunting
[Milliken 2376, K]

Araceae

Yanomami name: *xenoma a*

Remedy for ponerine ant stings (Xitei).
The stem or the petiole base is crushed and applied to the site of the sting.

This species is also used by the Maiongong of Roraima State to relieve the pain of ponerine ant and centipede stings. The stems of *Dieffenbachia* species, which are poisonous, are widely used for medicinal purposes including the treatment of insect stings. In Guatemala the mashed leaves and stems of *D. seguine* Schott are applied externally to the bites of poisonous animals (Morton 1981), and in Peru the stem sap is applied to the stings of ponerine ants (Kvist and Holm-Nielsen 1987).

Drymonia coccinea (Aubl.) Wiehler
[Milliken 2325, K]

Gesneriaceae

Yanomami name: *hurasi hanaki, hurasiki*

Remedy for fevers related to infectious epidemic diseases and malaria (Xitei).
An infusion of the crushed leaves and flowers (in hot water) is applied externally to the head and body as a bath. The crushed leaves may also be rubbed on the body to relieve muscular pains due to fevers (e.g., in the back and legs).

The Wayãpi of French Guiana also use *D. coccinea* as a febrifuge, crushed and rubbed on the body, and employ a decoction of *D. campostyla* Leeuwenb. in a similar manner (Grenand, Moretti, and Jacquemin 1987). In Colombia *D. semicordata* is used (externally) to relieve the pain of rheumatic joints (Schultes and Raffauf 1990).

Hippeastrum puniceum (Lam.) Kuntze
[Milliken 2342, K]

Amaryllidaceae

Yanomami name: *si waima a*

Stomach ache remedy (Xitei).
The bulb is tied tightly against the stomach. It is not taken internally or used as a bath because it provokes itching.

This species contains alkaloids, and the Siona take a preparation of the bulb as a purgative and as a stomach ache remedy (Schultes and Raffauf 1990). In Jamaica a poultice of the bulb used to be applied to sores and swellings (Morton 1981).

Machaerium quinata (Aubl.) Sandwith vel aff.
[Milliken 2388, K]

Leguminosae

Yanomami name: *rããsirima tʰotʰo*

Remedy for stomach ache and worms (Xitei).
Scrapings of the stem are mixed with cold water and a little of the (very bitter) extract is drunk. An infusion of the crushed leaves may also be applied externally as a bath.

The Maiongong of Roraima State drink an infusion of the bark of *Machaerium* sp. as a remedy for diarrhea and stomach ache. A decoction of the stem of *M. floribundum* Benth. is taken in Peru for diarrhea (Duke and Vasquez 1994). An infusion of the roots of *M. lunatum* Ducke is also used for diarrhea (Morton 1981). *Machaerium* sap is used to treat diarrhea in Colombia (La Rotta 1988).

Maranta arundinacea L. [Milliken 1726, K]

Marantaceae

Yanomami name: *hore kiki*

Used to heal wounds, cuts and small infected scratches, and to relieve their pain (Xitei). The grated rhizome is applied to the wound.

In Dominica the mashed rhizomes of this species used to be applied to wounds caused by arrows (Hodge and Taylor 1957). In French Guiana the rhizomes are used in a similar way for poisoned arrow wounds (Heckel 1897). In the Antilles the starch is applied externally to treat sunburn, erysipelas, dermatitis, wasp stings and gangrene (Morton 1981).

Monstera adansonii Schott [Milliken 2432, K]

Araceae

Yanomami name: *xãã a*

Remedy for inguinal abscesses (Balawaú).
The swellings (galls) which develop on the aerial roots are grated or crushed, and rubbed on the abscess to take away the pain and draw out the pus. Afterwards, the juice of the crushed plant is mixed with water and used to wash the open abscess.

The Siona and Kofán of Ecuador apply a decoction of the crushed plant to boils (Schultes and Raffauf 1990). The sap is said to be caustic and to cause lesions (Grenand, Moretti, and Jacquemin 1987). In the West Indies poultices of the leaves are used to relieve pain (Ayensu 1981).

Musa sp. (cultivar)

Musaceae

Yanomami name: *aiamo si*

Remedy for snake bite (Xitei).

