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THE CONSTRUCTION OF A NEW YANOMAMI ROUND-HOUSE

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ABSTRACT.—The results of a complete quantitative survey of the plant species used in the construction of a recently built communal Yanomami round-house (*yano*) are presented, together with descriptions of construction techniques and nomenclature. A total of 52 species were recorded as having been used. The most important species employed were *Xylopia* sp. (Annonaceae) for rafters and tie beams, *Manilkara huberi* (Sapotaceae) and *Centrolobium paraense* (Leguminosae) for posts, *Socratea exorrhiza* (Palmae) for walls and thatch supports, *Geonoma baculifera* (Palmae) for thatch, and *Heteropsis flexuosa* (Araceae) for lashing. The choice of species is discussed in the light of recent changes in the lifestyle of the Yanomami and is compared with records of other indigenous Amazonian architecture.

RESUMO.—São apresentados os resultados de um levantamento completo das espécies vegetais utilizadas na construção de uma habitação coletiva Yanomami (*yano*) recentemente erigida, juntamente com descrições das técnicas e nomenclatura dessa construção. Foi registrado um total de 52 espécies, das quais as mais importantes são: *Xylopia* sp. (Annonaceae) para vigas e traves de amarração, *Manilkara huberi* (Sapotaceae) e *Centrolobium paraense* (Leguminosae) para postes, *Socratea exorrhiza* (Palmae) para paredes e esteios do teto de palha, *Geonoma baculifera* (Palmae) para teto de palha e *Heteropsis flexuosa* (Araceae) para amarração. Discute-se a seleção de espécies à luz de recente mudanças no estilo de vida Yanomami, seleção essa que é comparada à descrição da arquitetura de outros povos indígenas da Amazônia.

RÉSUMÉ.—Cet article présente les résultats d'un relevé complet des espèces végétales utilisées dans la construction d'une habitation collective yanomani (*yano*) récente. Il comprend également une description des techniques et de la nomenclature relatives à cette construction. Des 52 espèces enregistrées, les plus importantes sont : *Xylopia* sp. (Annonaceae) pour les poutres et les soliveaux de la charpente, *Manilkara huberi* (Sapotaceae) et *Centrolibium paraense* (Leguminosae) pour les poteaux, *Socratea exorrhiza* (Palmae) pour les parois de la maison et les lattes de la toiture, *Geonoma baculifera* (Palmae) pour la couverture de palmes et *Heteropsis flexuosa* (Araceae) pour les ligatures. Ce choix d'espèces est analysé dans la perspective des changements qu'a récemment connu le mode de vie yanomani et il est comparé avec les résultats d'autres études sur l'architecture amérindienne d'Amazonie.

INTRODUCTION

Early in 1993 the *Watorikɨ theri pë* Yanomami, led by their headman Lourival, moved into a new *yano* (communal round-house) at the foot of the Serra Demini in northern Brazilian Amazonia (Figure 1). Construction of the house had been carried out over a period of several months, during which they had camped nearby in temporary shelters of the type used during long hunting and gathering trips. The distance that they had come from their last *yano* was short (2-3 km). This short move was prompted by the unexpected drying up of the stream (and spring) near the last *yano* during a very harsh dry season.

This micro-move is the latest relocation of the *Watorikɨ theri pë* at the end of a long series of migrations from the upland territory of the Serra Parima to the lowlands of the Demini river basin. Coming from the headwaters of the Rio Parima near the Venezuela/Brazil border, the fathers of the oldest *Watorikɨ theri pë* were living in the upper Rio Mucajaí region during the first decades of the 20th century. They then migrated south on the Upper Rio Catrimani and its tributaries. These macro-moves formed part of the general Yanomami expansion from the highland region of the Orinoco/Rio Branco headwaters into the surrounding lowlands, which began during the 19th century. This was probably caused by a demographic boom due to techno-economic change (acquisition of metal tools and new cultigens from neighboring groups, who had been in direct contact with the white frontier since the mid-18th century), and the availability of unoccupied land due to the dramatic decline in the populations of those neighboring groups during the 19th century (see Albert 1985: 29-42).

After migrating progressively through the Catrimani headwaters, the *Watorikɨ theri pë* arrived on the upper Lobo d'Almada river (a major tributary of the Catrimani river) in the late 1960s. Lourival (the current leader) and his older brothers then moved again, south, to a tributary of the Mapulaú (*Werehisipi u*) river, where in 1973 the majority of them, including Lourival's elders, were killed by an unknown epidemic. At this time, a road was in the process of being built across the lands into which they had moved, the BR-210 or Perimetral Norte, which has since been abandoned in that region. A contact post was set up in the area in 1974 by the Brazilian Indian Foundation (FUNAI) on the Rio Mapulaú, and the *Watořikɨ theri pë* settled there, soon becoming affected by another disastrous epidemic coming from the Catrimani river basin in 1977 (probably measles). The Mapulaú post was abandoned by FUNAI and burned by the Indians. A new post was later opened (1978-1979) at the foot of the Serra do Demini (its current location), near the end of the Perimetral Norte road (km 211). Since the end of the 1970s the *Watorikɨ theri pë* have, by a series of micro-moves, been gradually migrating towards this post and establishing increasingly regular contact. They now live only 30 minutes walk from the Demini FUNAI post, and receive regular medical attention from the CCPY (Comissão Pró-Yanomami) nurse who is based there. The head of the FUNAI post is a Yanomami man (Davi Kopenawa), who lives with his family in the village, and the CCPY nurse is the only non-indigenous person living there.

In July/August 1994, during a follow-up study of the medicinal plants used by the people of *Watorikɨ* (Milliken and Albert 1996), we found that even though almost two years had lapsed since termination of the construction of the new roundhouse, many of its inhabitants were able to identify without difficulty the types of trees from which each of the components of the house had been made. A comprehensive inventory of those tree species was carried out, and notes were made on the construction techniques and details, the results of which are presented here. Although the structure of some Yanomami dwellings has been described in various parts of their territory (Chagnon 1968; Fuerst 1967; Lizot 1984), and some of the principal construction materials used in those areas have been catalogued (Fuentes 1980; Lizot 1984), this is the first complete and quantitative inventory to have been carried out.

