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NUTRITIONAL VALUES AND INDIGENOUS PREFERENCES FOR SHEA FRUITS (*VITELLARIA PARADOXA* C.F. GAERTN. F.) IN AFRICAN AGROFORESTRY PARKLANDS[1]

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Maranz, Steven, Zeev Wiesman, Bishnu Chapagain *(Department of Environmental Science, Weizmann Institute of Science, P.O. Box 26, Rehovot, Israel; email steve.maranz@weismann.ac.il),* **Walter Mawuli Kpikpi** *(University for Development Studies, P.O. Box 1350, Tamale, Ghana),* **and Armelle de Saint Sauveur** *(Propage, 211 Rue du Faubourg Saint Antoine, 75011 Paris, France).* NUTRITIONAL VALUES AND INDIGENOUS PREFERENCES FOR SHEA FRUITS (*VITELLARIA PARADOXA* C.F. GAERTN. F.) IN AFRICAN AGROFORESTRY PARKLANDS. *Economic Botany 58(4): 588–600, 2004. Samples of dried shea fruit pulp were collected from tree populations in Mali, Burkina Faso, northern Cameroon, and Uganda. A variety of analytical methods was used to measure total soluble solids (TSS), crude protein, and mineral contents. The results demonstrate that shea fruits are a rich source of sugars, protein, calcium, and potassium during the ''hungry season'', when food stores run low and the energy-intensive work of preparing land for planting must be done. A companion survey of indigenous shea tree and fruit classification was carried out in study area villages. Indigenous savanna inhabitants, especially men, emphasize the importance of fruit pulp taste, while women emphasize the butter content of the nuts. Shea fruits have greater importance to the inhabitants of the drier savannas such as the Sahel, where shea fruits have been shown to have higher nutritional values. While there is currently much international interest in developing the potential of shea butter production in Africa, the role of the fruit pulp in the local diet needs to be taken into consideration in development programs.*

Key Words: *Vitellaria*; *Butyrospermum*; shea butter; fruit pulp nutritional value; parkland agroforestry.

Vitellaria paradoxa C.F. Gaertn. f. (family Sapotaceae), widely known under its synonym *Butyrospermum parkii* (G. Don) Kotschy, a tree that is small to medium in size, is endemic to the African savanna zone north of the equator (Fig. 1). It is known as the shea tree in Anglophone Africa and as karité in Francophone countries. The tree yields a high-stearate fat, called shea butter, that is extracted from the large seeds (nuts) by traditional methods. High-stearate fats are solid at ambient temperature and are characteristic of many trees in the family Sapotaceae, including economic species such as *Baillonella toxisperma* Pierre and *Madhuca longifolia* (J. Koenig) J.F. Macbr. Although none of these species is grown as a plantation crop, all have been exported for use in cosmetics manufacture and as cocoa butter equivalents in the chocolate industry (Lipp et al. 1999; Martin et al. 1987; Plenderleith and Brown, 2000; Storgaard 2000). Shea nuts continue to be an important commodity, with production figures from small farms in the main western African producer nations comparable to world pistachio production (Table 1), although the majority of the nuts collected are consumed locally (Collinson and Zewdie-Bosuener 1999).

As partners in a multinational project to assess and develop the potential of *Vitellaria*, we have recently reported the results of a comprehensive survey of shea kernel fat content and chemical composition across the species range (Maranz et al. 2004). However, while shea nuts and butter are important export commodities and play a major role in the local economy and diet, the fruit pulp is also widely consumed. Shea fruits ripen at the beginning of the monsoonal rains, during the hungry season when food reserves in granaries are running low (Booth and Wickens

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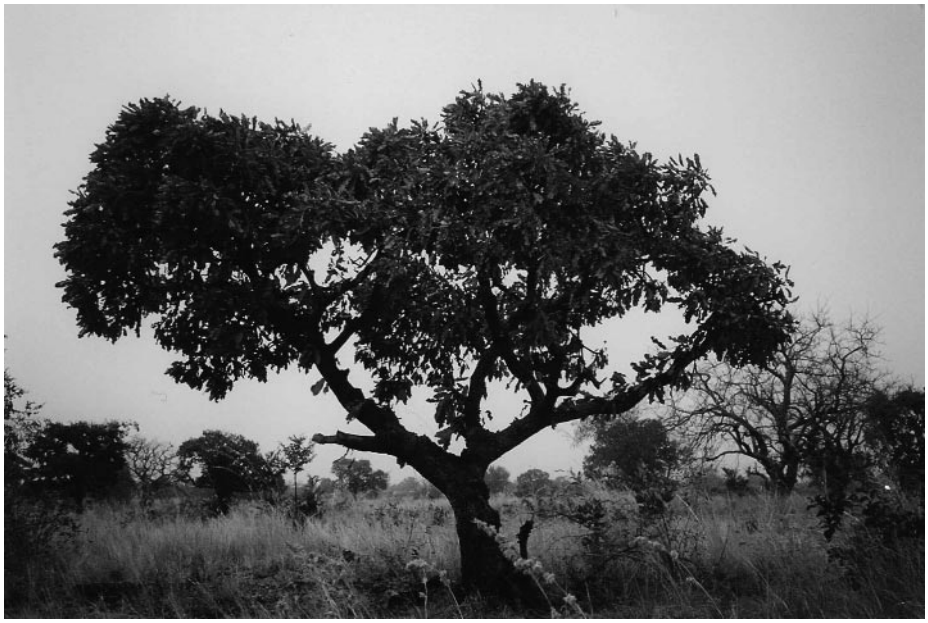

Fig. 1. Shea tree (*Vitellaria paradoxa* Gaernt. f., Sapotaceae) in Burkina Faso.

1988; Lamien et al. 1996). It is also at this time that field crops are being planted—a process that involves land preparation and other energy-intensive activities. Figure 2 graphically shows how shea fruits fit into the calendar of availability among other locally important fruits. The fruit clearly occupies an important period of time in the annual local dietary cycle.

In this paper, we report an analysis of the nutritional composition of shea fruit pulp, together with a survey of indigenous fruit preferences. Our intention is to demonstrate the importance of shea fruit pulp and to highlight indigenous fruit preferences. Because grafted shea varieties with the potential to influence traditional *Vitellaria* agroforestry are beginning to be propagated, we wish to emphasize the nonexport value of fruit pulp at a time when selection criteria are being formulated by policy makers.

VITELLARIA PARADOXA

Vitellaria is presently considered a monotypic genus with two subspecies that together populate a 5000-km stretch of African savanna (Salle et al. 1991). *Vitellaria paradoxa* ssp. *nilotica* occurs in East Africa, ranging through southern Sudan, northern Uganda, the western fringe of Ethiopia, and the northeast corner of the Democratic Republic of the Congo. *Vitellaria paradoxa* ssp. *paradoxa* ranges from the eastern Central African Republic westward to within a few kilometers of the Atlantic coast of Senegal (Hall et al. 1996).

Although often considered wild (Blench

TABLE 1. FAOSTAT 2002 WORLD PRODUCTION ESTIMATES FOR SELECTED TREE SEED CROPS.

Tree	Botanical name	Product	Mt
Cocoa	*Theobroma cacao* L.	Beans	2,830,724
Cashew	*Anacardium occidentale* L.	Nuts	1,698,895
Shea[1]	*Vitellaria paradoxa* Gaertner	Nuts	647,500
Pistachio	*Pistacia vera* L.	Nuts	548,759
Kola	*Cola* spp.	Nuts	217,500

[1] Estimates include only 7 of the 19 producer nations. The figures are not extremely reliable, but they do emphasize the relative importance of shea nuts.

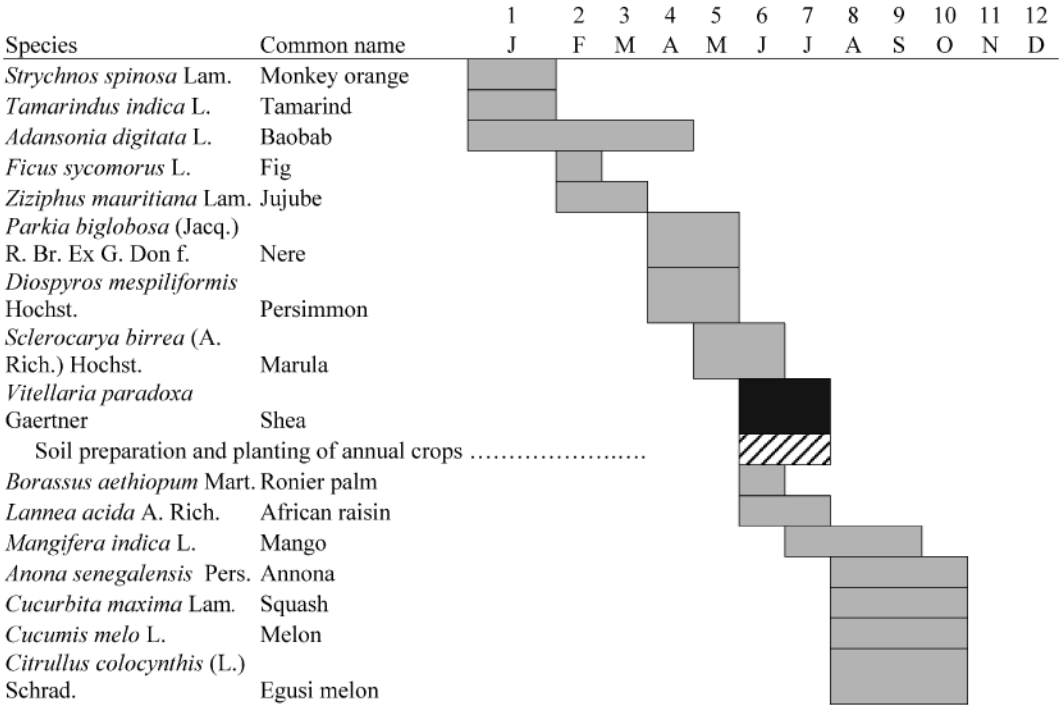

Fig. 2. Chart of seasonal availability of fruits (adapted from Bergeret and Ribot 1990). Shea fruits are the only widely available, energy-rich food source at planting time. Harvest of annual fruits begins as the shea crop dwindles. Harvest times given are for Senegal. Fruit availability may differ in other locations, usually depending on the long-term rainfall pattern. The relative time windows of different fruits are generally constant across the savanna zone.

2001; Boffa et al. 1996), shea trees commonly occur around human habitations and may sometimes constitute more than 80% of the woody biomass in farmers' fields (Lovett and Haq 2000). Shea trees, together with *Parkia biglobosa* (Jacq.) R. Br. Ex G. Don f., are the principal woody components of the Sudanian agricultural ecosystem (ICRAF 1997; Teklehaimanot 1997). This system was in use during the 14th century when Arab explorer Ibn Batuta crossed the Sahara and described a tree with sweet fruit resembling a plum that contained an oil-rich nut. The oil was used for cooking, as a lamp illuminant, and as a base for unguents. Ibn Batuta reported that the oil was very abundant in the region (Mauny 1953). Archaeological excavations in Burkina Faso and northern Nigeria have uncovered shea nut shells from village ruins dated at 1000 years old (Neumann et al. 1998).

Despite the cultivation of modern annual oil crops such as groundnut (*Arachis hypogaea* L.) and cotton (*Gossypium hirsutum* L.), and the influx of palm oil (oil palm, *Elaeis guineensis* Jacq.) from higher rainfall areas to the south, shea butter is still the primary cooking fat of the Sudanian savanna zone (Boffa et al. 1996). It is widely known and used as a skin ointment even outside of the *Vitellaria* distribution range. Salt diggers at Lac Rose in Senegal coat their bodies with shea butter before immersing themselves in the highly saline water to pry up salt slabs from the lake bed. The roots, leaves, and bark of the tree are also used medicinally for treating mouth sores, boils, burns, diarrhea, as a vermifuge, and as eyewash against spitting cobra venom (Neuwinger 1996). Large *Vitellaria* trunks may be used to make mortars for pounding grain. The wood is also used in building and is made into charcoal.