The juice is squeezed from the outer layer (bark) of the stem, and drunk in place of water. This use is specific to the variety.

In Trinidad a decoction of the roots of the banana plant is applied to snake bite and scorpion stings (Mor-

ton 1981). The water from the stem of certain varieties of banana plants is drunk in Indonesia (sweetened) as a remedy for snake bite (Dharma 1987).

Nicotiana tabacum L.

Solanaceae

Yanomami name: *pee nahe*

Remedy for botfly infestations of the skin (Xitei). The juice of the crushed or chewed leaves is applied to the skin above the larva, which dies and can be squeezed out.

The Ka'apor use this species in the same way to kill botfly larvae (Balée 1994), as do the Wayãpi of French Guiana (Grenand, Moretti, and Jacquemin 1987).

Picramnia spruceana Engl. [Milliken 1739, 2000, K]

Simaroubaceae

Yanomami name: *koexi hi* (Watoriki), *koa akaxi hi* (Balawaú)

Remedy for arrow wounds and for skin afflictions (scabies, impetigo) in babies (Watoriki).

The purple juice of the crushed leaves is applied externally to the affected region. For arrow wounds, the leaves are also chewed and the juice is swallowed. If the patient is unconscious, the juice is squeezed out into his/her mouth. The crushed leaves are packed into the wound and held in position with a vine, to staunch the bleeding and alleviate the pain. The juice is said to sting the wounds.

This species is used by the Boras of Peru to treat skin irritations (Duke and Vasquez 1994). The Shipibo-Conibo of Peru use a decoction of the leaves of *Picramnia* sp. to disinfect and heal wounds (Arévalo Valera 1994). In French Guiana an infusion of the bark of *P. tariri* DC. is also used for its astringent properties (Heckel 1897). In the Xingu region of Brazil the bark of various *Picramnia* species is used to treat skin problems (Freise 1933). The bark of *P. antidesma* Sw. was formerly exported to Europe from Central America for treating erysipelas and venereal diseases, and is used in Jamaica to treat skin ulcers (Morton 1981).

Pothomorphe peltata (L.) Miq. [Milliken 2346, K]

Piperaceae

Yanomami name: *mahekoma hanaki*

Malaria remedy, also for intestinal pains (Xitei).

An infusion of the crushed leaves is prepared in heated water. A small quantity is drunk, and the rest is applied externally to the head and body as a bath. For malaria, the crushed leaves may also be rubbed over the body.

This species is also used to treat malaria elsewhere in Brazil (Di Stasi et al. 1994; Sala-Neto et al. 1992), and for fevers in Colombia and Peru (La Rotta 1988; Rutter 1990). The leaf decoction is stomachic, and in Surinam an infusion of the leaves is taken to cure colds accompanied by intestinal pains (Morton 1981). In Mato Grosso do Sul an infusion of the leaves is taken for gastric problems (Berg and Silva 1988b). This species possesses analgesic properties (Di Stasi et al. 1989).

Protium fimbriatum Swart [Milliken 1765, 2357, K]

Burseraceae

Yanomami name: *weyeri hi* (Watoriki), *mani hi* (Xitei)

Decongestant and remedy for respiratory infections (Watoriki). Fortifier for new-born babies' agitation (insomnia) and breathing difficulties (Xitei).

For respiratory problems, the resin is sniffed deeply and rubbed on the chest. A small quantity is dissolved in water and drunk, and may also be poured over the head and body. For babies, the resin (*mani kiki*) is burned so that the smoke is inhaled.

Various *Protium* species are used to clear the nasal passages in the north-west Amazon (Schultes and Raffauf 1990). In Surinam, a small quantity of the resin of *P. heptaphyllum* March is dissolved in water and taken for chest congestion, bronchitis and asthma (Morton 1981). The Ka'apor use *P. polybotryum* (Turcz.) Engl. and *P. tenuifolium* (Engl.) Engl. as decongestants (Balée 1994). In Guyana, the vapor from a hot decoction of *Protium* resin is inhaled to relieve congestion of the lungs (Fanshawe 1948).