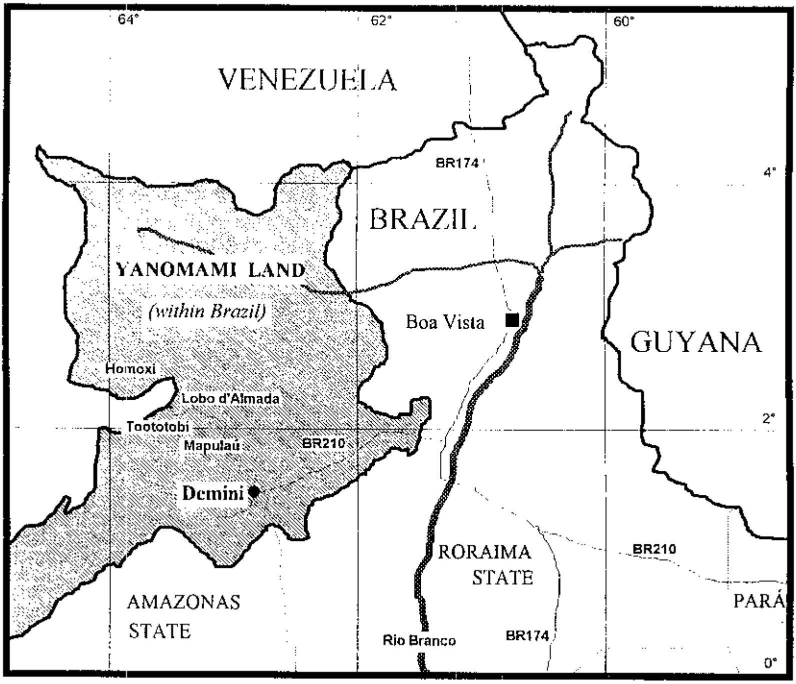

FIGURE 1.—Approximate location of the study area (Demini FUNAI Post)

THE STUDY SITE

The village of ***Watoriki*** (62°49′W, 01°31′N) lies in dense lowland evergreen rainforest at an altitude of approximately 150 m a.s.l. The climate is seasonal with a wet season between April and September and annual precipitation in excess of 2000 mm. The land to the south and south-east of the village is largely flat, traversed by streams, some of which, as we saw, tend to stop flowing in the dry season. The country rock of the area consists of metamorphics of the lower Pre-Cambrian Guiana Complex. Close to the village are numerous granitic hills and outcrops with steep smooth sides of bare reddish rock undergoing typical "onionskin" weathering. The characteristic vegetation capping these outcrops includes agaves, cacti, and other succulents. To the north and north-west of the village, hills rise towards the watershed between the Amazon and Orinoco basins. Although the soils in the area are largely clayey, dystrophic red-yellow latosols (RADAMBRASIL 1975), there are patches in the vicinity of the village which are distinctly sandy. The forest is diverse and mixed, showing a fairly typical composition for the region, with tree species representative of both the Amazon and Guayana regions present (see Steyermark *et al.* 1995).

METHODS

Detailed drawings and photographs were made of the construction details of the *yano*. Each of the categories of components was numbered, and their Yanomami names were recorded. A systematic quantitative survey of the names of the plants used to make each of these components was then conducted, category by category. From these data, a single list was composed of the Yanomami names for all of the plants employed in the construction of the *yano*. These plants were then collected in the surrounding forest (with Antonio Yanomami), and their names and uses were double-checked by consensus with at least one other resident in the village. Voucher specimens were kept, initially preserved in 70% alcohol (Schweinfurth method). These specimens, where fertile, have been lodged in the herbaria at Boa Vista (MIRR), Manaus (INPA), Kew (K), and New York (NY). Sterile voucher specimens are maintained at Kew only.

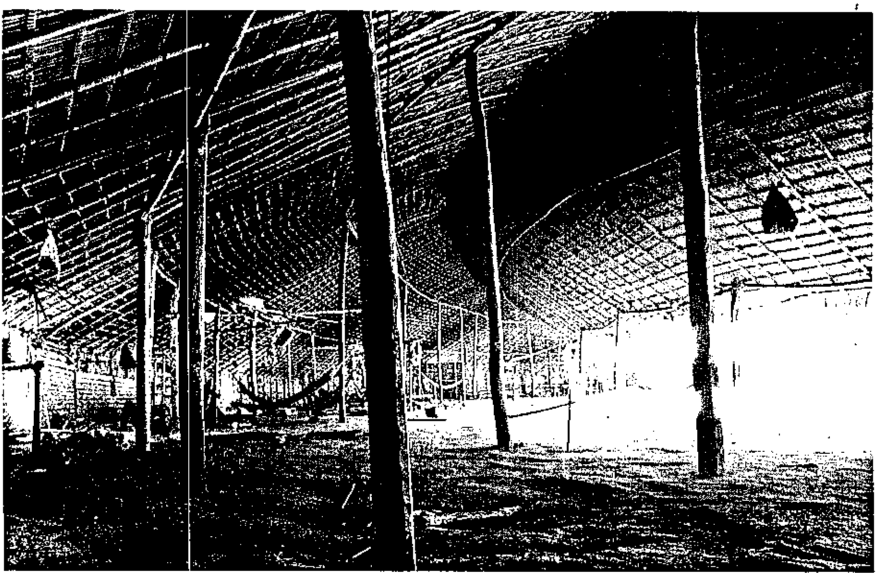

FIGURE 2.—Interior of the *Watoriki* round-house, with the opening to the central "plaza" on the right, and the outer wall on the left.

THE CONSTRUCTION AND COMPOSITION OF THE *YANO*

The *yano* at *Watoriki* consists of a covered ring-shaped structure approximately 80 m in diameter, walled on the outside and open on the inside (Figure 2). It is built in a clearing (*yano a roxi*) large enough to ensure that the tallest trees in the adjacent forest will not cause damage if they fall. At the centre of the *yano* is a large open space (*yano a miamo*). The Yanomami live in family groups scattered around the ring, each of which has its own cooking fire about which the hammocks are positioned. This conforms essentially to the typical layout of an open Yanomami round-house (*yano mat^h^a*), as described and illustrated by Chagnon (1968), Fuerst (1967), and Lizot (1984). Houses vary in size but are always round, so the size of the opening in the centre (*yano kahiki* or "*yano*'s mouth") necessarily increases as the diameter of the house increases. In the smallest "closed" houses (*yano komi*), this is reduced to a small smoke-hole at the centre, sometimes capped by a type of thatched chimney. The topmost point of a *yano komi* is known as the *yano oraka*.

FIGURE 3.—Detail of one of the main doors (*pata yoka*) at *Watoriki*, looking inwards. Note the thatched wall on the left, the *Socratea*-wood wall on the right, and the folding door (also made from *Socratea* wood).