The widely recognized value of shea butter has often overshadowed other uses of the tree, especially the importance of the fruit pulp in the local diet. Shea fruits consist of a thin epicarp and a soft mesocarp enclosing a single seed (occasionally two to four seeds). The epicarp and mesocarp together make up 33–75% of the fresh

Fig. 3. Map of Africa north of the equator showing parallel belts of savanna and the distribution of the shea tree, *Vitellaria paradoxa* Gaertn. f. Inset shows sampling locations in Mali and Burkina Faso within their respective climatic zones.

fruit weight, with an average of 55% (Ruyssen 1957). Men, women, and children eat and appreciate the pulp. Fresh fruits are also sold in local markets.

THE REGION

The *Vitellaria* cultivation zone covers most of the Sudanian savanna, which lies between the Guinean savanna bordering the equatorial forest to the south and the Sahel belt bordering the Sahara to the north (Fig. 3). It is intensively used for both grazing and rotational crop–fallow agriculture. *Vitellaria* also occurs in the adjacent drier Sahelian zone and in the wetter Guinean zones. Mean annual rainfall in the *Vitellaria* distribution area varies from 1500 mm in the south to 500 mm in the north, with a dry season of 5 to 8 months. Elevation ranges from 100 m to

over 1500 m in the highlands of Guinea, western Cameroon, and Uganda.

In the savanna agricultural ecosystem, economically desirable trees are maintained in farmers' fields at spacings that do not interfere with cultivation (Boffa et al. 1996), which is done mostly with hand implements, although animal traction may also be used (Lovett and Haq 2000). Undesirable or unproductive trees are cut down and used for firewood or implements (von Maydell 1990). Fallows contain numerous shea seedlings and saplings that are normally suppressed in cultivated fields. Fallows, as well as fields owned by women, also serve as reserves for medicinal plants and other species useful to households that are generally not given space in cultivated fields (Hall et al. 1996). Grass fires during the dry season reduce the number of woody perennials. Tilled soil in cultivated fields protects valued trees from fire and allows them to reach larger sizes and attain greater productivity (Ruyssen 1957).

Field crops cultivated between trees include sorghum (*Sorghum bicolor* L. Moench), manioc (*Manihot esculenta* Crantz), maize (*Zea mays* L.), and pearl millet (*Pennisetum glaucum* (L.) R.Br.). Common cash crops are groundnut and cotton.

Study Area

Two important populations were chosen for sampling: for subspecies *paradoxa,* the principal shea butter-producing region that spans Burkina Faso and southern Mali; for subspecies *nilotica,* the northern Uganda area. Both areas are characterized by higher rainfall in the south and an incrementally drier climate toward the north. The sampling area in northern Uganda is above 1000 m elevation, while the West African study area is between 100 and 600 m. Both areas are characterized by savanna parkland that is either presently cultivated or lying fallow from a previous farming cycle.

The Luo and Acholi are the major ethnic groups in the northern Uganda study area. In Burkina Faso, the Mossi people are intimately involved with the shea parkland agricultural ecosystem. In Mali, the Bambara have a similar farming system. Other sedentary peoples, including the Senoufo, Gourmantche, and Minianka, cultivate the shea parklands. The semi-nomadic cattle-herding Peul also harvest shea fruits and process shea butter.

Materials and Methods

Shea fruit pulp was collected as a supplement to extensive nut collection for shea butter analysis. Because *Vitellaria* populations in West Africa occur around a village hub, village trees in this region may be seen as representing a population unit and were sampled accordingly. Villagers were asked to identify superior trees according to local preferences. Pulp samples from five preferred trees in each of nine villages in Mali and seven in Burkina Faso were analyzed in this study. The villages were selected to represent the climatic/vegetational zones in which *Vitellaria* occurs (Fig. 3). In Mali, three villages were selected in the Guinean savanna zone (1100–1500 mm mean annual precipitation), three in the southern Sudanian savanna (900–1100 mm), and three in the northern Sudanian (Sudano-Sahelian) zone (500–900 mm). In Burkina Faso, one village was selected in the Guinean zone, and two each in the southern and northern Sudanian zones and the Sahel (500 mm or less).

In northern Uganda, fresh fruits were collected from 40 *V. paradoxa* ssp. *nilotica* trees distributed across the study area, again as a supplement to extensive nut collection for shea butter analysis. Because the human population pattern in northern Uganda is not village-based, trees were not sampled by village but rather in a manner designed to cover the study area spatially (P.N. Lovett pers. comm.). Fruits were also collected from superior trees identified by local farmers.

At all collection sites, freshly fallen whole fruits were picked up from the ground (shea fruits are not harvested from the tree because there is no color change to indicate ripeness) and placed in separate, numbered cloth bags. The pulp, including both epicarp and mesocarp, was removed from the nuts and sun-dried at a collection center. Samples were later oven-dried in the lab and ground in a coffee mill for chemical analysis. A few fresh fruits sent to us from northern Cameroon and northern Ghana (ssp. paradoxa) were prepared in a similar way. A total of 80 *V. paradoxa* ssp. *paradoxa* trees were analyzed from the Mali-Burkina Faso region, with an additional seven trees from Cameroon and Ghana and 40 *V. paradoxa* ssp. *nilotica* trees from Uganda.

In a companion study conducted in the same

TABLE 2. MEAN VALUES AND RANGES OF SHEA FRUIT PULP NUTRITIONAL PARAMETERS COMPARED WITH MARULA (*SCLEROCARYA BIRREA* HOECHST.) AND MANGO (*MANGIFERA INDICA* L.).

Analysis	Units[2]	Shea[1]			Marula[3]	Mango[4]
		N	Range	Mean		
Water	%	—	—	67	86	84
TSS	% Brix	223	4.0–33.9	13.3	3.0	15.0
Protein	g/100 g FW	126	0.8–3.4	1.8	0.7	0.0
P	mg/100 g FW	127	2.9–42.3	23	35	10
Zn	mg/100 g FW	127	0.3–5.2	1.21	2.95	0.30
Fe	mg/100 g FW	127	0.3–58.1	5.4	30.5	0.8
Mg	mg/100 g FW	127	9.4–90.6	43	20	18
Ca	mg/100 g FW	127	24–364	141	35	10
K	mg/100 g FW	127	105–1208	542	333	214
Cu	mg/100 g FW	127	0.0	0.0	1.7	0.12
Mn	mg/100 g FW	127	0–1.29	0.31	0.69	—
B	mg/100 g FW	127	0.3–6.5	2.4		—
Protein	g/100 g DW	126	2.4–10.3	5.6	4.7	0
P	mg/100 g DW	127	9–128	69	251	63
Zn	mg/100 g DW	127	1–16	4	21	1.9
Fe	mg/100 g DW	127	1–176	16	218	5.0
Mg	mg/100 g DW	127	28–275	129	143	113
Ca	mg/100 g DW	127	72–1103	426	253	63
K	mg/100 g DW	127	318–3660	1686	2375	1338
Cu	mg/100 g DW	127	0	0	12	0.8
Mn	mg/100 g DW	127	0–3.9	0.9	4.9	—
B	mg/100 g DW	127	1–20	7		—

[1] Values are for shea fruits from Mali, Burkina Faso, Ghana, Cameroon, and Uganda.
[2] Fresh (FW) and dry weight (DW) values are given.
[3] Adapted from Thiongo et al., 2002. Values are for Kenyan fruits.
[4] Adapted from the NEVO table (1996).

villages in Mali and Burkina Faso (Saint Sauveur 1999), inhabitants were asked to explain indigenous shea fruit and tree classification and to tell which characteristics they valued the most. Farmers in northern Uganda were also surveyed for their shea tree and fruit classification and preferences. Responses to the questions were intended for use in developing a profile of the ideal shea tree from an indigenous point of view, which would then serve as a baseline for the selection of superior shea varieties.

Nitrogen was determined by the Kjeldahl method using sulfuric acid digestion of 200-mg samples of dried, pulverized fruit pulp from each tree (Isaac and Johnson 1976). Crude protein was calculated by multiplying the percentage of nitrogen by a factor of 6.25 (AOAC 2002). Mineral content (P, K, Ca, Fe, Mg, Zn, Mn, and Cu) was determined by atomic absorption spectrophotometry (Hanlon 1992a, b) after digestion in sulfuric and nitric acid. Total soluble solids (TSS) were determined using 1-g pulverized samples mixed in 50 ml deionized distilled water and analyzed with a Palate Digital Refractometer (PR-100 ATAGO Co. Ltd. Japan).

Statistical analysis was performed using STATISTICA software (StatSoft, Inc. 2002).

RESULTS

CHEMICAL COMPOSITION OF SHEA FRUIT PULP

Shea fruit pulp content of protein, soluble solids, and major minerals is reported in Table 2. The range of values for shea indicates that there is a great deal of variability in all measured parameters. Middle-range values compare very favorably with other important tropical fruits. The protein content (0.8–3.4 g/100 g fresh pulp) is high for a fruit. TSS (considered here to represent sugars) range from low (4.0%) to very high (33.9%). TSS from the Mossi Plateau area of Burkina Faso averaged just over 20%. Shea pulp potassium levels exceed that of banana (542 vs.

TABLE 3. SHEA FRUIT NUTRITIONAL PARAMETERS BY CLIMATE ZONE IN MALI AND BURKINA FASO.

Parameter	Unit	Sahel	N. Sudanian	S. Sudanian	N. Guinean
Ca	mg/100 g	270 c	173 b	184 b	136 a
K	mg/100 g	810 b	547 a	601 ab	540 a
Mg	mg/100 g	69 c	48 ab	53 b	41 a
B	mg/100 g	3.6 a	3.6 a	3.7 a	3.5 a
Mn	mg/100 g	0.32 a	0.26 a	0.30 a	0.32 a
Fe	mg/100 g	3.2 a	3.5 a	4.0 a	4.8 a
Zn	mg/100 g	0.87 a	1.07 a	1.34 a	1.08 a
P	mg/100 g	24.9 a	20.3 a	22.1 a	19.7 a
Protein	g/100 g	2.1 a	1.9 a	2.1 a	1.9 a
TSS	% Brix	12.8 a	17.1 a	15.5 a	18.8 a
Glucose	Mg/100 g	133 a	258 a	197 a	261 a
Acidity	mEq/100 g	0.30 a	0.38 a	0.51 a	0.45 a
EC	dS/m	2.0 a	1.5 a	1.5 a	1.8 a

Letters indicate statistically significant differences between climate zone means ($\alpha = 0.05$, unequal *N* HSD). EC, Electrical conductivity.

357 mg/100 g mean), which is known as a rich potassium source (though not usually available in rural savanna markets). Many of the shea trees analyzed had a pulp potassium content of more than 1000 mg/100 g. Shea pulp is also a rich source of calcium (141 mg/100 g) compared with marula (35 mg/100 g) and mango (10 mg/100 g). Shea pulp phosphorus, zinc, and magnesium contents are comparable to marula. The only mineral we found deficient in shea pulp is copper, which did not show up as a trace in any sample.

Statistical comparison of shea fruits in different climatic zones shows a strong effect of climate (Table 3). Potassium, magnesium, and calcium levels are significantly highest in fruits from the dry Sahel region and lowest in the wetter Guinean zone ($\alpha = 0.05$, unequal N HSD; see StatSoft, Inc. 2002). Values for these minerals range from 1.5 to 2.0 times higher in the Sahel compared with the Guinean zone. Levels of protein, phosphorus, and magnesium are also highest in fruits from the Sahel, although the differences are not significant ($\alpha = 0.20$, unequal N HSD). In contrast, iron and TSS are highest in the Guinean zone and lowest in the Sahel. Electrical conductivity (EC) and acidity show opposite trends: high acidity and low EC in fruits from the wetter areas and low acidity with high EC in the Sahel.