Swartzia schomburgkii Benth. var. *guayanensis* Cowan [Milliken 1926, 2321, K]

Leguminosae

Yanomami name: *xotokoma hi, xitokoma hi*

Remedy for diarrhea and intestinal pains (Xitei).

Scrapings of the inner bark are mixed with cold water and a little of the extract is drunk.

In Colombia an infusion of the unripe pods of this species is taken as a vermifuge, and the Makunas use a preparation of the plant to treat dysentery; various species of *Swartzia* are used as vermifuges and diarrhea medicines in the northwest Amazon (Schultes and Raffauf 1990).

Tabernaemontana macrocalyx Muell. Arg. [Milliken 2425, K]

Apocynaceae

Yanomami name: *akiã hi* (Watoriki), *asokoma hi, akiama hanaki,* (Xitei) *axokama hi* (Balawaú)

Remedy for botfly infestations of the skin (Xitei). Also for burns (Balawaú).

A little of the latex is placed over the breathing-hole of the larva to kill it. The larva can then be squeezed out. The latex is applied directly to the burn.

The Maiongong of Roraima State also use the latex of this species to kill botflies. The Palikur of French Guiana use the latex to treat skin infections (Grenand, Moretti, and Jacquemin 1987), as do some of the Guyana peoples (Fanshawe 1948). The Chácobo of Bolivia use the latex of a *Tabernaemontana* species to kill botfly larvae (Boom 1987).

Vismia guianensis (Aubl.) Choisy [Milliken 2360, K]

Guttiferae

Yanomami name: *siiriama sihi*

Remedy for skin burns and wounds (Xitei).

The latex is applied directly to the wound.

In Costa Rica and in Brazil the latex of this species is used to treat skin afflictions (Morton 1981). In Guyana it is used to treat cuts, itching and thrush (Lachman-White, Adams, and Trotz 1987). *Vismia ferruginea* Kunth is applied directly to wounds as an antiseptic in Brazil, Peru and Colombia (Schultes and Raffauf 1990).

Zanthoxylum rhoifolium Lam. [Milliken 2327, K]

Rutaceae

Yanomami name: *nahiri hanaki*

Remedy for fevers (Xitei).

The young leaves are crushed in hot water and applied externally to the head and body. The crushed leaves may also be rubbed over the body.

This species, which contains alkaloids, is used by the Créoles of French Guiana to treat malarial fevers (Grenand, Moretti, and Jacquemin 1987). Other *Zanthoxylum* spp. are used to treat fevers in Peru, French Guiana and Brazil (Freise 1933; Heckel 1897; Rutter 1990).

Zingiber officinale Roscoe [Milliken 2058, K]

Zingiberaceae

Yanomami name: *amarʰa kiki* (Watoriki, Xitei)

Cough remedy (Watoriki). Febrifuge and analgesic for malaria (Xitei).

For coughs, a small piece of the rhizome is crushed in cold water and the extract is drunk. The grated rhizome is mixed with cold water and drunk to bring down fevers associated with malaria, and is rubbed on the legs to calm muscular pains (myalgia) also associated with malaria and fevers.

The Ka'apor use it to treat colds and sore throats (Balée 1994). It serves as a sudorific for fevers, and is used in Costa Rica to relieve throat inflammation, coughs and bronchitis; in Surinam the rhizome is also chewed for coughs, and in Trinidad a decoction is drunk to treat malaria (Morton 1981). In Brazil it is used externally as a rubefacient to treat localized body pains (Abreu Matos 1989).