The outer wall at *Watoriki*, about 1.25 m high, is breached by four main doors, which are blocked off from the adjacent living areas by short walls (Figure 3, 4). These principal openings lead directly to the main trails which run from the village to the nearby streams, to the gardens, and to the other Yanomami villages in the region. Main doors (*pata yoka*) are classified according to where they lead: *hwama yoka* ("guest doors") and *periyo yoka* (trail doors) open onto the principal paths where visitors and travellers enter and leave the village. In addition, there are *rama yoka* (hunting doors) where hunting paths leave, *napë yoka* (stranger doors) where paths lead to white settlements, *hutu yoka* where paths lead to the gardens, and doors where paths leading to water (*mãu uka yo*) leave the village. There are also a number of other, smaller, doors (*wai yoka*) which open onto the *yano a roxi* clearing, and are used by the families who live alongside them. The floor of the roofed area is made of beaten earth, raised slightly above the level of the central "plaza." A considerable quantity of water can accumulate in this central area during heavy rainstorms, which is channeled out through two drains. The roof of the ring is made up of two parts; the outer (main) roof which covers the living area and which slopes outwards, and the inner (secondary) roof which slopes inwards (Figure 5). The outer roof overlaps the inner (about 5 m above ground level), preventing rain from entering the small gap which separates them. This gap allows the smoke of the cooking fires to escape.

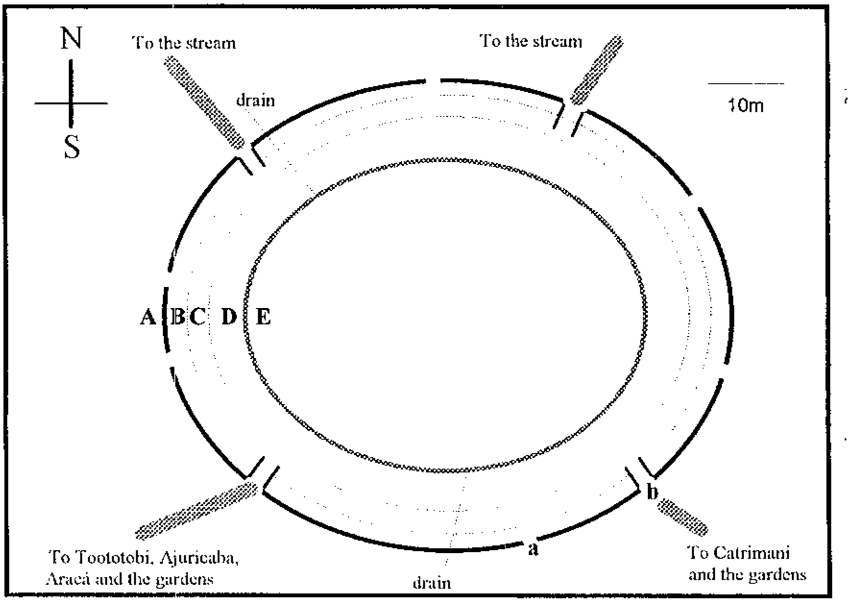

FIGURE 4.—Aerial plan of the *Watoriki* round-house, showing the living areas, doors and principal trails. A) *yano a roxi* (clearing around *yano*); B) *yano a xĩkã* (feminine space), ±1.5 m width; C) *nahi* (hearth, family space), ±3 m width; D) *yano a hẽhã* (masculine space), ±5.25 m width; E) *yano a miamo* (central "plaza"); a) *wai yoka*; b) *pata yoka* (see text for more details on doors).

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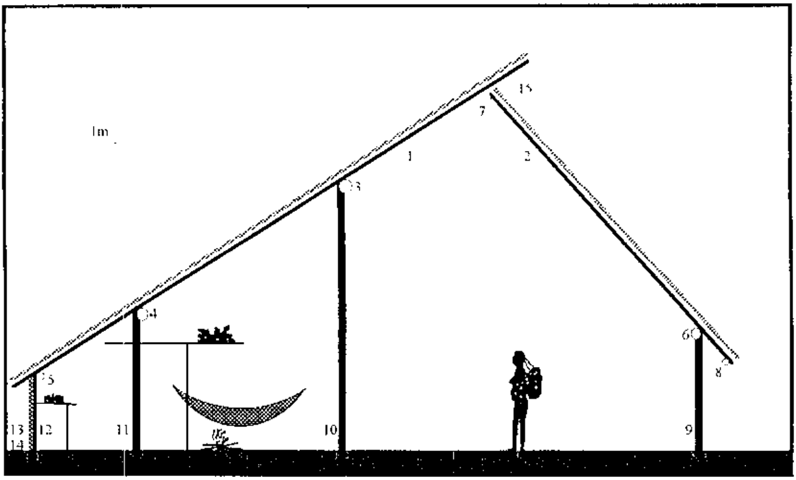

FIGURE 5.—Cross-section of the *Watorikɨ* round-house (to scale), showing the principal components (excluding thatch details). On the right is the opening to the central "plaza." 1-2) *yano araatima nahikɨ* or *yano naanahikɨ* (rafters); 3-8) *yano nahikɨ mamo* (tie-beams/purlins); 9) *xatia kɨkɨ* or *hẽhãã kɨkɨ* (posts); 10) *hẽhããtima nahikɨ* or *hẽhãã kɨkɨ* (posts); 11) *t^{h}onahima nahikɨ* or *t^{h}onahima kɨkɨ* (posts); 12) *xĩkããtima nahikɨ* or *xĩkãã kɨkɨ* (posts); 13) *arana kɨkɨ* or *aranakɨ* (outer wall); 14) *yano koro* (outer wall base); 15) *yano ora* (high point of roof).

The roofed area is approximately 10 m in breadth, of which a little less than half is used as living space, occupied by clusters of hammocks around cooking fires and by racks and shelves on which food and a few belongings are stored. This includes the outer "female" portion behind the women's hammocks (*yano a xĩkã*), and inside this the hearth area occupied by the men's and children's hammocks (*nahi*). The portion between the hearths and the central opening is known as (*yano a hẽhã*). This inner half of the roofed area is kept clear and is used for communal and ceremonial activities and as a corridor. These zones, which are shown in Figure 4, correspond to the spaces between the concentric rings of posts shown in Figure 5. The central open area (*yano a miamo*) is also for ceremonial use and acts as a playground for children, etc. The overall impression is one of airiness and space, resulting in an extremely pleasant living environment. The outer wall keeps out most of the wind, the inner opening allows sufficient light to enter, and the roof keeps the temperature comfortable even on the hottest of days.