A comparison by country of statistical means for TSS and protein is given in Table 4. The Burkina Faso shea population is significantly higher in TSS than other areas, even though more Burkinabé sampling sites are in drier zones. Northern Uganda, with rainfall comparable to the West African Guinean zone, has the lowest mean TSS (10.3%). The lone sample from northern Ghana (not shown), with a TSS of 21%, is comparable to samples collected in Burkina Faso near the Ghana border. Protein contents are highest in Cameroon and Mali.

Ugandan shea fruits are lower in both protein and TSS. Ugandan shea trees belong to subspecies *nilotica.* A comparison between values for subspecies *nilotica* fruits and subspecies *para-*

TABLE 4. COMPARISON OF SHEA FRUIT PULP TSS AND PROTEIN.

	TSS (% Brix)		Protein (%)	
Country	Mean	*N*	Mean	*N*
Uganda	10.3 a	40	1.3 a	39
Burkina Faso	17.1 b	85	1.8 b	35
Mali	11.1 a	98	2.1 c	45
Cameroon	13.4 ab	6	2.3 c	6

Letters indicate statistically significant difference at $P \leq 0.05$ (Fisher LSD).

doxa fruits (Mali, Burkina Faso, and Cameroon) is shown in Table 5. Our sampling of subspecies *nilotica* indicates statistically significant higher levels of iron; otherwise, subspecies *paradoxa* tends to be higher in most parameters.

Village population means show a great deal of variation between sites in all measured parameters (Table 6). This is particularly true of pulp mineral levels, which can vary drastically from tree to tree. Highest mineral values occur in the northernmost village populations (the driest locations). TSS and protein levels tended to be more stable within a given population. Ugandan sites were consistently low in both parameters, while West African shea populations showed a range of low to high TSS and protein.

ETHNOBOTANY

The butter extracted from shea nuts is an important source of cash for the women of the savanna parklands. Women do all of the fruit collecting and butter processing, which is very labor-intensive. During the shea harvest period (usually May–June), women may rise before daylight and travel far afield to collect fallen shea fruits. Fruits are not knocked down from trees because of the difficulty in distinguishing between fully mature and still ripening fruits. The fat content of immature fruits increases until the fruit attains full maturity, so that nuts from picked fruit or from fruit blown down prematurely by rainstorms have an undesirably low fat content. Basins full of fruits are carried back to villages, where the pulp is usually eaten and the nuts dried for butter extraction or for sale in the market or to traders.

In the indigenous preferences survey by Saint Sauveur (1999), group discussions highlighted the importance of pulp taste as a quality criterion (Fig. 4). In every village, taste was a consideration in the classification of either fruits or trees. Among criteria used to identify a good-quality tree, the quantity of fruit produced was most often cited, followed by fruit taste. Among criteria used to identify a good-quality fruit, sweet pulp ranked first (quoted in 83% of the sites, men and women combined), fleshy fruit was third (39%), and ripe fruit was fifth (22%). For the men, the sweet pulp is the primary value of the fruit (in almost 100% of villages), while most female respondents also cited butter yield as a key characteristic of a good shea tree (about 75%) versus less than 30% of men.

TABLE 5. COMPARISON OF *VITELLARIA PARADOXA* SSP. *NILOTICA* FRUIT PULP FROM UGANDA WITH SSP. *PARADOXA* FRUIT PULP FROM MALI, BURKINA FASO, GHANA, AND CAMEROON.

Subspecies	TSS (% Brix)	Protein (%)	Zn (mg/100g)	Fe (mg/100g)	Mn (mg/100g)	Mg (mg/100g)	Ca (mg/100g)	K (mg/100g)
V. paradoxa ssp. *nilotica*	10.3 a	1.3 a	1.46 a	7.8 b	0.34 a	26 a	59 a	426 a
V. paradoxa ssp. *paradoxa*	13.9 b	2.0 b	1.09 a	4.3 a	0.30 a	50 b	178 b	595 b

All values are given in terms of fresh fruit. Statistically significant differences ($\alpha = 0.05$, Fisher LSD) are noted with letters.

TABLE 6. MEAN VALUES OF SHEA FRUIT PULP NUTRITIONAL PARAMETERS IN LOCAL POPULATIONS.

Village or district	Country	Mean mineral content (mg/100 g)								TSS (%)	Protein (g/100g)
		K	Ca	Mg	P	Zn	Fe	Mn	B		
Lan	Burkina Faso	379	147	45	13	0.8	1.4	0.1	3.8	20.4	1.4
Ouadangou	Burkina Faso	929	283	82	24	0.6	2.6	0.3	3.8	6.7	2.5
Peni	Burkina Faso	552	192	48	28	0.7	1.9	0.3	3.5	17.3	2.0
Sapone	Burkina Faso	426	161	49	21	0.6	2.0	0.3	5.1	20.1	1.7
Siniena	Burkina Faso	562	125	44	22	1.2	2.0	0.3	2.9	19.5	1.5
Touroum	Burkina Faso	691	256	57	26	1.1	3.8	0.3	3.4	11.2	1.8
Yasso	Burkina Faso	496	157	48	16	0.7	1.7	0.3	3.2	20.8	1.6
Mafa-Kilda	Cameroon	602	165	47	27	0.5	1.6	0.3	1.7	13.4	2.3
Badougou	Mali	552	130	41	22	1.4	4.8	0.3	3.7	14.2	1.9
Fourou	Mali	474	142	35	18	0.8	5.3	0.2	4.7	13.9	2.5
Gouani	Mali	717	189	50	24	2.5	8.3	0.4	2.8	7.5	2.4
Koumantou	Mali	456	122	37	17	0.8	6.5	0.3	3.0	15.4	1.7
Massala	Mali	544	211	47	20	1.0	2.5	0.1	3.0	16.7	1.6
M'Peresso	Mali	551	160	41	22	1.8	3.1	0.3	4.2	11.3	2.8
Niamana	Mali	486	193	50	18	2.3	2.6	0.3	3.6	12.5	2.3
Sebekoro	Mali	807	178	57	24	0.9	5.2	0.4	4.2	4.3	1.9
Sirakorola	Mali	747	199	71	26	0.6	8.5	0.3	3.8	4.4	2.1
Abim	Uganda	462	62	20	22	0.32	11.0	0.32	—	6.7	1.0
Adwari	Uganda	464	52	24	28	0.58	2.9	0.26	—	9.8	1.8
Lapono	Uganda	397	65	28	24	0.65	4.8	0.32	—	10.5	1.2
Lira-Palwo	Uganda	527	52	24	33	0.65	3.1	0.32	—	11.7	1.7
Okwang	Uganda	391	65	28	26	0.86	16.3	0.51	—	10.1	1.2
Olilim	Uganda	322	28	14	12	0.32	0.9	0.00	—	11.6	1.3
Orum	Uganda	477	66	26	19	0.52	3.3	0.27	—	10.3	1.4
Patongo	Uganda	410	56	30	25	0.75	7.8	0.32	—	11.9	1.2

All values are for fresh pulp.

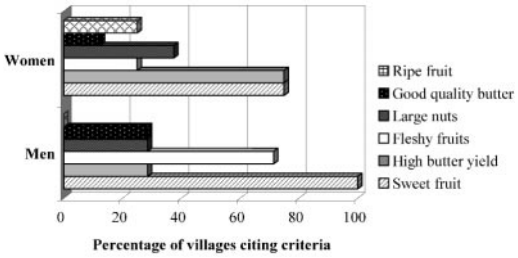

Fig. 4. Chart of indigenous shea fruit preferences in villages in Burkina Faso and Mali showing differences by gender. The citation of ripe fruit as a value refers to the premature dropping of fruits in some shea genotypes and as a result of wind gusts during monsoonal storms. Immature fruits have low kernel fat contents and reduce the profitability of extraction labor for women.

Indigenous classification varied from village to village, sometimes within the same ethnic group. Men and women often do not have the same classification within the same village and ethnic group: men's categories of trees are characterized mainly by fruit taste and quantity, while women's classification is based more on butter production and nut aspect (for example, ''white'' nut testae indicate an underdeveloped kernel, which will yield little butter). In general, trees with consistent year-to-year yields, sweet pulp, and high fat contents were considered ideal.

Men in Mali and Burkina Faso identify an important nonfood use of shea trees—shade. A shea tree with a full canopy provides a much appreciated resting place in farmers' fields. Leafiness is also cited in Uganda as an important tree characteristic, although as a measure of tree health. Shea trees in Uganda typically have a strongly rosetted appearance, with sparse tufts of leaves sprouting directly from main branches. This kind of rosetting in other tree species is symptomatic of fungal attack (Abou-Jawdah et al. 2002). Leafy trees may be exhibiting tolerance to disease and as such are recognized locally as better producers. Men are more likely to perceive value in shea trees as a source of charcoal. Charcoal production and sale is exclusively in male hands.

Discussion

The concentration of major minerals (calcium, potassium, and magnesium) is significantly higher in Sahelian shea fruit pulp than fruit from wetter areas. This result probably reflects the lower level of soil mineral leaching by rainfall in the drier areas—an explanation that is supported by the higher iron content in Guinean zone fruits, which would be expected in ferralitic soils leached of their nutrient cations. The greater osmotic stress to which Sahelian shea trees are exposed may also contribute to increased tissue mineral content. However, whereas pulp TSS should also be highest under osmotic stress, Sahelian populations have the lowest TSS values. We suspect that as a response to the short rainy season, Sahelian shea trees have to partition a disproportionately greater amount of photosynthate into seed fat development at the expense of pulp TSS. High seed fat content probably increases the chances of seedling establishment before the onset of the dry season, resulting in natural selection of higher fat types in short-season areas. This proposal is supported by our seed fat data, which show significantly higher fat content in Sahelian *Vitellaria* populations (Maranz and Wiesman 2003).

The comparison of subspecies *paradoxa* with subspecies *nilotica* shows that West African fruits are superior in almost every nutritional category. Differences in climate, elevation, and soils between the Ugandan highlands and West African lowlands are sufficiently great that the nutritional differences cannot be attributed to genetic differences between the subspecies. However, there is a significant overall difference between the nutritional value that Ugandan farmers obtain from shea fruits in comparison with their western African counterparts.

In the survey of indigenous fruit preferences, it was found that villagers situated in the northern, drier parts of the *Vitellaria* range, where fruits are scarce, value the shea fruit flesh more than villages located in wetter areas, where more species of fruit trees are available and *Vitellaria* is mainly a source of fat. Nutritional data also support the greater value of shea fruits in drier areas. The levels of major minerals can be twice that of fruit in the higher rainfall zones. Protein content is also higher, though not significantly so. Although pulp TSS tends to be lower in drier areas, this is not true in Burkina Faso, especially in the intensive shea cultivation area of the Mossi Plateau. This raises the possibility of indigenous selection for sweet fruit pulp in this area.

Large fruit size was generally not considered very important in Mali and Burkina Faso. About

TABLE 7. MEAN SHEA NUT DRY WEIGHT BY VILLAGE AND REGION.

Site	Country	Nut DW (g)	Fruit FW	N
Sirakorola	Mali	3.8 a	15.2	26
M'Peresso	Mali	4.5 b	18.2	25
Peni	Burkina Faso	4.6 bc	18.6	25
Sebekoro	Mali	4.9 bcd	20.0	25
Gouani	Mali	5.0 bcd	20.4	26
Fourou	Mali	5.1 bcde	20.7	25
Sapone	Burkina Faso	5.2 cde	21.0	25
Massala	Mali	5.2 cde	21.0	25
Ouadangou	Burkina Faso	5.3 def	21.4	25
Lan	Burkina Faso	5.6 defg	22.6	24
Yasso	Burkina Faso	5.7 efg	23.1	27
N. Uganda	Uganda	5.8 defg	23.5	7
Siniena	Burkina Faso	5.9 fg	23.7	26
Kontagora	Nigeria	6.0 fg	24.3	25
Mafa-Kilda	N. Cameroon	8.6 h	34.8	6
Foumban	W. Cameroon	11.2 i	45.4	4
Bangante	W. Cameroon	15.0 j	60.8	6

Fresh fruit weight (FW) is estimated using a calculation factor of 4.05 × nut dry weight (DW). Real fresh weights will differ, because the proportion of seed to pulp is variable. Significant differences are noted by letters ($\alpha = 0.05$, Fisher LSD).