Discussion

The 198 medicinal plant and fungus species now recorded among the Yanomami constitute a very considerable pharmacopoeia, comparable with (or larger than) many of those recorded among other Amazonian indigenous peoples. Bennett (1992) cited, for example, 245 medicinal species among the Shuar of Ecuador (including more than 100 for gastrointestinal ailments and 98 for skin ailments), Grenand, Moretti, and Jacquemin (1987) listed 180 among the Wayãpi of French Guiana, and Boom (1987) listed 174 used by the Chácobo of Bolivia. Cavalcante and Frikel (1973) positively identified 171 among the Tiriyó of Brazil and collected a further 157 specimens which were not classified, Balée (1994) listed 110 species used by the Ka'apor of Brazil, and Glenboski (1983) listed 84 among the Tikuna in Colombia. Although none of these claim to represent the total knowledge of the people concerned, they presumably give some idea of the numbers of species employed. The time spent in the field at Xitei and Balawaú during the present study was relatively short, and in neither of the two new locations could the species recorded be taken to represent the sum of the medicinal species known there. Without doubt the total number of medicinal species known to the Yanomami is very much greater than that which we have documented, and their pharmacopocia may in time prove to be one of the most diverse recorded. To some extent this may be a result of the considerable cultural diversity which exists among the larger population herein referred to as the Yanomami, and of the significant altitudinal (±100–1600 m) and hence floristic/ecological variation which is found across their extensive territory, which includes parts of the basins of three major rivers (the Branco, Negro and Orinoco). This diversity of knowledge and resources is reflected not only in their use of medicinal plants, but in most aspects of their ethnobotany (Lizot 1984; Milliken, Albert, and Goodwin Gomez in prep.).

The representation of plant families among the medicinal species collected at Xitei, and among the overall list of medicinal species, is very similar to that recorded at Watoriki (Table 1), with particularly strong representation of the Leguminosae (sens. lat.) and the Piperaceae at the specific level. There is a small group of families which consistently appears among the most strongly represented, with 91 (46%) of the species coming from only 11 (14%) of the families in the overall list. As has already been discussed (Milliken and Albert 1996), the taxonomic composition of the Yanomami pharmacopoeia is fairly typical of those recorded in the northern Amazon. Although this may be taken as a pointer to the most pharmacologically active families in the region, it is important to bear in mind the relative sizes and diversities of those families,

which will clearly have an influence upon their representation. However, clear disparities between family size and 'family use value' have been demonstrated for medicinal plants in Peru by Phillips and Gentry (1993).

One of the more striking differences found at Xitei was the relatively large number of Gesneriaceae used there for medicinal purposes, which may be a consequence of a greater abundance of this family in higher-altitude forests than in the lowland forests at Watoriki. A substantial number of the medicinal plants collected at Xitei do not occur in the vicinity of Watoriki, e.g., *Swartzia schomburgkii, Croton palanostigma* vel aff. and *Tabernaemontana macrocalyx*, and to some degree this can be taken to account for the differences between the information recorded at these two locations.

The overall list of uses to which the medicinal plants and fungi are put (Table 3) differs little from that which was originally recorded at Watoriki, with fevers substantially the most important, followed by intestinal disorders, malaria, toothache, eye infections and respiratory disorders etc. The possible historical implications of the predominance of these treatments have been discussed (Milliken and Albert 1996). For most medicinal applications, the range of families and genera employed is extremely diverse. Some of the boundaries between the illnesses, and thus between the medicinal applications, perceived by the Yanomami differ significantly from those generally accepted in Western medicine, making it difficult to draw absolute parallels. The category labelled "infectious epidemic diseases" for example, known as *xawara a wai* or *teosi a wai* (Xitei), includes a variety of disorders and owes its definition more to the Yanomami's perception of its causes than to the exact symptoms. *Teosi a wai* (God's epidemics), which derives from the Portuguese word for God (Deus), refers generically to epidemics associated with the coming of the white people (e.g., measles, influenza, whooping cough etc.), and at least 18 specific epidemic diseases fall within the category *xawara a wai* (see Albert and Goodwin Gomez 1997). The majority of the plants used to treat these epidemic disease categories are applied externally, probably acting as febrifuges or sudorifics.

There are considerable differences between the names used for plants by the Yanomami at Xitei and those at Watoriki, as can be seen for some of the species cited in the results. This corresponds to significant linguistic differences between these areas. The language of both groups corresponds to the "Yanomam" (Migliazza 1972) or "Eastern Yanomami" (Ramirez 1994) language, but the inhabitants of the Alto Catrimani region (to which the Watoriki t^{h}eri pë pertain) speak a different dialect to those of the Alto Mucajaí region in which Xitei is included (Albert and Goodwin Gomez 1997). When questioned about the medicinal properties of the species used at Watoriki, the people at Xitei failed to recognize the names of many of the species, and when they did recognize the names they disclaimed knowledge of medicinal properties for many of them. However, there was a considerable degree of overlap between the medicinal species known at the three sites, in spite of the fact that the medicinal uses to which those species were put was not always the same from one location to another (see Results). When recordings of the discussions of medicinal plants at Xitei were subsequently played to the older people at Watoriki, their reaction was not to question the information which was new to them, but to accept it with considerable interest and enthusiasm.