The roof is thatched with the fish-tail-shaped leaves of *Geonoma baculifera*, a small lower-understory palm. These are folded in half and tied by the rachis, closely overlapping, to thin lengths of wood from the *manakasi* palm *Socratea exorrhiza* (Figure 6). The resulting "tiles" are placed horizontally across the rafters, again closely overlapping, and secured with the tough but flexible aerial roots of the epiphytic/climbing aroid *Heteropsis flexuosa*. During the roofing process a rough scaffolding, *yano ĩrakɨ*, is erected. *Heteropsis* (*masi kɨkɨ*) roots, which are also used for basketry, are employed throughout the house for lashing its various components together. The aerial roots of the epiphytic climber *Thoracocarpus bissectus* and the stems of the lianas *Callichlamys latifolia* and *Arrabidaea* sp. were also said to be suitable for this purpose. To thatch one square meter of roof, approximately 160 *Geonoma* leaves are used, and an estimated 500,000 leaves, calculated by estimating the roof area, were used for the whole building. To prevent the small leaves from being displaced or damaged in strong winds, the leaves of the larger palms *Maximiliana maripa* and *Jessenia bataua* are attached (vertically) on top of the *Geonoma* thatch.

FIGURE 6.—Detail of the thatch at ***Watoriki***. Note the slender *Socratea* wood slats around which the individual leaves are folded, visible at the top right of the picture. Each leaf is folded double at the midrib (at the edge furthest from the camera).

A quantitative list of the 52 species recorded as used for timber, thatch, and lashing in the construction of the ***yano*** at ***Watoriki***, and the components for which they were employed, is given in Tables 1 and 2. However, it should be borne in mind that since it was found that a few of the Yanomami plant names, such as ***sikāri a***, were found to refer to more than one species of tree (generally in the same genus or family), this may also be the case for others. It is likely therefore that a greater number of species were actually employed in the construction of the ***yano*** than is estimated here.

Most of the principal wooden components of the house had been stripped of their bark, but this was not universally the case. The bark had been left on the rafters from where they cross the outside tie-beams to their outer ends, probably to help protect them from the weather. In the choice of wood for rafters, the criteria are primarily length (9 m for the outer roof) and straightness, and secondarily, strength and lightness. Trees of the families Myristicaceae, Annonaceae, and certain Leguminosae are particularly well suited for this purpose on account of their

TABLE 1.—Inventory of the wooden components of the *Watoriki* round-house, listed by tree species. Column numbers correspond to the numbered components in Figure 5.

Family	Species	Name	Voucher No. (WM, K)	1	2	3	4	5	6	7	8	9	10	11	12	Total
Annonaceae	*Anaxagorea acuminata* (Dun.) A. St.-Hil.	*rāina tihi*	1774	1												1
	Duguetia lepidota (Miq.) Pulle	*amatha hi*	1803	4			6									10
	Fusaea longifolia (Aubl.) Saff.	*hwapo mahi*	1881	1	2	4	3	6							2	18
	Guatteria sp.	*seisci unahi*	2082	47	44	1		3	1	2						98
	Xylopia sp.	*yao nahi*	2014	366	91	24	34	16	10	17	12					570
Apocynaceae	*Aspidosperma* sp.	*rahaka mahi*	1975				1	1	1						1	4
Bignoniaceae	*Tabebuia capitata* (Bur. & K. Schum.) Sandw.	*masianari kohi*	2053											1		1
Burseraceae	*Protium fimbriatum* Swart	*weyeri hi*	1765	1												1
Chrysobalanaceae	*Couepia caryophylloides* R. Ben.	*wãro uhi*	2015		6			1							23	30
	Licania aff. *heteromorpha* Benth.	*maraka axihi*	2040	3	5				1							9
	Licania kunthiana Hook.f.	*maraka nahi*	2035		3											3
	Licania cf. *polita* Spruce ex Hook.f.	*xihini hi*	2045	2	11											13
Elaeocarpaceae	*Sloanea macrophylla* Benth. ex Turcz. vel sp. aff.	*akapa ahi*	2038		1											1
Euphorbiaceae	*Croton matourensis* Aubl.	*ara usihi*	1923	1							1					2
	Maprounea guianensis Aubl.	*yĩp~ɨ hi*	2072		1											1
	Pogonophora schomburgkiana Miers	*tihitihi nahi*	2043	1										2		3
Flacourtiaceae	*Casearia guianensis* (Aubl.) Urban	*yāpi mamo hi*	2050		3			1		1	2				10	17
	Casearia javitensis Kunth	*waxia hi*	1787		3											3
Lauraceae	*Aniba riparia* (Mez) Kunth	*thuë mamo hi*	1993	2	5			5	4		3		8	4	25	56
	Licaria aurea (Huber) Kosterm.	*hōkō mahi*	2002		1											1
	Nectandra sp.	*rapa mahi*	2063	1												1
Lecythidaceae	*Eschweilera coriacea* (A.DC.) Mori	*hokoto uhi*	2007												1	1
Leguminosae	*Centrolobium paraense* Tul.	*hewë nahi*	1989									17	15	23	6	61
	Martiodendron sp.	*paxo hi*	2054		1									1		2
	Tachigali myrmecophila (Ducke) Ducke vel aff.	*kataa nahi*	2047	58	30	7	2	10	10	11	4				4	136
	Zollernia paraensis Huber	*uki sihi*	1959										1			1
Meliaceae	*Trichilia* sp.	*akanaxi ahi*	2011					1							7	8
Monimiaceae	*Siparuna decipiens* (Tul.) DC.	*maharema ahi*	1724					1							12	13
Moraceae	*Pourouma ovata* Tréc.	*momɨnari usihi*	2041		2											2
	Pourouma tomentosa Miq. ssp. *persecta* Standl. ex C.C. Berg	*kahu akahi*	2044	2	3											5
	Pseudolmedia laevis (R. & P.) Macbride	*asõa sihi*	1741								1					1

TABLE 1.—Continued.