70% of the men stated that fleshy fruits (high pulp/seed ratio) were desirable. We note, however, that people in our survey areas are not aware of the much larger fruits found in other areas, such as Cameroon. Looking at our database of nut dry weights and a sampling of whole, fresh shea fruits, we estimate fresh fruit weight to vary from 15 to 60 g (Table 7). Shea fruits in the West Cameroon highlands may reach 100 g if they have two seeds. The fat content and shea butter yield from these large seeds is very low. Women in some areas, such as Ghana, may prefer small, more compact seeds (Lovett and Haq 2000), evidently because of a higher return on their butter extraction labor.

Indigenous classification of shea emphasizes fruit taste as well as seed fat content. In the survey of indigenous preferences, women cited fruit sweetness as often as butter yield when describing desirable fruit traits (Fig. 4). Men cited fruit sweetness four times more often than butter yield. This reflects the division of labor between women and men. Women collect the fruits in the field, and then they extract and sell the butter, nuts, and decorticated kernels in the market. The money earned belongs exclusively to the women in most cases. Because men do not share in shea butter profits, the value of the trees for them is primarily in fresh fruit for consumption. Because shea fruits ripen at the time of year when men are working in the fields preparing the soil for planting, being able to sit in the shade of shea trees and rest while eating shea fruits is an important part of the culture. Shea trees may represent as much as 80% of the woody species growing in farmers' fields (Lovett and Haq 2000), so the quantity of shea fruits consumed during land preparation can be considerable. The nutritional value of the fruit, both quantitatively and qualitatively, clearly plays a major role in the diet at this time of year.

The importance of the fruit pulp is relevant to the current international interest in developing the potential of shea butter production in Africa. Our results indicate the importance of considering the role of fruit pulp in the local diet when implementing *Vitellaria* selection programs and formulating rural policy in the shea zone.

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LITERATURE CITED

Abou-Jawdah, Y., A. Karakashian, H. Sobh, M. Martini, and I. Lee. 2002. An epidemic of almond witches'-broom in Lebanon: Classification and phylogenetic relationships of the associated phytoplasma. Plant Disease 86:477–484.

AOAC. 2002. Protein in fruit products. Official methods of analysis of AOAC international, 16th Ed., Vol. II. AOAC International, Gaithersburg, MD, Chap. 37, p. 10.

Bergeret, A., and J. C. Ribot. 1990. L'Arbre nourricier en pays sahélien. Editions de la Maison des Sciences de l'Homme, Paris, 225 pp.

Blench, R. 2001. Trees on the march: The dispersal of economic trees in the prehistory of West-Central Africa. ODI, Safa Conference, Cambridge, U.K., May 26, 2000, 13 pp.

Boffa, J-M., G. Yameogo, P. Nikiema, and J. B. Taonda. 1996. What future for the shea tree? Agroforestry Today 8(4):5–9.

Booth, F. E. M., and G. E. Wickens. 1988. Non-timber uses of selected arid zone trees and shrubs in Africa. FAO Conservation Guide 19, ISBN 92-5-102745-5, 12 pp.

Collinson, C., and A. Zewdie-Bosuener. 1999. Shea butter markets: Their implications for Ghanaian shea butter processors and exporters. Project A0772, Report No. 2403, 20 pp.

Hall, J. B., D. P. Aebischer, H. F. Tomlinson, E. Osei-Amaning, and J. R. Hindle. 1996. *Vitellaria paradoxa*: A monograph. School of Agricultural and Forest Sciences, University of Wales, Bangor, U.K., 105 pp.

Hanlon, E. A. 1992a. Determination of K, Ca, and Mg in plants by atomic absorption techniques. Pages 33–36 in C. O. Plank, ed., Plant analysis reference procedures for Southern Region of the U.S. Cooperative Services Bulletin 368. University of Georgia, Athens.

———. 1992b. Determination of total Mn, Fe, Cu, and Zn in plants by atomic absorption techniques. Pages 49–51 in C. O. Plank, ed., Plant analysis reference procedures for Southern Region of the U.S. Cooperative Services Bulletin 368. University of Georgia, Athens.

ICRAF. 1997. Agroforestry in the Sahel of West Africa. ICRAF bulletin, Bamako, Mali, 12 pp.

Isaac, R. A., and W. C. Johnson. 1976. Determination of total nitrogen in plant tissue. Journal of the Association of Analytical Chemists 59:98–100.

Lamien, N., A. Sidibe, and J. Bayala. 1996. The joy of cooking: recipes for the success of shea tree. Agroforestry Today Oct–Dec 1996:10–11.

Lipp, M., C. Simoneau, F. Ulberth, and E. Anklam. 1999. Devising analytical methods for the determination of cocoa butter and other vegetable fats in chocolate with the aim of checking compliance with existing community labeling. Food Products Unit, European Commission Joint Research Center, Final Report, Contract No. 12673-97-02 AICA ISPB, 10 pp.

Lovett, P. N., and N. Haq. 2000. Evidence for anthropic selection of the Shea nut tree (*Vitellaria paradoxa*). Agroforestry Systems 48:293–304.

Maranz, S., and Z. Wiesman. 2003. Evidence for indigenous selection and distribution of the shea tree, *Vitellaria paradoxa,* and its potential significance to prevailing parkland savanna tree patterns in sub-Saharan Africa north of the equator. Journal of Biogeography 30(10):1505–1516.

Maranz, S., Z. Wiesman, J. Bisgaard, and G. Bianchi. 2004. Germplasm resources of *Vitellaria paradoxa* based on variations in fat composition across the species distribution range. Agroforestry Systems 60(1):71–76.

Martin, F. W., C. W. Campbell, and R. M. Ruberte. 1987. Perennial edible fruits of the Tropics: An inventory. U.S. Department of Agriculture, Agriculture Handbook No. 642, 252 pp.

Mauny, R. 1953. Notes historiques autour des principales plantes cultivées d'Afrique Occidentale. Bulletin de l'Institut Fondamental d'Afrique Noire (IFAN) 15:684–730.

Neumann, K., S. Kahlheber, and D. Uebel. 1998. Remains of woody plants from Saouga, a medieval West African village. Vegetation History and Archaeobotany 7:57–77.

Neuwinger, H. D. 1996. African ethnobotany: Poisons and drugs. Chapman and Hall, Weinheim, Germany.

NEVO Table. 1996. Nevo Foundation, Netherlands Nutritional Center, cited in The Fruit Pages. http://www.thefruitpages.com.

Plenderleith, K., and N. Brown. 2000. *Baillonella toxisperma*: A state of knowledge study. Oxford Forestry Institute, Department of Plant Sciences, Oxford University, Oxford, U.K., 39 pp.

Ruyssen, B. 1957. Le karité au Soudan, Premiere Partie, Aire géographique du karité en Afrique et au Soudan. L'Agronomie Tropicale XI(2):143–171.

Saint Sauveur, A. (de). 1999. Indigenous management practices of farmed parklands. Pages 61–78 in Teklehaimanot, Z., ed., Improved management of agroforestry parkland systems in sub-saharan Africa. First Annual Report, 1 October 1998–30 September 1999. School of Agricultural and Forest Sciences, University of Wales, Bangor, U.K.

Salle, G., A. Boussin, A. Raynal-Roques, and F. Brunck. 1991. Le karité: état de nos connaissances et perspectives de recherche. Pages 427–439 in Riedacker, A., E. Dreyer, C. Pafadnam, H. Joly, and G. Bory, eds., Physiologie des arbres et arbustes en zones arides et semi-arides. John Libbey Eurotext, Groupe d'Etude de l'Arbre, Paris.

StatSoft, Inc. 2002. STATISTICA for Windows. Tulsa, OK: StatSoft, Inc., 2300 E. 14th St., Tulsa, OK, 74104, www.statsoft.com.

Storgaard, S. 2000. New vegetable fats. Sweetec 2(4/00):16–21.

Teklehaimanot, Z. 1997. Improved management of

agroforestry parkland systems in sub-saharan Africa. Project proposal submitted to INCO-DC European Commission, 11 September 1997. School of Agricultural and Forest Sciences, University of Wales, Bangor, U.K.

Thiongo, M. K., S. Kingori, and H. Jaenicke. 2002. The taste of the wild: Variation in the nutritional quality of marula fruits and opportunities for domestication. Acta Horticulturae 575:237–244.

Von Maydell, H. J. 1990. Arbres et arbustes du Sahel: Leurs caracteristiques et leurs utilisations. Margraf, Weikersheim, Germany, 531 pp.

Book Reviews
Daniel F. Austin, Book Review Editor

Gardens of New Spain. How Mediterranean Plants and Foods Changed America. Dunmire, William W. 2004. University of Texas Press, Post Office Box 7819, Austin, TX 78713-7819. xx + 375 pp. (paperback). U.S.$ 24.95. ISBN 0-292-70564-6.

Bill Dunmire previously collaborated with Gail Tierney in two delightful books on the plants and people of the southwestern United States (1995. *Wild Plants of the Pueblo Province*; 1997. *Wild Plants and Native Peoples of the Four Corners*). Alone Bill has written this engaging and information-packed volume on the arrival and impact of plants that the Europeans brought to the New World. Much previously has been written of New World contributions to Old World lives. Now that has been balanced with details of the other part of the story.

This book outlines the history of Spanish colonization in the New World and the arrival with them of their favorite plants. The story begins with the status of life in Spain on the cusp of American exploration and contrasts that with foods and worldviews in Mexico and what became the southwestern United States. Chapters 4–6 tell of the ''pathways'' to the New World between 1492 and 1521, with discussions of Spanish agricultural arrival and the associated trade systems and livestock. Then, it explains how the Spanish first brought their culture, religion, and plants into Mexico, New Mexico, Arizona, and Texas before discussing either Florida or California. There is a Master Plant List (pp. 315–324), a Glossary, a Sources providing data supporting each chapter (pp. 329–342), a Selected Bibliography (pp. 343–362) of ca. 400 titles, and an Index.

Most chapters are introduced with a map (13 total) showing the points needed for orientation and understanding movements by people. Also scattered throughout are sketches of tools and other items of the period, and many chapters end in discussions of individual cultivated plants, with drawings of each. All illustrations were created by Bill's wife, Evangeline L. Dunmire. Most of the black-and-white photographs were taken by the author. The only color in the book is on the cover, featuring photos of the courtyard garden at the Parroquia de San Luis Obispo in Texcoco, grapes, plums, and a traditional farmer harvesting her safflower. The quality of these makes me wish that all pictures were in color.

There are 12 tables providing various information on the plants pertinent to the individual chapters. The data packed into these tables on the 158 Old World species in the master list is wonderful. Nowhere else is there as much information about so many topics on these species and their arrival in the New World. Dunmire clearly worked long and hard on compiling these data and presents them in a lucid, compact format. Since the New and Old World plants became intermingled in indigenous and European-derived cultures, he has included pertinent New World species in the second part of the master list (57 spp.).

Bill has a delightful twist that brings the history of these plants into the modern world in the Epilogue (pp. 309–314). He highlights two individuals, Anita Chavez and Rudy Perea, as representatives of traditional agriculture who continue growing many of the Mediterranean and American plants together in modern New Mexico.

This is a thoroughly researched and readable book that will interest all readers of this journal. I strongly recommend it!

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The Pteridophytes of Mexico. Mickel, John T. and Alan R. Smith. Memoirs of the New York Botanical Garden vol. 88. The New York Botanical Garden Press, Bronx, NY 10458-5126, USA. xvi + 1055 pp. (hardcover). U.S.$ 125.00. ISBN 0-89327-458-5.