One of the questions which arose during our initial research at Watoriki (Milliken and Albert 1996) was where and when their knowledge of anti-malarial plants was developed. Since the invasion of their lands by wildcat gold miners (*garimpeiros*) at the end of the 1980s, malaria has posed a very serious health problem for the Yanomami, and has caused a great number of deaths (MacMillan 1995). It was initially thought that, having lived in relative isolation until that time, they had not been exposed to the disease and would therefore have no knowledge of medicinal plants with which to treat it. However, this was clearly not the case at Watoriki, where 10 species were collected which were specifically said to be used for treating malaria (seven internally and three externally), one of which (*Aspidosperma nitidum* Benth., Apocynaceae) is widely used for the same purpose elsewhere in the Amazon. The Watoriki t^{h}eri pë have been in direct or indirect contact (through other Yanomami groups) with neighboring Indian groups such as the Ye'kuana and the Makú of the lower Parima since the first decades of the 20th century (for the acquisition of metal tools), and in direct contact, however sporadic,

with white people since the late 1960s (Catrimani mission, Ajuricaba FUNAI post and Tootobi mission). It is therefore possible that they contracted malaria and learned about or discovered some of the remedies at the time of these contacts (see Milliken and Albert 1996).

This suggested that the Yanomami living in the more isolated regions such as Xitei, where there was minimal outside contact until the arrival of the *garimpeiros* in 1988, might still have been in the position of knowing little or nothing about anti-malarial plants. However, at Xitei four specifically anti-malarial plants (for internal use) were collected, including *Aspidosperma nitidum* and a further three which had not been collected at Watoriki, and several other species were specified as being used externally (either as baths or as compresses for the enlarged spleen) in the treatment of the disease. It is interesting that two of the new anti-malarial species recorded at Xitei are from the same genus as a species which is also employed for malaria at Watoriki. The significance of the division between externally and internally applied anti-malarial medicines is debatable. Although there is a strong probability that many of the medicines used externally are acting on the symptoms of malaria (i.e., fevers, spleenomegaly, body pains etc.) rather than on the disease itself, the possibility of absorption through the skin of active anti-plasmodial compounds cannot be discounted.

To gather some insight into how and when the Yanomami developed their knowledge of anti-malarial plants requires a more detailed knowledge of the history of the disease in the area. Some light is thrown on the subject by a transcription of a tape which was recorded in 1995 with Roberto, an old headman at Balawaú, who used to live at Tootobi:

> "We got malaria [*hura*: 'spleen-disease'] from the beginning, when we lived over there, in the highlands. People used to travel to the *Hero u* [tributary of the upper Mucajaí] where the *Watatasi pë* lived [extinct non-Yanomami Amerindian group]. That's where people got to know malaria. That's where people used to go and visit. Do you know the *Hero u*? Do you know the *Watatasi pë* people? These *Watatasi pë* were strangers. Our people used to get there from the place called *Konokepë* [an old garden on the upper Tootobi river] to visit the *Watatasi pë* and get metal tools [pieces of worn out machetes and axes] from them. They used to go there and get only a few metal pieces. There were also the *Maitha pë* people [probably another extinct Amerindian group]. Did you know them? The old people first made contact with the *Maitha pë*. They didn't know you *napë pë* [strangers/enemies]. The old people first made contact with the *Maitha pë* from where they lived in the highlands, very far [between the upper Tootobi and the Orinoco rivers]. It was with these people that they first learned to be contaminated with malaria. So they cured themselves with these things [quoted plant names] because there were no 'white people' at that time. There were no whites and none of their medicines."