Family	Species	Name	Voucher No. (WM, K)	1	2	3	4	5	6	7	8	9	10	11	12	Total
Myristicaceae	*Iryanthera laevis* Mgf; *Iryanthera juruensis* Warb.	***sikāri a***	2048/9	20	129			2		1	15				7	174
	Virola elongata (Benth.) Warb.	***yākõana a***	1780	2	3											5
Myrtaceae	*Eugenia flavescens* DC vel sp. aff.	***pore hi***	2052			1	6		1			4	2	1	75	90
	Eugenia sp.	***korokoro sihi***	2065												1	1
	Myrcia sp.	***totori mayõ hi***	2033	1		3	3	5				12	3	4	32	63
Palmae	*Bactris monticola* Barb. Rodr.	***mokamo si***	1983	1	1											2
	Socratea exorrhiza (Mart.) H. Wendl.	***manaka si***	1866								9					9
Quiinaceae	*Quiina florida* Tul. vel sp. aff.	***naxuruma ahi***	2037	1		2	3						1			7
Rubiaceae	*Duroia eriopila* L.f.	***hera xihi***	1749	1					2			2			2	7
Sapotaceae	*Chrysophyllum argenteum* Jacq.	***nafra hi***	2046										1		11	12
	Manilkara huberi (Ducke) Standl.	***xaraka ahi***	2042		1							12	22	43		78
	Pouteria caimito (Ruiz & Pav) Radlk.	***paxo wãt^{h}emo hi***	2010										1			1
	Pouteria cladantha Sandw.	***hõrõmo nahi***	2039	2	2	1		2				3	2		3	15
	Pouteria hispida Eyma	***yãwa xihi***	2064												1	1
	Pouteria venosa (Mart.) Baehni ssp. *amazonica* Penn.	***maĩko nahi***	2074												7	7
Violaceae	*Amphirrhox surinamensis* Eichl.	***maxopo mahi***	1708												55	55
	Rinorea lindeniana (Tul.) O. Kuntze	***okora xihi***	1895		1										23	24
		Unnamed				1			2							3
				518	349	44	58	54	32	32	47	50	56	79	308	1627

architecture. Of these, Hallé *et al.* (1978) assign *Iryanthera* and *Virola* (Myristicaceae) to the Massart model of tree architecture, *Xylopia* (Annonaceae) to the Roux model, and *Tachigali* and *Sclerolobium* (Leguminosae) to the Petit model, all of which are defined as having "monopodial orthotropic trunk axes with plagiotropic branches" (straight unbranched trunks with horizontal branches). The Annonaceae and Myristicaceae account for 81% of the 867 rafters used at ***Watoriki*** (64% and 17% respectively). Young individuals of *Tachigali myrmecophila* (Leguminosae) are also used in considerable numbers. The preferred species for rafters is *Xylopia* sp., which makes up 53% of all the rafters and 71% of those of the outer roof. The reason for the difference in these figures is that the outer roof, which is of the greatest importance since it covers the living area, was built first. When it came to the building of the inner roof, however, the remaining *Xylopia* trees were said to have been so far away from the village that a greater proportion of other species (notably *Iryanthera* spp.) were used instead.

TABLE 2.—Species used for thatching, lashing, and minor structural elements in Yanomami roundhouse construction

Species	Family	Uses	Voucher specimens
Arrabidaea sp.	Bignoniaceae	Stem for lashing	2018
Callichlamys latifolia (Rich.) Schum.	Bignoniaceae	Stem for lashing	2019
Geonoma baculifera (Poit.) Kunth *	Palmae	Fronds for thatch	2034
Heteropsis flexuosa (Kunth) Bunting*	Araceae	Roots for lashing	2008
Jessenia bataua (Mart.) Burret*	Palmae	Fronds for securing thatch	-
Maximiliana maripa (Correa de Serra) Drude*	Palmae	Fronds for securing thatch	- -
Socratea exorrhiza (Mart.) H. Wendl	Palmae	Wood for thatch supports, walls, doors	- -
Thoracocarpus bissectus (Vell.) Harl.	Cyclanthaceae	Roots for lashing	1994

* Species used at ***Watoriki***

The requirements for the tie-beams, which must also be slender and strong but which are generally considerably shorter than the rafters, are met by most of the species used for the latter. Again *Xylopia* and *Tachigali* are strongly represented. The lesser need for length, however, allows some of the harder species which are more commonly used for posts to be used, whereas the greater need for strength perhaps precludes the use of certain rafter species such as *Iryanthera* and *Virola*. The support posts (***yano nahiki***), of which the innermost three rings are the most important structurally, must be very strong and, as they are partially buried, resistant to rotting. Close-grained hardwoods are used for these posts. Of the 185 posts of these three inner rings, 97% are made from the wood of the four tree families: Sapotaceae (45.5%), Leguminosae (31%), Myrtaceae (14%), and Lauraceae (6.5%). Two species are particularly important: *Manilkara huberi* (42% of the posts) and *Centrolobium paraense* (30%). The outermost ring of posts is represented by a greater variety of species (21) since, although it supports a considerable weight, it is made up of a far greater number of posts (308) and thus individual strength is of less importance.

The outer wall of the *yano* is made up either of split sections of the trunk of *Socratea exorrhiza* (a wood which is particularly easy to split and thus ideal for the purpose), laid vertically or horizontally, or of thatch of the type used for the roof (Figure 3). These thatched walls are supported by a line of slender uprights (***xĩkãhami kɨkɨ*** or ***xĩkãmahihami kɨkɨ***). *Socratea* is also used for the short walls beside the four main entrances. The composition of the wall and of other structural components varies around the perimeter, demonstrating the individuality of the family groups living beside it. The family which is to live in a particular section of the round-house is largely responsible for its construction, so the species used in any area will depend to some extent upon personal preference. In the case of the outer wall, this may depend upon whether the inhabitants remember the days when inter-village skirmishes were common in the area where they lived, that is, when the strength of the wall (or in some cases of an outer palisade) as a defense was of greater importance than it is now. According to Smole (1976), these outer palisades, which are more common in the Parima highlands, would be maintained only when raids were expected. Fuerst (1967) described walls at Toototobi which were composed of an inner layer of *Socratea* planks and an outer layer of thatch, thus serving both as an effective wind-break and as a substitute for a palisade.

DISCUSSION: THE *YANO* IN CONTEXT

Watorikɨ *in the context of previous Yanomami studies.*—Fuentes (1980), in his general studies of the plants used by the Yanomami in Venezuela, listed the Yanomami names of 11 trees which were commonly used for house construction. Not all of these were identified, but they included the genera *Centrolobium*, *Duguetia*, *Eschweilera*, *Tabebuia* and *Tachigali*, all of which were recorded in the present study, as well as one member of the Burseraceae. Four plants were recorded as used for lashing, including *Heteropsis* and *Cydista* (Bignoniaceae), the second of which was not recorded at ***Watorikɨ***, but corresponds to the other bignoniaceous lianas collected there. In his travels among the upland Yanomami, Prance (personal communication) recorded a much greater use of the wood of *Eschweilera* spp. for posts than was found at ***Watorikɨ***, where it was virtually absent. Lizot (1984) cites the use of eight preferred trees from his upland study area in Venezuela, and the occasional use of a further eight. Again, the majority of these were not identified, but they included *Duguetia*, *Eschweilera*, *Tachigali*, *Guarea* (Meliaceae), *Geissospermum* (Apocynaceae), and *Pera* (Euphorbiaceae), the last three of which were not used at ***Watorikɨ***.