Monumental and comprehensive—words used by the publisher to promote this book. I agree. The entire fern flora of Mexico is covered—more than 1,000 species in 124 genera. Forty new taxa are described. The volume ''weds the world's richest dryland pteridoflora of northern Mexico and western United States with the rich wet forests of Mesoamerica, South America, and the West Indies'' (p. 1, abstract). Because so many taxa occur in adjacent as well as more distant lands, this book is useful beyond the boundaries of Mexico. It is an essential addition to the Flora of North America volume on Pteridophytes, in part because of the illustrations.

Descriptions, geographic distributions, habitat information, and more are provided for all taxa, along with key literature citations. There are indented keys to all taxa. Nearly all taxa are illustrated by line drawings that are elegant, detailed, diagnostic, and large enough in this large-format book to be truly useful. Most of the illustrations are done by Haruto Fukudo, who masterfully designed the plates, and many of the other drawings are by Bobbi Angell. I especially appreciate that the text and illustrations are arranged alphabetically by genus and species making the book easy to

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use. (Arrangements of higher taxa are given in the introduction.) Specimens seen by the authors and ones used for illustrations are cited, which makes the work verifiable for future workers. All species and infraspecific taxa are mapped by means of one dot per state. As always, there will be taxonomic disagreements among specialists, especially for the higher taxa, but the authors succinctly present their taxonomic reasoning, which mercifully is on the conservative side. The book design is straightforward and user-friendly.

This book deserves wider availability than the price will allow—it does not deserve to be a rare book. Thus, I make a plea to organizations such as CONOCYT, the National Science Foundation, and private foundations and donors to provide greater subvention for price reduction of major works like the *Pteridophytes of Mexico*. I thank the authors, illustrators, and publisher for giving us this treasure.

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The Urban Cliff Revolution. New Findings on the Origins and Evolution of Human Habitats. Larson, Douglas, Uta Matthes, Peter E. Kelly, Jeremy Lundholm, and John Gerath. 2004. Fitzhenry & Whiteside, 195 Allstate Pkway., Markham, ON L3R 4T8, Canada and 121 Harvard Avenue, Suite 2, Allston, MA 02134. xiv + 198 pp. (hardcover). U.S.$ 28.95. ISBN 1-55041-848-3.

Larson, Matthes, and Kelly (1999 and 2000), from the Cliff Ecology Research Group at the University of Guelph, Ontario, are well known in ecology for *Cliff Ecology*, their work on the unique ecology and coevolutionary history of cliffs. Lundholm, now in the Department of Biology, St. Mary's University, Halifax, Nova Scotia and Gerrath, a student in the Botany Department, University of Guelph, are both former members of the CERG as well. As can be expected from their backgrounds, the quality of the ecology and biology in the book is excellent. The writing style and ease of use is also remarkably good, perhaps exceeding the authors' goal of writing in the style and tradition of renowned scientists such as Ian Tattersall, Stephen Jay Gould, Wade Davis, and E.O. Wilson. The book itself is very nice quality, affordable, and contains excellent illustrations, photographs, and tables. The organization is ideal for both the interested scientific reader and university students, with an easy-to-use organization. The book has a detailed table of contents and index with both endnotes at the end of each of the seven chapters and a complete Reference section.

That said, I was concerned as I read the first few chapters. The authors set up the foundation of their argument and the Urban Cliff Hypothesis as the basis for human co-evolution with a suite of organisms originating in cliff habitats. References, evidence, and theoretical arguments were all made from a strictly biological perspective. Very little mention was made of recent archaeological or paleoanthropological research or theory, especially that pertaining to origins of agriculture, foraging, and plant/animal domestication. The absence of human or hominid intent in the coevolutionary process, while just an artifact of the ecological paradigm of the authors, was coupled by the lack of depth in cited anthropological literature in the early chapters.

Readers should stick with the book, however, as this is remedied beginning in Chapter 3. The authors finish developing the Urban Cliff Hypothesis as a basis and move on to implications and exploration of the ramifications of the concept. They point out the cliff and talus origins of several economically-important species, the utility of caves for much of human and hominid history, and how these translate into our constructed habitats over the ages. As Larson et al. develop the Urban Cliff Hypothesis, they discuss our spiritual connection with cliffs and buildings with similar features. The similarities of the urban landscape and ecology to cliff sites are startling. Larson et al. show how we've brought along long-time companions like pigeons, rats, owls, cockroaches, tulips, even cabbage to our ''modern'' communities.

This is definitely a good book for anyone interested in such diverse topics as human evolution, origins of agriculture, plant & animal domestication, economic botany, and community ecology. It would also make an excellent sourcebook or reader for courses in these topics, as it is bound to raise questions and bring together biological and cultural theory.

LITERATURE CITED

Larson, D. W., U. Matthes, and P. E. Kelly. 1999. Cliffs as natural refuges. Am. Sci. 87:410–417.

———, ———, and ———. 2000. Cliff ecology. Cambridge University Press, Cambridge.

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The Purposes and Teaching of Applied Ethnobotany. Hamilton, Alan C., Pei Shengji, Kessy, J., Khan, Ashiq A., Lagos-Witte, S. and Shinwari, Z. K. 2003. People and Plants Working paper No. 11. WWF-US, Godalming, UK, 72 pp. (paperback). Available gratis @URL: www.rbgkew.org.uk/peopleplants. No ISSN or ISBN.

This is another of the ''Working Papers'' produced by the People and Plants Initiative. This program has produced many useful books, videos, working papers, handbooks, and discussion papers all designed to further the development of the study of the relationship between plants and people. This particular working paper focuses on ''applied ethnobotany'' which the authors define as ''ethnobotany applied to conservation and sustainable development.'' It suggests that in the past ethnobotanical studies primarily have been academic exercises or served only external interests, rather than benefiting local people or conservation. It is from this perspective that the authors offer specific examples of ethnobotanical research more directed to local interests. The paper then suggests that applied ethnobotany has relevance to botany, forestry, agriculture and medicine, as well as other fields. The challenges of teaching an interdisciplinary field are discussed, and suggestions made on topics and curriculum, acquiring competence in core areas, and the complexities of interdepartmental cooperation in the institutional setting. This paper is the result of many of the authors' own experiences, and offers numerous worthy suggestions. Best of all, it is distributed at no charge, by downloading from the internet. Those interested in ethnobotany should add this work to their bibliographic collections.

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Plants That Fight Cancer. Kintzios, Spiridon E. and Maria G. Barberaki, eds. 2003. CRC Press LLC, 2000 N.W. Corporate Blvd., Boca Raton, FL 33431. vii + 296 pp. (hardcover). U.S.$ 134.96. ISBN 0-415-29853-9.

Plants That Fight Cancer is a slim volume that attempts to survey the vast array of plants with antitumor and anti-leukemic properties. As this sort of review will inevitably likely become out-of-date rather quickly, it should at least provide solid background information with extensive references and act as a springboard for further research. The opening chapter of this book is, in fact, a concise explanation of carcinogenesis and the different types of cancer, and includes a section on the steps that are taken to go from plant to product. The second chapter provides a brief overview of plant-derived natural products that have shown cytotoxic or other anti-cancer activity. It is divided by chemical class, but not illustrated with representative chemical structures; the only chemical structures are those that show the different types of alkaloids (and some of these are incorrect). This is unfortunate, because representative chemical structures are not easy to locate within the book for those unfamiliar with chemistry. Instead, the reader is referred to the pages where information about a plant containing one of these compounds can be found. There is an Appendix of chemical structures at the end of the book with 95 drawings, but it oddly includes common solvents like hexane and tetrahydrofuran.

After the first introductory chapters, the remainder of the book is devoted to the plants with anticancer activity. The third chapter deals with terrestrial plants, and is divided into those currently used in clinical therapy, those with promise, and those in which ''tradition fails to meet reality.'' The book only details five plants that are currently used in clinical therapy, and one of them is mistletoe (*Viscum album*), which, the authors state, is ''not approved by the U.S. Food and Drug Administration.'' This is followed by a more extensive description of plant species with ''laboratory-proven potential.''

As I read through this chapter, I was rather surprised to find numerous errors in plant names, familial designations, and countless typographical errors and awkward sentence structures. The photos in the book are generally poor; many have little contrast, or are grainy or pixilated. Despite the fact that each plant species had extensive reference lists, citations in the text were often lacking. I found numerous claims that were not referenced, and at least one random citation I checked had no reference. These rather simple problems suggest a lack of careful editing and attention to detail that is critical to any scientific review.

The final chapter focuses on marine algae, and is organized in a totally different manner from the previous chapter. Rather than a section for each species, it deals with larger taxonomic and chemical groups, and actually proves to be more successful. It is easier to find information in the extensive tables, which are clear and well referenced. Chemical structures of the compounds described in the tables and text are illustrated in the chapter. This is a much better way of developing an understanding of the chemotaxonomy of organisms and structure-activity relationships of natural products.

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The Settlement of the American Continent. A Multidisciplinary Approach to Human Biogeography. Barton, Michael C., Goeffrey A. Clar, David R. Yesner, and Geroges A. Person, eds. 2004. The University of Arizona Press, 355 S. Euclid, Ste. 103, Tucson, AZ 85719. vii + 281 pp. (hardcover). U.S.$ 75.00. ISBN 0-8165-2323-1.

Trying to speculate on the first migrations to the Western Hemisphere from the East is clearly a daunting task. *The Settlement of the American Continents* does a great job in trying to better understand this important human event and its impact on these continents. As the authors have stated, the best way to understand the settlement of the American continents is to take ''a multidisciplinary approach to human biogeography.'' Clark et al. (Chapter 1) recognize that there is much work to be done, even citing the need for better understanding the ecological and social processes of this first colonization.

The Settlement of the American Continents is not a book for ethnobotanists studying present day cultures and their uses of plants. Perhaps in the future the use of plants by Paleo-Indians may add to a better understanding of the peopling of the American continents. After all, the availability or unavailability of plants has influenced human migrations across the globe for thousands of years. This is evidenced by the spice trade, the sugar-slave trade, the history of cacao, and other culturally and economically important plants.

The book is divided into three sections. The first section, ''The First American Settlers,'' presents papers on genetics, human craniofacial morphology, language, Clovis artifact assemblages, and bioarcheology to describe the original inhabitants as a people of ''multiple but not innumerable origins.''

The second section, ''The Trail of the Americans,'' provides a refreshing look at the possible routes these early people may have taken to get to the New World. Of the migration models proposed—the Bering Land Bridge model, a modification of this known as the Pacific Coast model, the Australian Route, and the North Atlantic model—the first is the most widely accepted. It was refreshing to have the other routes discussed in detail for I have always believed that there were a variety of plausible ways to get to the Americas from other parts of the world. Those early ancestors of mine were a bold, daring people who were not intimidated by the unknown—they grasped it and used it to their advantage. As Mandryk points out in her chapter 10, the ice-free corridor model is a myth which, because of its simplicity, was widely accepted. Fortunately, she and others have not taken the easy way out.

The third section, ''The Land and People Transformed,'' addresses the ecological effects of these new arrivals on a pristine environment. Of most interest is Chilton's ''Gender, Age, and Subsistence Diversity in Paleo-Indian Societies'' where she elucidates the important role of women and children in Paleo-Indian societies.

Overall, *The Settlement of the American Continents* sheds light on the diversity of the Paleo-Indian populations of the Americas. It also suggests a new, updated view of the peopling of these continents. The authors have done a great job in helping us better understand this once in a lifetime historic event. Although it is not exactly a book for ethnobotanists or economic botanists, it is a great resource for those interested in a refreshing view of the first colonization of the Americas and those who participated in that event.