This statement supports our earlier speculation (Milliken and Albert 1996) that at least some groups of Yanomami came into contact with malaria considerably earlier than has previously been supposed, perhaps as early as the first decades of the 20th century, and that their knowledge of anti-malarial medicine has been evolving since then. This suggestion is supported by the observations of Holdridge (1933), who noted the presence of endemic malaria in the early 1930s on the lower Demini and Aracá rivers, where white settlers had moved in to collect *balata* (latex), *castanha do Pará* (Brazil nuts) and *piaçaba* (palm fibre) on the fringe of the Yanomami territory. Smole (1976:50) also mentioned a probable malaria epidemic in 1935–1940 on the Padamo river (Parima highlands), an area inhabited by the Ye'kuana (Maiongong) people (a Carib speaking group). The Yanomami were in contact with the Ye'kuana at the beginning of the century, as well as with the Purukoto (Carib language), Makú (isolated language), Marakana (isolated), Kamarakoto (Taurepang), Kaliana (Sapé) and Awaké (isolated). They also used to raid white settlements on the Aracá river (Albert 1985:55–56, 59–60), so it is possible that some of them may have already contracted malaria during that period.

Given therefore that some Yanomami groups have probably been in sporadic contact with malaria for a very considerable period of time, through indirect and eventually direct contact with white people, it is natural that since their first encounters with the disease they have been developing a knowledge of the plants which can be used to combat it, either through experimentation or through transmission from other peoples, or, more likely, through a combination of the two. Evidence of experimentation with medicinal plants among the Yanomami was observed at

Watoriki in 1994, where one man had prepared a mixture of plants (normally used as fish poisons and hallucinogens) to treat cutaneous leishmaniasis, apparently successfully. This was based not on the knowledge that the plants would cure leishmaniasis, but on their obvious 'power' as witnessed by their other properties. Certain tastes are associated with particular medicinal properties by the Yanomami, and to some degree these are used in the identification of medicinal species. Plants which are peppery to the taste or which sting (*hrami*) are associated with skin disorders such as itching (*xuhuti*). Those which are bitter (*koaimi*) are used to 'kill' internal pathogenic agents (*yai thëpë*, = 'unknown, unnamed, bad things') felt within the body (worms and other internal parasites, *Plasmodium* etc.), and those which taste acidic (*naxi*) are good for regaining energy and taste. The conscious association of bitter-tasting plants with anti-malarial activity is common in the northern Amazon (Milliken 1997), and some of these other taste-activity associations are probably similarly widespread.

The early sporadic incursions of malaria into the Yanomami area probably diminished or ceased entirely with the later disappearance of all of the neighboring tribes except for the Ye'kuana. When the resulting period of isolation began to come to an end in the 1950s-1960s with the initiation of sustained direct contact with white people (mainly at mission posts), and was finally shattered by the gold-rush in the 1980s, the disastrous malaria epidemic which resulted from this direct contact, though new in its scale and its devastation, was probably not an entirely incomprehensible phenomenon to the older Yanomami.

Colchester and Lister (1978) recorded 16 species of medicinal plants among the Sanema (Northern Yanomami) in Venezuela, during a general ethnobotanical survey in the Orinoco-Ventuari, and 101 species with the neighbouring Ye'kuana. These 16 plants were used to treat stomach upsets (3 species), snake bites (2), insect bites (2), coughs and colds (2), diarrhea (2), sore eyes (2), sepsis (1), fevers (1) and cuts (1). They concluded that "whereas the Piaroa and Ye'kuana possess very well developed herb-lores, the Macu and Sanema have almost none at all. Moreover, many of the few remedies mentioned by the Sanema are clearly recently learned from the Ye'kuana . . . ." In the area studied by Colchester and Lister the Ye'kuana and Sanema had been living in close contact for several decades, and the fact that the Sanema had not assimilated the majority of the Ye'kuana pharmacopoeia (which is highly diverse) was interpreted as suggesting that the effect of using those plants may have been more psychological than pharmacological.