Watorikɨ *in the context of change.*—The ***Watorikɨ theri pë*** lived for approximately five years in their last *yano*, before moving to the present site. This is an average time for a Yanomami group to remain in one place. These moves generally occur after a minimum of two-three years and a maximum of five-seven years, intensification of contact having a tendency to increase the amount of time spent in one place up to this maximum or beyond. As has been mentioned, the ***Watorikɨ theri pë*** moved to their current location primarily because water remains available there during the dry season. They have developed a degree of dependence on trade goods and medical assistance from the FUNAI post (Demini), and claim that they have no plans to move again in the forseeable future. The concern was expressed that further migration in the direction of the post would take them further away from a supply of *Geonoma* leaves for thatching. It would also almost certainly result in an increased dependence and in furtherance of social change, which was also of some concern to some of the older people in the village. Instead, they intend to return to the old practice of trekking when the hunting becomes difficult or when the thatch needs to be replaced (the latter having been unnecessary in the past), or, for example, when the women need a large supply of *Heteropsis* roots to make new baskets. Traditionally they would have spent about one third to half the year away from the village, hunting and gathering and living in temporary camps considerable distances away. During this time of fallow, the game would return to the vicinity of the village, the pests and parasites (cockroaches, chiggers, etc.) would die off, and the bananas and manioc and other crops would ripen and mature in the swidden gardens. This fallow practice has largely died out with the process of sedentarization and with movements towards sources of medical support and trade goods (metal tools and pans, glass beads, shorts, etc.). However, it appears that the new demands created by that sedentarization, for materials which would formerly have been met by moving on to a new area, could lead to a renaissance of the trekking practice.

In discussions of the construction of the ***Watorikɨ yano*** and the necessity of maintaining it over a relatively long period, the major preoccupation among the Yanomami interviewed was with the thatch and the availability of *Geonoma* leaves for its replenishment. The gathering of the half million or so leaves for its initial thatching was evidently a mammoth task, and it seems that *G. baculifera* takes a long time to regenerate. It is interesting that Balée (1994), in his study of the ethnobotany of the Ka'apor Indians of the Eastern Amazon, cites this species as one of only two which are directly threatened with "micro-local extinction [extirpation] by traditional Ka'apor forest utilization." In some of the longer-established Ka'apor settlements, the *Geonoma* palms in the surrounding forests have been so depleted that they have had to resort to using other palm genera for thatching.

The thatching of the roof provides a clear example of the dynamic nature of Yanomami construction techniques. Prior to the construction of the ***yano*** at ***Watorikɨ***, the houses used by this group consisted only of an outwards sloping roof and a back wall, as is still the case among most other Yanomami communities of the region. The inner roof, which gives the advantage of shade throughout the day, was a relatively recent introduction. It was said to have been borrowed from the Shamatari (western Yanomami) village of ***Kapirota u*** (situated on the Jutaí, a tributary of the Demini river near the Aracá New Tribes Mission), which the ***Watorikɨ theri pë*** used to visit regularly. The thatching technique, which is described above, was said to have been learned from workers employed at an SPI (Indian Protection Service) post, established on the upper Demini in the early 1940s when a border commission team (CBDL) came to the region. These workers were generally from other Indian groups such as the Tukano, and would help to build houses and camps using their own traditional thatching techniques. At the time the upland Yanomami were using the leaves of *G. deversa* (WM1729, K) for their thatch, supported by the aerial roots of *Heteropsis* — a technique also in current use by the Maiongong Indians in the uplands to the north. When the ***Watoriki theri pë*** moved down into the lowlands, where *G. baculifera*, a better thatching species, is found in greater abundance, they adopted the method used today. This is the same technique described by Fuerst (1967) from a ***yano*** on the Tootobi river.

TABLE 3.—Some tree species used for construction by the ***Watoriki theri pë*** when they lived in the uplands

Yanomami name	Species	Family	Voucher (WM, K)
hayama sihi	-	-	
hõkõ mahi	*Licaria aurea* (Huber) Kosterm.	Lauraceae	2002
iroma sihi	*Ocotea* sp.	Lauraceae	2073
mãiko nahi	*Pouteria venosa* (Mart.) Baehni	Sapotaceae	2074
maima si	*Euterpe precatoria* Mart.	Palmae	1904
naxuruma ahi	*Quiina florida* Tul. vel aff.	Quiinaceae	2037
paroko xihi	*Dialium guianense* (Aubl.) Sandw.	Leguminosae	2070
paya hi	*Sclerolobium* sp.	Leguminosae	2075
poxe mamokasi hi*	*Pouteria* sp.	Sapotaceae	2084
rapa hi	*Martiodendron* sp.	Leguminosae	2076
t^h^uë mamo hi	*Aniba riparia* (Mez) Kunth	Lauraceae	1993
yĩpĩ hi	*Maprounea guianensis* Aubl.	Euphorbiaceae	2072

* The preferred construction species

In the past there would have been considerably less need for the Yanomami to be as discerning about the timber species used in the construction of the house as they had been at ***Watoriki***, since the group would have moved again to a new site before the wood had a chance to rot. A list of some of the tree species said to have been used by the group in the past is given in Table 3. The cutting of a large hardwood tree, particularly before the introduction of effective cutting tools, would have been an arduous task and one worth avoiding if it was not necessary. Furthermore, the choice of available species would have been different in the upland regions from which these people came. Now, building for a longer-term residence, the Yanomami have had to choose rot-resistant hardwoods for their house — particularly for the support posts. The range of species with the right properties for semi-permanent posts is clearly much smaller than that for temporary posts or other components. Both *Centrolobium paraense* and *Manilkara huberi*, the preferred species, are widely recognized in the timber trade as extremely resistant to rot (Rizzini 1971). In terms of the materials used, the ***yano*** at ***Watoriki*** cannot therefore be said to be a *typical* (or "traditional") Yanomami construction in the strict sense. It has been consciously adapted to suit the changing circumstances, as indeed have many other aspects of their material life. This capacity for adaptation and change, which is vital for the survival of any population over the long term, is one of the strengths of the Yanomami.

Although tradition obviously plays an important part in the choice of materials for house construction, opportunism is inevitably an important factor as well.