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Plant Resources of South-East Asia. No. 17. Fiber Plants. Brink, M. and R. P. Escobin, eds. 2003. Prosea Foundation, Backhuys Publishers, P.O. Box 321, 2300 AH, Leiden, The Netherlands. 456 pp. (hardcover). EURO 120.00. ISBN 90-5782-129-X.

The goal of the Prosea (Plant Resources of South East Asia) program is to produce an illustrated multivolume handbook of useful plants of South-East Asia. Since 1989, Prosea has published 19 volumes (24 books total), describing nearly 7000 useful plants in different commodity groups. Species are included in each commodity group based on their main use. All major plant entries include information regarding authority, bibliographic citation, synonyms, a number of the vernacular names used throughout South-East Asia (also English), origin and geographic distribution, uses, agronomy, botany, ecology, harvesting, handling, genetic resources, prospects, literature, and illustrations! Following the major descriptions is a section with brief descriptions of taxa with minor importance in that commodity group. A listing of species with secondary use in that commodity is provided with further reference to the volume of their main use. All Prosea handbooks end with a bibliography, glossary section, information regarding sources for the illustrations, scientific and vernacular names indexes.

The previous paragraph is a general description of the Prosea handbook series. In my opinion, the Prosea series represents an invaluable educational, extension, and research tool as an ethnobotanical flora of South-East Asia. To my knowledge, not since Crevost, Lemairé, and Petelot's series *Catalog des produits de l'Indochine* (1917–1941) has such an undertaking of the documentation of plant resources in South-East Asia been accomplished.

The latest publication, Prosea No.17 Fiber plants, provides detailed descriptions of 72 major fiber plants. These include cultivated and well-known species, such as *Gossypium* L., to those collected from the wild, i.e., *Donax canniformis* (G. Forster) K. Schumann. In addition to the major fiber plants are brief descriptions of 129 minor species and a list of 450 plant species whose use as fiber plants is secondary to their primary use! From these numbers, we can see the use of plant fibers is an integral part of cultures in South-East Asia.

Well done, and yet, often underappreciated, are the introduction chapter and illustrations of the Prosea handbooks. The different editors for each volume write an introduction that gives detailed information including: definition(s) for the commodity group, justification for inclusion of chosen taxa, followed by morphological, chemical, and physical properties, to describing processing techniques just to name a few. In this case, through a careful read of the introduction, a student new to fiber plants can begin to understand why ramie (*Boehmeria nivea* (L.) Gaudich.) is suitable for fine textiles versus jute (*Corchorus* L.) used for burlap bags.

As for the illustrations, the careful selection and drawing of taxa (habit and plant parts) is greatly appreciated. Reviewing the sources for the illustrations (often multiple resources for a single taxon) one can see that the program took seriously their goal to produce an illustrated handbook.

On the negative side, though previously justified, is the separation of some species I feel are very important as fiber plants but grouped in a different commodity group (i.e., *Cannabis* included in Prosea No. 12. Medicinal and poisonous plants). Due to fiber not being their primary use, one needs to refer to the other handbooks. Fortunately, the discussions of non-primary uses are also well written.

Needless to say, Prosea No. 17 Fiber Plants is a valuable addition to the Prosea handbook series. It is an indispensable addition to the library of those interested in the current uses, for basketry, to potential uses, as geotextiles, of fiber plants of South-East Asia and its peoples.

Literature Cited

Crevost, C., C. Lemairé, and A. Petelot. 1917–1941. Catalog des produits de l'Indochine. 6 volumes. Gouvernement Général de l'Indochine, Hanoi, Vietnam.

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Phylogenetic Trees Made Easy. A How-to Manual, Second Edition. Hall, Barry G. 2004. Sinauer Associates, Inc., P.O. Box 407, Sunderland, MA 01275-0407. xiv + 221 pp. (paperback). U.S.$ 31.95. ISBN 0-87893-312-3.

Building phylogenic trees with sequence data is popular today for many reasons, not the least of which is visualization of the potential genetic relationships among taxa. *Phylogenetic Trees Made Easy* is accompanied with a CD containing two programs, a trial version of *PAUP* and CodonAlign as well as examples files to be along with the book for following along.

This is the second edition of a popular guide book and Hall has updated all the relevant web pages and screens to bring the book up to date. While it is impossible to have a static book keep track of all the program updates, the book allows for this by explaining each step and what it is used for, thus enabling the reader to easily follow along. The many screen shots are extremely helpful in aiding one to follow along.

Hall's overall goal of writing a ''cookbook'' that allows one to build a phylogeny from sequence data is successful. The book, via the CD, has example files that mimic the exact stages one goes through when building a phylogeny. This allows the reader to see if they have their own data files formatted correctly. For those wanting even more information, there are sections for advanced options that describe in detail why you may or may not want to use the default values on the relevant programs. The section on advance options for the BLAST program is especially useful. This is a strength of the book in that it details how the overall tree topology may be affected by even minor changes.

I would certainly recommend the book for those who are thinking of doing a phylogeny using sequence data.

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Genera Orchidacearum, volume 1. General Introduction, Apostasioideae, Cypripedioideae. Pridgeon, Alec M., Phillip J. Cribb, Mark W. Chase, and Finn N. Rasmussen, eds. 1999, reprinted 2003. Oxford University Press, ISBN 0-19-850513-2; xv + 197 pp. $120 at us.oup.com.

Genera Orchidacearum, volume 2. Orchidoideae (Part one). Pridgeon, Alec M., Phillip J. Cribb, Mark W. Chase, and Finn N. Rasmussen, eds. 2001. Oxford University Press, ISBN 0-19-850710-0; xix + 416 pp. $120 at us.oup.com.

Genera Orchidacearum, volume 3. Orchidoideae (Part two) Vanilloideae. Pridgeon, Alec M., Phillip J. Cribb, Mark W. Chase, and Finn N. Rasmussen, eds. 2001. Oxford University Press, Great Clarendon Street, Oxford OX2 6DP, Great Britain; distributed in USA by Oxford University Press, 198 Madison Ave., New York, NY 10016. xviii + 360 pp. (hardcover). U.S.$ 150.00. ISBN 0-19-850711-9. [ISBN 0-19-8507199 in the book itself, but 0-19-850711-9 elsewhere, including on the website]

These are the first three of a projected 5 volumes. The final two volumes are intended to cover subfam-

ilies Vanilloideae and Epidendroideae (Part one) in volume 4, and subfamily Epidendroideae (Part two) in volume 5 or such was the plan when volume 1 appeared. The plan now (as given in volume 3) is to devote volumes 4 and 5 solely to the Epidendroideae.

The intention is to a produce a comprehensive, exhaustive, definitive treatment of all the genera of the family on modern phylogenetic grounds, using cladistic methodology. Volume 1 contains a most spirited and lucid chapter by Mark W. Chase entitled ''Molecular systematics, parsimony, and orchid classification.'' In the current whirlwind of controversy in the taxonomic world, it is a calm voice of reason. It should be required reading for all the participants in the argument.

Throughout, the tone of the three volumes is one of quiet scholarship. Without condescending to the reader, every term is carefully explained. And the world knows how complicated the terminology of Orchidaceae is. Every genus name is explained or translated. Because it pops out at the beginning of indexes, I'd long wondered what the origin of *Aa* might be. It's to be found on page 24 of volume 3.

Each segment of each treatment is identified as to authorship, with bolded 2- or 3-letter abbreviations, and one can easily search among the alphabetically-arranged ''Contributors'' in the forematter of each volume to discover who wrote what. I cannot recall ever having seen anything so thorough. (An alphabetical listing by abbreviations would be helpful.) The editors themselves are major authors, but by my rough count, there are about 40 other contributors as well, a truly international effort.

The books are graced with color photographs: 16 in volume 1, 122 in volume 2; and 105 in volume 3. Every genus is adorned with a line drawing of one of its species, and every genus has a composite distribution map; such maps are also given for some higher taxonomic categories as well. There are keys appropriately positioned throughout the three volumes.

Each genus has a section on ''Uses'' and another on ''Cultivation.'' Given their importance in horticulture, these two segments will be of the greatest use to gardeners and fanciers of all stripes. Where no species are known to be cultivated, the authors say so, and oftentimes suggest a proper medium, if members of the genus should come into cultivation, based on what is known about related genera.

It is a great service to readers and librarians that all titles of all books and journals are spelled out completely. And all words that are Latin plurals (like families, subfamilies, sections, and series) are treated as grammatical plurals; it is a teeth-gritting exercise to read works where the obvious plural-ness of the terms is ignored.

In the front of volume 2, there is a five-page essay on ''The origin and biogeography of Orchidaceae,'' by Mark W. Chase. Its positioning is unexpected, and it deserves special mention. It is obvious from the literature citations that it was written after the contents of volume 1 had gone to press. Here the reader will discover that ''Although the Orchidaceae are highly evolved, they are reasonably early-emerging monocots and do not in a phylogenetic sense represent one of the more terminal (recently evolved) lineages.'' This turns conventional wisdom (as reflected in introductory texts) on its head.

Botanists can only look forward to the successful conclusion of this multi-volume work. And the publisher deserves plaudits for having produced these volumes in so lavish a format.

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Cultivated Annual Oilseed Crops of India. Sengupta, K. and P. K. Das. 2003. Naya Udyog, 206, Bidhan Sarani, Kollata, 700 006, India. x + 296 pp. (hardcover). U.S.$ 40.00, Rs 600.00. ISBN 81-85971-34-X.

The authors' Preface states that after cereals, oilseeds are the most important group of crops in India. Comprising 19% of the world's acreage devoted to oilseeds, India contributes only 9% to world oilseed production. India ranks first in acreage planted in sesame, peanut [groundnut in this volume, using the British epithet], and safflower. The country ranks second, third and fourth respectively in the world's land committed to rapeseed/mustard, sunflower, and soybean.

These figures reveal disappointing productivity, and thus increasing yield has been one of the major issues of the agricultural sector of the country. Safflower, niger, and sesame seed have been most adversely affected, since acreage devoted to those crops has declined, despite the 1986 mandate by India's Technology Mission on Oilseeds.

The authors state that their aim was to compile information about the scientific advancements made regarding each of the Indian oil crops, covering botany, floral biology, cytology, cytogenetics, genetics, biotechnology, crop management, and crop protection. They opted to focus on rapeseed and mustard, groundnut, sesame, safflower, soybean, sunflower and niger.

The goal for this publication is commendable, but its execution is weak. Although a table (pp 5–6) ranks the oil crops grown in India's major annual oilseed growing states, it would have been helpful had the book provided a map illustrating those production areas for each oilseed crop. Unfortunately, the sole map (p 4) gives geographical ranges just for groundnut, rapeseed/mustard and soybean. Another general comment is that the authors use specialist local terms such

as *ghani*, a traditional oil press, without defining or illustrating them for a general readership.

Important facts relevant to their discussion are omitted. The heading Keeping Quality (p 27) in the authors' first chapter, General Overview, omits the important fact that sesame oil contains natural constituents, sesamin and sesamolin, antioxidants that protect against rancidity. The category Antinutritional Factors (p 28) mentions aflotoxin in peanut, but neglects to mention that there are a growing number of cases of food allergies to peanut and to sesame seed.

As indicated by the bibliography in the sesame chapter, the contents seem very much out of date. Directly relevant articles from two decades ago were omitted. It is bewildering that despite so many reports that provide evidence to the contrary (Bedigian 1988, 2003, Bedigian et al. 1985, Bedigian et al. 1986; Bhat et al. 1999; Hiremath and Patil 1999; Nanthakumar et al. 2000) the authors still espouse early opinions. They write without foundation that ''*Sesamum indicum* [. . .] is believed to have its secondary origin in India,'' while in the ''existence of variability and related wild species, tropical Africa can be considered one of its primary centres of origin.''

If this work is reissued, it would be beneficial to hire an editor fluent with English to polish the grammar, to correct typographical errors, and above all to add an index, an essential amenity!