The suggestion that these plants are not directly responsible for the medicinal properties with which they are attributed is strongly questioned by the considerable correlation between the uses to which many of then are put by the Yanomami in Brazil, and the uses to which they are put by other peoples (see the comparative data given with the species listed in this paper, and the discussion in Milliken and Albert 1996). In many cases these correlations are between peoples who are separated by very substantial geographical and linguistic distances, indicating that the uses have probably been developed independently. There are certainly some similarities between the pharmacopoeia of the Yanomami and of the Maiongong (Ye'kuana or Maquiritare), with whom general collecting of medicinal plants, and more particularly of anti-malarial plants, was conducted by WM at Auaris and Uaicas (within the Brazilian Yanomami territory) in 1994. Ten species were collected whose medicinal uses were identical to those made by the Yanomami (e.g., *Anacardium excelsum, Bauhinia guianensis, Dieffenbachia bolivarana* and *Peperomia macrostachya*), seven species were collected which are also used medicinally by the Yanomami but for other purposes (e.g., *Renealmia alpinia*), and six for which other members of the same genus are used for the same medicinal purposes by the Yanomami (e.g., *Albizia* sp., *Faramea* sp., *Guarea* sp. and *Machaerium* sp.). However, whether these similarities are due to parallel discoveries of the medicinal properties of the local flora, or whether they are due to a transfer of information between the groups, would be hard to determine. It may indeed have been a combination of the two. Early relationships between the Yanomami and the Ye'kuana were hostile, and a lasting situation of amicable trading links only developed during this century (Albert 1985:40, 60; Colchester 1982:87). Whether this period of peaceful contact, and/or the previous periods of occasional trading, have been sufficient for the transfer of information to the Northern Yanomami, and then its subsequent passage to the Eastern Yanomami, is a matter for speculation.

Our data from Xitei are not the first records in the literature of the use of medicinal plants

among the upland Yanomami: the data collected by Colchester and Lister (1978) among the Sanema have already been mentioned. Further records of medicinal plants (in each case of a handful of species) have also been made among the lowland Shamatari in Venezuela, who belong to a different language group from the Sanema and from the people at Watoriki and Xitei (e.g., Eguillor-Garcia 1984; Fuentes 1980; Lizot 1984), but similar to the people of Balawaú, an upland Shamatari group (Hwayasiki t'eri pë). However, the discovery of a very substantial knowledge of medicinal plants in the upland Xitei region, as discussed here, in addition to the data already recorded among the Yanomami in the lowlands, strongly suggests that this is by no means the local phenomenon speculated upon at Watoriki (Milliken and Albert 1996), but that it is common to the Yanomami throughout their territory. Initial studies at Watoriki, like those among the Shamatari, only revealed small quantities of information regarding medicinal plants. It was only when a concerted effort was made to investigate this side of their culture that the true richness of their knowledge was revealed.

Conclusion

The pharmacopoeia of the Yanomami Indians (sens. lat.), which is now known to comprise at least 198 species of plants and fungi, is as diverse and developed as that of most other Amazonian peoples. The species used, and the ways in which they are employed, have much in common with those recorded among indigenous and non-indigenous communities both within and outwith the region. Phytotherapy plays a subordinate role to shamanic medicine in the Yanomami system of healthcare, but is nonetheless of considerable significance. The diverse knowledge of medicinal plants previously recorded in the lowland community of Watoriki is not restricted to that group, but is also found amongst upland Yanomami communities (Xitei) and communities pertaining to other language groups (Balawaú). Evidence from this study, combined with hints from the existing literature, suggest that further research would prove it to be universal within the tribe, and that the number of medicinal species recorded would continue to rise substantially. The high diversity of plants used in medicine by the Yanomami is at the same time a consequence of the substantial variations in floristic composition of the forest across their territory, largely due to altitudinal variations and to its position on a major geographical divide (the Amazon/Orinoco watershed), and to the unusual degree of residential dispersion and cultural variation which exists among the tribe as a result of historical intra-tribal hostilities and semi-nomadic migrations.

The fact that a substantial knowledge of medicinal plants has now been recorded among a group of Yanomami who have had very little contact with neighboring tribes or with other outsiders until the end of the 1980s (Xitei) reinforces the interpretation that this knowledge is probably largely original to them, having been developed through long-term experimentation with the local flora. The knowledge of anti-malarial plants is also more widespread among the Yanomami than had previously been supposed, probably as a consequence of sporadic contact with the disease in the early part of the 20th century, and subsequent experimentation with curative plants. Contemporary evidence of such experimentation, spurred by the pressure of the sudden malaria epidemic of the 1980s, has recently been reported among the Macuxi and Ingaricó in Roraima (Milliken 1997). However, the possibility of borrowing by the Yanomami of some medicinal plant information from neighboring peoples, such as the Ye'kuana, cannot be discounted. The willingness which the Watoriki Yanomami showed to learn of new medicinal plants from the Xitei Yanomami has already been commented upon, and there is no reason to suppose that, given the appropriate friendly relations, they would not be equally open to learning from other peoples.