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There is a limit to the distance which any piece of wood is worth carrying, however pressing the needs for durability, and the composition of the forest in the immediate vicinity of the chosen site will evidently influence strongly the composition of the house (or conversely the location of the house may perhaps be affected by the composition of the forest). In quantitative analyses of the useful properties of the trees in delimited forest hectare plots, as perceived by four Amazonian forest tribes, the percentage of species seen as suitable for construction varied from 30.3% (Tembé) to 2.9% (Panare) (Prance *et al.* 1987). The degree to which the house will be built of "ideal" species will be determined by the abundance of those species in the area, the necessity for an "ideal" house, and the manpower and technology available. The possession of a chain-saw, for instance, would doubtless have had a significant effect on the species used at ***Watorikɨ***.

An example of the effect of such technological change was observed among the Waimiri Atroari Indians, also in the State of Amazonas (Milliken *et al.* 1992). When one of the groups living close to the BR174 highway built a hen-house in 1989, they chose to construct it entirely from the wood of a species of *Manilkara* which grows in abundance in the *caatinga* (white-sand) forests some distance from the village. They were able to do this because they had the use not only of a chain-saw, but also of motorized transport to bring the timber back to the village. Other groups living far from the road, however, were observed to have used a far greater diversity of tree species in their buildings, and this would almost certainly have been the case with the hen-house in similar circumstances. Thirty-two percent of the tree species in one hectare of *terra firme* forest were said by the Waimiri Atroari to be suitable for construction (Milliken *et al.* 1992).

Watorikɨ** in the context of Amazonian construction.*—To continue the comparison with the Waimiri Atroari, one can observe considerable similarities in the use of construction species between ***Watorikɨ and the Waimiri Atroari village of Maré (situated far from the road which crosses their lands). At Maré, as at ***Watorikɨ***, the rafters were made from the wood of various Annonaceae (including *Xylopia*), Myristicaceae (including *Iryanthera* spp.), and *Tachigali myrmecophila*. The main support posts were all made from *Minquartia guianensis* Aubl. (Olacaceae), a very hard and resistant wood much used for this purpose in Amazonia but apparently absent from the forest at ***Watorikɨ***. This species is so prized by the Tembé Indians of Pará that there is a taboo on its burning, the breaking of which is said to result in numerous deaths in the village (Balée 1987). The outer ring of posts at Maré, as with the Yanomami, was built from a broad range of genera including *Eschweilera*, *Licania*, *Pouteria*, *Quiina*, and various Lauraceae and Meliaceae. As with the Yanomami house, the main lashing material used at Maré was *Heteropsis* sp.

Heteropsis roots (known as *cipó titica* in the Brazilian vernacular) are, by virtue of their strength, flexibility and (in many areas) abundance, probably the most commonly used lashing material in the Amazon. Although the fibrous inner barks of certain species of Lecythidaceae and Annonaceae are sometimes used for this purpose, such as by the Wai-Wai of SE Roraima State (WM personal observation), it seems that the *Heteropsis* vines are more durable. However, there are also references to the use elsewhere of bignoniaceous and cyclanthaceous vines in house construction (as recorded at ***Watorikɨ***). According to Boom (1987), for example, the Chácobo of Bolivia employ the genera *Anemopaegma*, *Arrabidaea*, *Cydista*, and *Mellon* (Bignoniaceae) and also use *Thoracocarpus bissectus* (Cyclanthaceae). According to Glenboski (1983), the Tikuna of Colombia use a species of *Asplundia* (Cyclanthaceae) for lashing, and the Cayapa of Ecuador use both *Asplundia* and *Paragonia* (Bignoniaceae) species in the same way (Barfod and Kvist 1996).

TABLE 4.—Comparison of the principal plant families employed in house construction (numbers of species used) at *Watoriki* with those from three studies in Peru.

Watoriki	Pinedo-Vasquez *et al.* (1990)	Parodi (1988)	Phillips and Gentry (1993)*
Sapotaceae (6)	Annonaceae (12)	Annonaceae (14)	Lauraceae
Annonaceae (5)	Palmae (5)	Palmae (12)	Myristicaceae
Palmae (5)	Sapotaceae (4)	Sapotaceae (6)	Annonaceae
Chrysobalanaceae (4)	Humiriaceae (2)	Leguminosae (6)	Leguminosae (Caesalpinoideae)
Leguminosae (4)	Melastomataceae (2)	Lauraceae (5)	Meliaceae
Euphorbiaceae (3)	Moraceae (2)	Moraceae (5)	Leguminosae (Papilionoideae)
Moraceae (3)	Myrtaceae (2)	Guttiferae (3)	Burseraceae
Myristicaceae (3)	Rubiaceae (2)	Cyclanthaceae (3)	Guttiferae

* Listed by descending "family use value"

It is noteworthy that the two most important plant families employed in construction at *Watoriki* (in terms of numbers of species used for the wooden components) were the Annonaceae and the Sapotaceae, since these two families were likewise the most important represented in two published lists of construction materials used in Peru presented by Parodi (1988) and Pinedo-Vasquez *et al.* (1990) (see Table 4). As with the Yanomami, the Sapotaceae were used principally for support posts and the Annonaceae for rafters and beams at these locations. In another Peruvian study (Phillips and Gentry 1993), an analysis was made of the numbers of species employed for each of the principal components of houses. In that study, 122 tree species were cited as suitable for beams and rafters, etc., whereas only 44 were cited for house posts, and Balée (1994) reports that 48 species are used by the Ka'apor Indians of Brazil for roof parts but only 10 for posts. Similar proportions were found at *Watoriki*, where 38 species were used for the roof components and 14 for the three principal load-bearing rings of house posts. These figures emphasize the particularly specialized requirements of the buried posts.

The degree to which a tree trunk will resist rotting and termite attack depends both on chemical and physical factors. The wood (secondary xylem) of certain species of *Eschweilera*, for example, contains silica (Ter Welle 1976), and it seems that this provides some degree of resistance to termites. Many Chrysobalanaceae (e.g., *Licania*) also contain silica, which is extracted from the ashes and used to strengthen pottery by many Amazonian tribes (Prance 1972). Balée (1994) suggests that this is the reason for their frequently being used for rafters and beams by the Ka'apor. Similarly, the phenolic compounds found in various members of the Lauraceae and Sapotaceae (see Schultes and Raffauf 1990) may be responsible

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for their resistance to fungal rot. In a review of the timber properties of certain Guyanan species (Fanshawe 1948), *Pouteria cladantha* and *P. venosa* (Sapotaceae) have been described as "very resistant to decay."