Literature Cited

Bedigian, D. 1988. *Sesamum indicum* L. (Pedaliaceae): Ethnobotany in Sudan, crop diversity, lignans, origin, and related taxa. Pages 25: 315–321 in P. Goldblatt and P. P. Lowry, eds., Modern Systematic Studies in African Botany. AETFAT Monographs in Systematic Botany, Missouri Botanical Garden, St. Louis, MO.

———. 2003. Evolution of Sesame Revisited: Domestication, Diversity and Prospects. Genetic Resources and Crop Evolution 50:779–787.

———, D. S. Seigler, and J. R. Harlan. 1985. Sesamin, sesamolin and the origin of sesame. Biochemical Systematics and Ecology 13:133–139.

———, C. A. Smyth and J. R. Harlan. 1986. Patterns of morphological variation in sesame. Economic Botany 40:353–365.

Bhat, K. V., P. P. Babrekar, and S. Lakhanpaul. 1999. Study of genetic diversity in Indian and exotic sesame (*Sesamum indicum* L.) germplasm using random amplified polymorphic DNA (RAPD) markers. Euphytica 110:21–33.

Hiremath, S. C., and C. G. Patil. 1999. Genome homology and the putative progenitor of sesame. Journal of Cytology and Genetics 34:69–74.

Nanthakumar, G., K. N. Singh, and P. Vaidyanathan. 2000. Relationships between cultivated Sesame (*Sesamum* sp.) and the wild relatives based on morphological characters, isozymes and RAPD markers. Journal of Genetics and Breeding 54:5–12.

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Against Extinction. The Story of Conservation. Adams, William M. 2004. Earthscan, 8–12 Camden High Street, London, NW1 0JH, UK and Stylus Publishing, LLC, 22883, 22883 Quicksliver Drive, Stirling, VA 20166–2012. xvi + 311 pp. (paperback). U.S.$ 27.50 (paperback), U.S.$ 89.95 (hardcover). ISBN 1-84407-056-5 (paperback), 1-84407-055-7 (hardcover).

Against Extinction scrutinizes the paradox that extinction and conservation share common roots. Adams reaches back to the early seventeenth century to relate major extinctions to unregulated hunting during the Age of Exploration, but swiftly transports us to the late nineteenth and early twentieth century. In the world order of the British gentry and their American counterparts, nature was a challenge to be tamed, developed, and managed. This intellectual perspective advanced that further extinctions could be avoided by careful regulation, and thus the conservation movement was born. And yet this same Age of Imperialism initiated the wanton ''collection'' of wildlife trophies and ''scientific specimens.'' This passion precipitated a rapid population decline among African, and to a lesser extent, North American animal species. Focusing primarily on African fauna, the author chronicles this decline in explicit detail, as well as the sometimes-controversial efforts to reverse it. Sixty-one pages of back notes support this work.

Adams weaves a web of the myriad concepts, debates, actors, and efforts of the Anglo-American conservation movement over space and time. This is no simplistic project. Some of our conservation heroes, such as Lord Robert Baden-Powell the founder of Boy Scouts, and President Theodore Roosevelt, expressed their love of nature by trophy hunting. This paradox persists today as hunters regard themselves as conservationists. In the late twentieth and early twenty-first century, conservation has evolved into an international movement, having supporters from all walks of life. New concepts link maintenance of biodiversity to sustainable wild harvests. And yet, Adams notes that the need for species and habitat conservation is not universally accepted nor even understood by all cultures in the same way. Nor do all cultures reject the anthropogenic nature of ''wilderness'' as we do. These are culture-specific constructs, not universal realities. Relentlessly, Adams confronts us with questions: ''What is natural?'' ''What is possible?'' Even experts dis-

agree on how much and what kind of human intervention is too much or too little.

Third World countries that emulate Britain and the United States now embrace our paradigms of economic growth. The First World charges the developing countries to preserve their remaining ancient ecosystems, while disregarding our own model of ''progress'' through environmental degradation. Thus Adams goads us to consider that sustainable development may be a luxury that poor people cannot afford. In the end, we discover that we, too, are strands in the web.

In the preface, Adam's defines the parameters of his study, and presents a clean outline of the book, interpreting the contribution of each chapter to his design. He includes a valuable ''List of Acronyms and Abbreviations'' to facilitate tracing the genealogy of NGO's, government agencies, and other organizations essential to the saga. While the author acknowledges his focus on Britain, Africa, and the United States, he correctly observes the necessity of these boundaries to limit the project's size. This work can easily stand alone as a major contribution to conservation history. While the book shortchanges flora, and broad ecosystems, it nevertheless fills a large gap in the literature and is recommended as both reference and upper level text.

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Cardamom: the genus *Elettaria*. Ravindran, P. N. and K. J. Madhusoodanan, eds. 2002. Medicinal and Aromatic Plants—Industrial Profiles, Vol. 30. Taylor & Francis, Inc. 29 W. 35th Street, New York, NY 10001. vii + 374 pp. (hardcover). U.S.$ 139.95. ISBN 0-415-28493-7.

From the dawn of human civilization spices were sought after as eagerly as gold and precious stones. Editor Ravindran used these words in his Preface, introducing navigational exploration that reached the Malabar Coast in 1498: ''Cardamom, otherwise known as Malabar cardamom . . . is often qualified as the queen of spices.'' ''Arab traders took cardamom from the Malabar Coast and traded with ancient and medieval Greece and Rome.'' ''The Western Ghats forests of the Malabar Coast (the present Kerala) is the center of origin and diversity for cardamom.''

The early history of cardamom is described through the eyes of ancient observers. Impetus for its trade seems to be associated with that of black pepper, dubbed the King of Spices here. Previously in the native states of Travancore and Cochin, cardamom was a monopoly of the *Raja* (King) of Travancore who made it compulsory that all the produce be sold to his official, who forwarded it to the main depot in Alleppey.

Cardamom is the focus of 23 contributors, all from institutes in India, as research on cardamom is concentrated in India; little is being done elsewhere. In the Editor's Introduction we learn that Cardamom is a large perennial, herbaceous rhizomatous monocot. It is grown extensively in the hilly regions of South India at elevations of 800–1,300 m, as an under crop in forest lands. Cardamom is also grown in Sri Lanka, Papua New Guinea, Tanzania and Guatemala, now the largest producer.

History is reviewed first in absorbing detail, using the vast resources of Watt (1872). Dioscorides, in his *First Book* commented on the cardamom brought from Armenia and Bosphorus. Arabs were the major traders of Indian spices and they were successful in hoodwinking the Mediterranean merchants by keeping the sources of the spices a secret, so that even a historian like Pliny thought that cardamom was produced in India. Their monopoly ended once the Portuguese landed on the West Coast of India.

Much ado is made of the bleaching of cardamom, notably with the aid of water from a particular well, which is supposed to have the power of bleaching and improving the flavor of dried cardamom fruit (Watt 1872). Mollison (1900) [cited by Ridley (1912)] described an elaborate method of bleaching cardamom, using soapnut-water [Latin binomial not given].

In India the area of cardamom crop has declined over the last decade. Its cultivation is located in Kerala, Karnataka and Tamil Nadu states. Figure 1.1, pg. 4 gives a map of Cardamom growing countries, but lists only Tanzania in Africa. It is surprising that Ethiopia was omitted, because it was identified as a major crop and export of Ethiopia during a field trip in connection with the AETFAT Congress in September 2003. An Ethiopian colleague reported that cardamom is the fourth principal cash crop of Ethiopia.

This book's contents follow the general formula of the series, and provide thorough coverage of most spheres: botany, crop improvement and biotechnology; chemistry; agronomy; nutrition diseases and insect pests; harvesting and processing; industrial processing and products; economy; properties and end uses; yield gaps and production constraints. The book's closing chapters treat large cardamom (*Amomum subulatum* Roxb.) and false cardamoms.

The core of this book: Agronomy and Management of Cardamom, is well organized, and touches on all aspects, from climate to planting system. Properties and End Uses reviews carminative, antimicrobial, anticarcinogenic and anti-inflammatory activity, antioxidant function and anti-feedant properties, including its triumph over the house dust mite. It is good for the stomach (settles it), eases gas pains and nausea, is digestive, aids neuro-muscular pain, is antispasmodic, expectorant, and warming. It is effective inhaled for

the bronchial system; assists in stimulating the lungs, expelling phlegm and can be used for easing coughs and bronchitis. It is also used as an aphrodisiac mixture.

An observant reader can find a few typographical errors, and in places, grammatically awkward phrases. Nevertheless this volume in the superb Medicinal and Aromatic Plants—Industrial Profiles series, is an essential guide to the spice. Sometimes called Grains of Paradise, cardamom adds a characteristic pungent flavoring to numerous recipes, including Syrian coffee, Hadhrami rice, German Lebkuchen and Indian rice pudding. A bonus feature unique to this volume is Appendix II that provides select archetypal cardamom-containing recipes e.g., tandoori chicken, squab or quail, and lamb biriyani.

Literature Cited

Mollison, J. W. 1900. Cardamom cultivation in the Bombay Presidency. Agric. Ledger, 11 (Quoted by Ridley 1912.)

Ridley, H. N. 1912. Spices. Macmillan & Co. Ltd., London.

Watt, G. 1872. Dictionary of Economic Products of India. 3:227–236. [Publisher and place not cited].

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Chinese Herbal Medicine. Modern Applications of Traditional Formulas. Liu, Chongyun, Angela Tseng, and Sue Yang. 2005 (actual date 7-28-04). CRC Press LLC, 2000 N.W. Corporate Blvd., Boca Raton, FL 33431. xvi + 886 pp. (hardcover). U.S.$ 89.95, £49.99. ISBN 0-8493-1568-9.

This work presents an extensive compilation of Traditional Chinese Medicine (TCM) formulas and their possible modern uses. The largest section is organized according to TCM terminology (e.g., ''spleen qi deficiency'') and provides over 800 detailed formulas, with modifications for individual circumstances. A second section is organized by allopathic classifications, although the TCM-based explanatory paragraphs will annoy many allopaths. This information-dense reference is clearly aimed at readers with some prior knowledge: instructions for preparation of formulas are limited, and the TCM vocabulary remains confusing to the layman despite an explanatory table and glossary. Western students and practitioners of TCM should find it most useful.

Individual ingredients in the formulas are listed by Chinese names in pinyin romanization. In a third section, extensive tables of herbs provide English common names, dosages, TCM characteristics, indications, and cautions. This section is organized by primary use, so that an herb cannot be found without recourse to the index (which inconveniently includes only pinyin names). Six appendices cross-reference English, pinyin and ''Botanical Latin'' names for herbs. Unfortunately, the last does not refer to scientific nomenclature, but to the quaint designations from European scholarly medicine, which are often unclear or inadequate (e.g., Fructus Crataegi, which does not convey the fact that certain species of hawthorn are to be preferred). It is frequently impossible to determine unambiguously what material is recommended, so that some other reference is necessary. It would have been simple to add species or generic names to the tables, where appropriate, and their absence is a serious flaw.

TCM is known for its broad use of animal, vegetable and mineral ingredients; the nastiest listed here include wingless cockroach, flying squirrel feces, cattle gallstone, and ''boy urine''! (Yes, it is included in a few formulas.) No doubt most of this is worthless folklore, but given that many plant-derived Chinese medicines have impressive bioactivity when tested by modern scientific means, one wonders whether any of these less pleasant ingredients have a real function.

Names of traditional formulas, translated into English, are sometimes quite intriguing (''Purple Snow Special Pill''), and the condition index includes such gems as ''Too lazy to talk'' and ''Taxation malaria.'' It's too bad that formula and herb names were not provided in Chinese characters as well: these convey more information than pinyin and would have given the text more visual appeal and charm. Despite the various nomenclatural omissions, this book as a whole is well produced and will be a valuable reference for those who are interested.