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Appendix 1

Voucher specimens† representing each of the plant and fungus families discussed in the text and in table 1.

Acanthaceae 1701, 1977, 2363; Amaryllidaceae 2342; Anacardiaceae 1733, 1761; Annonaceae 1774, 1803, 1874, 2089, 2318, 2434; Apocynaceae 1734, 1820, 1925, 1975, 2381; Araceae 1716, 1725, 1731, 1790, 1791, 1878, 2300A, 2376, 2409, 2432, 2433; Araliaceae 2322; Aristolochiaceae 1981; Begoniaceae 2334; Bignoniaceae 1719, 1732, 1964; Blechnaceae 2352; Bromeliaceae 2374; Burseraceae 1765, 2066, 2359, 2370; Cannaceae 2389; Chrysobalanaceae 2395; Convolvulaceae 2422; Cucurbitaceae 1921; Cyclanthaceae 2341, 2400; Cyperaceae 1751, 2354; Dilleniaceae 2373; Dioscoreaceae 1799; Dryopteridaceae 1721, 2312; Elaeocarpaceae 2320; Ericaceae 2335; Euphorbiaceae 1980, 2301A, 2311; Flacourtiaceae 1787; Ganodermataceae 2375; Gesneriaceae 1813, 2325, 2337, 2338, 2382, 2402; Gramineae 1775; Guttiferae 1723, 1737, 1856, 1867, 1982, 2355, 2360, 2380; Heliconiaceae 1892; Hernandiaceae 1950; Iridaceae 1727; Lecythidaceae 2323; Leguminosae 1704, 1735, 1736, 1759, 1865, 1879, 1926, 1927, 1959, 2302A, 2330, 2369, 2388; Loganiaceae 2399, 2423; Malpighiaceae 1995; Malvaceae 1800; Marantaceae 1726, 2396; Marattiaceae 2394; Melastomataceae 2324, 2364, 2387, 2397; Meliaceae 2316, 2336; Menispermaceae 1779, 1961, 2328, 2408, 2426; Meruliaceae 1708A; Monimiaceae 1702, 1724, 1893; Moraceae 1741, 1764, 1768, 1806, 1960, 1962, 2307A, 2345, 2349; Musaceae 1907, 1908; Myristicaceae 1810; Myrtaceae 2315, 2329, 2371; Orchidaceae 2304A, 2406, 2407; Palmae 1729, 1821, 1866; Passifloraceae 2032; Phallaceae 1869; Phytolaccaceae 1928; Piperaceae 1720, 1742, 1788, 1804, 1886, 1899, 1924, 2306A, 2346, 2365, 2398, 2420; Plagiochilaceae 2386; Polygalaceae 2378; Polygonaceae 1873, 1970, 2016, 2368; Polypodiaceae 1890; Polyporaceae 2437; Pteridaceae 2317, 2340; Ranunculaceae 2436; Rubiaceae 1705, 1711, 1712, 1730, 1738, 2348, 2383, 2390; Rutaceae 1728, 1747, 1789, 2327; Schizaeaceae 2391; Simaroubaceae 1739; Smilacaceae 2392; Solanaceae 1755, 2403; Sterculiaceae 1760, 2372; Thelypteridaceae 2419; Theophrastaceae 1953; Tricholomataceae 1794; Urticaceae 1785, 1968; Violaceae 1708, 1895; Xylariaceae 1864; Zingiberaceae 1700, 1710, 1969, 1971, 2058, 2326, 2344.

* Note: The article cited in Milliken and Albert (1996) as Biocca (1979b) was erroneously attributed, and was written by Padre L. Cocco.

† Numbers refer to collections in the Milliken series deposited in the Kew (K) herbarium.