A comparison of the tree species used for construction at *Watoriki* with the choice of species by the Chácobo of Bolivia again shows considerable similarity at the generic level. There, the genera employed for posts included *Aniba, Ocotea* (Lauraceae), *Manilkara, Pouteria* (Sapotaceae), *Eschweilera* (Lecythidaceae), and *Dialium* (Leguminosae), and those used for rafters, etc., included *Guatteria, Anaxagorea, Duguetia, Xylopia* (Annonaceae), and *Aspidosperma* (Apocynaceae) (Boom 1987). These correlations, which could probably be found between semi-nomadic peoples all over the forested regions of the Amazon basin, are more obvious than the correlations found when comparing certain other use categories of plants (e.g., medicines). This should not be surprising; the properties of the wood of the trees in an area will very soon become clear to anybody who regularly has to fell them manually in order to make swidden clearings, and who will then observe their relative rates of decomposition as they lie in the fields.

CONCLUSION

The *yano* described at *Watoriki* is largely typical (structurally) in the context of traditional Yanomami dwelling construction, but the choice of species used to build it has been adapted to meet the demands of small changes in the group's lifestyle, and certain building techniques have likewise been modified. Adaptive changes in house construction are a common phenomenon amongst tribal peoples entering sustained contact with outside societies, and in this case one of the primary factors promoting change has been the increasing sedentariness of the group, resulting from their rising dependence on health support and trade goods, which has led to a need for more durable construction materials. This shift towards a more sedentary lifestyle is widespread among the contacted indigenous groups of Amazonia.

The choice of materials used at *Watoriki* will also have inevitably been influenced by the altered availability of suitable plant species in the lowland forests to which the group has recently migrated, and by the relatively recent introduction of more effective cutting tools than they traditionally possessed, facilitating the use of harder wood and larger trees. These changes in the available plant resources and in their use are reflected in many aspects of Yanomami ethnobotany, including in their use of medicinal plants (see Milliken and Albert 1996) and in their choice of food plants.

There are very clear similarities in the choice and use of building materials at *Watoriki* with those of other Amazonian tribes, resulting from the extensive knowledge of the strength and durability of plant materials which these peoples evidently possess, and the similarity of their circumstances, resources, and technological capabilities. These similarities in species choice are particularly evident in the more specialized components such as thatching and lashing materials. The notably large number of species used in the construction of the *Watoriki* round-house (52 or more) may to some extent be a consequence of its very considerable size and the limited local availability of the most suitable (ideal) species. This is clearly evident in the case of the choice of wood for rafters. However, this is also a reflection of the outstanding breadth and diversity of knowledge which the Yanomami possess as regards the useful properties of the plants of their environment.

The Yanomami are a highly adaptable people, and are ready to alter many aspects of their material culture in order to suit changing circumstances, or to benefit from new resources or technology originating either from other Yanomami groups or from outsiders. However, only when the outside social and cultural pressures of contact are still limited can these alterations be maintained within an overall traditional frame. Compared with some of the more radical changes observed among many Amazonian indigenous groups, such as the common shift from large communal dwellings to clusters of small family houses, the changes in overall building design seen at *Watoriki* are minimal, reflecting the comparative paucity of influence which the regional Brazilian society has had upon them to date. The abandonment of communal dwellings, which is likely to have significant effects upon the cohesion of a group, is much more likely to be the result of direct pressures from outsiders (e.g., missionaries and FUNAI workers), than to be an adaptive response to changing circumstances.

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BOOK REVIEW

Seasonally Dry Tropical Forests. Stephen H. Bullock, Harold A. Mooney, and Ernesto Medina (editors). Cambridge University Press, Cambridge, UK, 1995. Pp. xvii 450. $100.00 (cloth). ISBN 0 521 43514 5.

Over the past few decades major research and conservation efforts have focused on saving the tropical "rain" forests. Dry forests, however, occupy a much larger portion of the tropics than do rain (and moist) forests. Furthermore, because the climate is more hospitable to *Homo sapiens*, most tropical-dwelling folks have chosen to call what is dry "home" (it is where the species evolved, after all). Dry tropical forests have thus been used, changed, and degraded to a greater extent and for a longer period of time than adjacent humid forests. Although rain forest research and conservation efforts are much needed, basic and applied research to direct management and conservation of dry forests are even more critical. A stated goal of this volume is to summarize what is known of these forests in order to direct further research.

This book is a compilation of the proceedings of a symposium held at the Estación de Biología Chamela, Jalisco, México, and sponsored by the Universidad Nacional Autónoma de México (UNAM). The year is not indicated. It is a refreshingly well-edited text. Each chapter is clearly outlined with its own summary and references, and a comprehensive index to the volume is provided. The focus of *Seasonally Dry Tropical Forests* is admittedly slanted toward the neotropics (10 of the 17 chapters). This bias reflects the present state of knowledge in the neo- versus paleotropics and, if anything, points to the dearth of studies in the Old World. With only one or two exceptions (e.g., Matson and Vitousek), the chapters summarize existing studies on various aspects of dry tropical forest ecology and often make comparisons with rain/moist forests. It is a valuable addition to anyone's library who works anywhere in the tropics.

The introductory chapter by Bullock, Mooney, and Medina provides a detailed synopsis of each contributed chapter. Four chapters review the distribution and structure of tropical dry forests in Central America and the Caribbean (Murphy and Lugo), Brazil (Sampaio), Africa (Menaut, Lepage, and Abbadie), and Thailand (Rundel and Boonpragob), including human impacts. Graham and Dilcher have contributed a chapter on the (Cenozoic) paleobotany of northern Latin America and the southern United States (only microfossil records exist). Three chapters examine the diversity of neotropical dry forests' woody species (Gentry, to whom this volume is dedicated), vertebrates (Ceballos), and life forms of higher plants (Medina).

The remaining chapters address specific ecological aspects of neotropical dry forests, drought responses in trees (Holbrook, Whitbeck, and Mooney), plant reproduction (Bullock), and plant-herbivore interactions in Mesoamerican tropical dry forests (Dirzo and Dominguez), and physiological ecology of tropical dry forests in general, namely biomass distribution and primary productivity (Martinez-Yrmzar), nutrient cycling (Jaramillo and Sanford), biology of the below-ground system (Cuevas), and a nitrogen trace gas emissions study at Chamela (Matson and Vitousek).

Most of these chapters address the impacts of humans on dry tropical forests to some degree. Only the last two chapters have human/environment interactions as their theme. As such they will be of greater interest to ethnobiologists. Maass reviews the ways in which conversion of tropical dry forest to pasture and agriculture affect the environment. He then compares these impacts with humid forests to emphasize the importance of developing appropriate management. The final chapter on the ethnobotany of the Mexican tropical dry forests (Bye) provides a summary of research done to date, and includes an analysis of plant use between two biological stations in Mexico's dry (Chamela) and wet (Los Tuxtlas) tropics.

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