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The Handbook of Clinically Tested Herbal Remedies. Barrett, Marilyn, ed. 2004. The Haworth Press, Inc., 10 Alice Street, Binghamton, NY 13904-1580. Vol. 1: xxxvii + 744 pp. Vol. 2: xxxviii + 745-1435 (hardcover). U.S.$ 159.95. ISBN 0-7890-2723-2, 0-7890-2724-0.

This book is an impressive compilation and evaluation of the tested efficacy of the most common botanicals and herbal products. Thirty individual botanicals, 10 multi-ingredient formulas, 160 products and 360 clinical studies are discussed, and ranked by the quality of the trials, in this incredibly valuable reference book.

Two volumes are needed to contain the multitude of information stored within this book. The volumes are broken into 3 parts; Fundamentals of Herbal Medicine,

Methods, and Botanical Profiles. Part 1 gives an excellent explanation of the history and regulation of botanicals in the United States and uses several chapters to make the reader aware of the need for understanding how botanicals are evaluated. Part 2 details how the guidelines were established to allow the author and contributors to rank the efficacy of the botanicals and herbal products. Finally, Part 3 contains product and clinical trial information. In this section individual botanicals are discussed in terms of preparations used in reviewed clinical studies, summaries of the reviewed clinical studies, summary tables, adverse reactions or side effects, and details on products made from the botanical and clinical studies. Bibliographic references were also included for each botanical or herbal formula presented. Herbal formulas are also detailed using the same clear-cut approach as the individual botanicals.

This book is useful for pharmacists, herbalists, science educators, and anyone looking for a clinical evaluation of a botanical or herbal product. Barrett's work will provide society with an evidence-based platform for their use of herbal medicines and botanicals. The accuracy this book demonstrates in terms of reviewer evaluation of clinical trials should be praised. Not only do the contributors discuss clinical trials completed by the pharmaceutical manufacturers of the product, they subjectively evaluate the trials in terms of the efficacy of the trial. Although the author's evaluation of the individual trial designs may be lost to someone not familiar with statistics, the problem is mollified by the explanation of the trial provided in the authors' and reviewers' comments. Thus, this book clearly outlines the scientific effectiveness of botanicals in a language many people can understand. In addition, this reference would make a valuable addition as a textbook to students studying methodologies within the sciences or appropriate statistical design.

The author and her contributors should be proud of their accomplishment, as this reference handbook has been needed for a long time. Although other books have been designed to compile reference information about particular herbal products, none that I have read match the level of comprehensiveness found within this book. It will certainly be indispensable for people interested in the comparing products according to the efficacy of their clinical trials.

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Cropping Systems. Trends and Advances. Shrestha, Anil, ed. 2004. Food Products Press, an imprint of Haworth Press, Inc., 10 Alice Springs, Binghamton, NY 13904-1580. vi + 720 pp. (paperback). U.S.$ 59.95. ISBN 1-56022-107-0. [co-published simultaneously as *Journal of Crop Production*, Volume 8, Numbers 1/2 (#15/16) and Volume 9, Numbers 1/2 (#17/18) 2003].

A preliminary review of this book indicated that it would be useful to a number of different teaching fields, including not only agronomy but also the plant and environmental sciences. Upon closer examination, I found this book to also provide a fairly complete review of contemporary American agriculture research, with some reasonably good historical backgrounds. Editor Shrestha has assembled 25 research papers that systematically cover themes ranging from current practices in soil management (cover crops, tillage, root dynamics, crop selection and rotation) to cropping systems that focus on: CO_2 sequestration and climate change, precision agriculture, sustainable cotton cropping, transgenic crops, water quality, IPM (Integrated Pest Management), weed management, and research management, among others. Six papers provide an international perspective: yam-based cropping in Africa, new crop technologies in West Africa, Brazilian agriculture in transition, Eastern Europe cropping systems, mixed cropping systems in Guatemala, as well as changes in cereal yields and prices worldwide. Two papers by Canadian authors provide an added dimension to the North American research.

Cropping Systems begins with a paper by Shrestha and Clements that outlines a holistic systems approach to cropping systems. They do a convincing job of emphasizing a greater need for interdisciplinary research groups that encompass environmental, social, and economic sustainability. The authors are optimistic that research will more quickly disseminate to the working farm. Others authors in the text, however, point out the challenges to the adoption of holistic thinking by farmers.

There is abundant quantitative data, tables, and figures throughout the book which represents the norm of agricultural journals. Most of the chapters have reference to the common thread of sustainability and with various interpretations on what that might be: reduction of chemicals, reduction of soil erosion, improving water quality, stable agricultural communities, better management of research, and more farmer profit among others. IPM was well done, with a comprehensive overview that extended to pests, weeds, tools, and other decision-making aids on a crop by crop basis. This chapter could stand alone for the agronomy student. It was good to see a paper on crop production and climate change. The authors presented the results of soybean and sorghum trials, grown under elevated CO_2 levels in open top field chambers in the state of Alabama. The paper on cropping systems and water quality concerns, represented fresh thinking on agriculture's impact on water. The authors examined water

quality from a multi-disciplinary perspective; not just from a classical science (null hypothesis evaluation) but also invoking ''precautionary principle'' analysis. The paper on transgenic crops will be useful to those interested in the research status and benefits of twenty or so crops. The authors, however, might have provided a corresponding balance by including some drawbacks of transgenic technology. For those interested in food security, the final chapter of this book on crop yields world-wide is an essential read.

One weakness of this book is the lack of representation from organic agriculture; either from the growing research literature, the American marketplace, or the landscape perspectives. Overall, the text is a valuable contribution to the literature. The incredible number of references used for each article is indicative of the professionalism of all of the authors.

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Genetically Modified Crops. Their Development, Uses, and Risks. Liang, G. H. and Daniel Z. Skinner, eds. 2004. Food Products Press, an Imprint of the Haworth Press, Inc., Alice Street, Binghamton, NY 13904-1580. xviii + 394 pp. (paperback). U.S.$ 49.95. ISBN 1-56022-281-6

This book provides updated research on several genetically modified crops including grains, pulses, forages, vegetables and grasses and their potential uses as bioreactors, in drought tolerance, and as commercial proteins. With an emphasis on cell and tissue methods, this publication offers a current insight on which crops are being transformed and by what genes. There is detailed review of recombinant technologies, and some challenging genetic and transgenic locus analysis in about every chapter, making this book suited toward an audience of advanced undergraduate students, graduate students, and life science researchers. There is an educational element to this book that could be beneficial to individuals that are biologically literate but not directly involved in transgenic research. For example, the discussion of the role of genetically modified crops in feeding a growing and water-deficient world is valuable. Many of the methods are decipherable including some of the transformation mechanisms (biolistic protoplast mediated) which were more adequately described in a few chapters. Graduate students who have spent long hours in the laboratory will perhaps be able to better frame their own experiments with the good descriptions in this book of agricultural biotechnology methods and protocols including a review of gene delivery techniques, blotting, assaying and progeny testing.

There are fourteen chapters in the book, three of which may be classified under tools and genetic engineering systems. Those plants that each warrant separate chapters are corn, wheat, alfalfa, sorghum, rice, cotton, soybean, and turf grass. Vegetable crops are found in one chapter along with two useful lists: a progress list of 18 crops and their novel proteins and a second list of agronomically useful traits by crop species. The transgenic applications of plant hormones is provided in a separate chapter with basic descriptions of each hormone and potential transgenic uses. The workhorse of many genetically engineered plants, the soil bacteria, *Agrobacterium tumefaciens,* is summarized here and with a narrative of all the old and new ''Roundup Ready'' plants including alfalfa, turf grass, cotton and soybeans. There is a good review of the turf grass industry and the ecological and economic impact in the United States. With some 245 grass cultivars developed in the United States since 1946, and expenditures totaling 45 billion, it is little wonder that transgenic research has entered this industry. Perhaps the most interesting chapter deals with the chicken egg white protein, avidin, and its delicate insertion in corn for use as a biopesticide and in medical research.

With genetically modified crops making up two-thirds of American processed foods, the book could have been strengthened by spending more time on the third part of the title of the book, that being ''risk.'' Risk as defined by the text is a set of mathematical models and probabilities of outcomes. Unfortunately no risk assessment was found and the discussion of the topic was restricted, although some of the limitations and drawbacks with genetically modified crops were discussed in the chapters. Despite this limitation, I got the feeling that the 35 contributors to this book, all of which are plant scientists, were making an effort to lift some veil of secrecy on their research world and allay the fears of what is steadily becoming a more discerning public. This book is relevant to those who wish to gain a greater understanding of the contentious topic of genetically modified crops and how they are produced.

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Traditional Medicinal Plants and Malaria. Willcox, Merlin, Gerard Boedeker, and Philippe Rasoanaivo, eds. 2004. Traditional Herbal Medicines for Modern Times. Vol. 4. Hardman, Roland (ed.). CRC Press LLC, 2000 N.W. Corporate Blvd., Boca Raton, FL 33431. xxv + 431 pp. (hardcover). U.S.$ 99.95, £60.99. ISBN 0-415-30112-2.

Malaria is probably the world's most understudied major disease. It causes several hundred million illnesses and over a million deaths annually, yet the available pharmaceutical drugs are expensive and so limited in number that drug resistance is a serious problem. New approaches are desperately needed, and traditional herbal treatments for malaria are an obvious starting point.

This book presents some interesting examples, notably *Artemisia annua,* source of artemisinin derivatives, which are the latest big (but often unaffordable) drugs for malaria. This case at least shows the value of screening antimalarial herbs using the pharmaceutical model. However, *A. annua* contains several other known antimalarial compounds (related species have antimalarial activity without artemisinin), and clinical studies show that a traditional aqueous infusion can effectively treat malaria. While Western bias rejects such uses of crude extracts, this balanced work acknowledges that traditional preparations may be useful, particularly where the alternative is no treatment.

In fact, this book is exceptional in directing itself primarily to scientists of limited means in countries on the front lines of the fight against malaria. The attitude throughout is pragmatic. For example, a plant that cures symptoms without totally eradicating parasites may be deemed a failure in the West, but one author observes that in areas of constant exposure, such eradication may be pointless and even reduce innate defenses. Observational or cohort studies are recommended for an affordable preliminary evaluation of a remedy in local use. While positive results can support the local use, prospective trials must precede recommendations for widespread use. A discussion of reasonable clinical trial methods, complete with sample data sheets and supply lists, will surely inspire research. In case traditional use data are inadequate to demonstrate probable safety before conducting such a trial, there is an equally helpful chapter on animal toxicity testing.

In vitro and animal screening tests are reviewed, with the caveat that certain assays are uninformative if the mechanism of action is other than expected. It is suggested, therefore, that research on a botanical in active local use should begin with a human cohort study, to avoid false negatives that could cause a valuable plant to be rejected. The utility of insect-repellent or insecticidal plants is also discussed, with examples and a review of preferred testing methods.

Finally, the researcher needs access to ethnobotanical data to select species for study. Some promising taxa are mentioned; one chapter provides lists of plants used on multiple continents. (The complete worldwide list would have included over 1,200 species.) Other chapters offer advice on the conduct of ethnobotanical studies. Overall, this book is written and edited to a high standard, well-referenced, and nicely printed. The authors and editors are to be congratulated for this valuable work.

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Ethnobotany and Conservation of Biocultural Diversity. Carlson, T. J. S. and L. Maffi, eds. 2004. Advances in Economic Botany, Volume 15, The New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, NY10458-5126. 356 pp. (paperback). U.S.$ 29.95. ISBN 0893274534.

First the bad news: This latest volume in the Advances in Economic Botany (AEB) series is described as ''based in part on a symposium by the same title held at the 16th International Botanical Congress in Saint Louis, Missouri, August 1–7, 1999.'' It is not always explicit which of the included chapters were originally papers presented at the Congress. It is clear, however, that not until the summer of 2004 did this volume finally hit the bookstands. I point this out because given the copyright date of the book, my first reaction to the above 1999 date was one of disappointment and doubt as to the currency of the research articles presented.

Now the good news: After reviewing this book, I believe it could be one of the best investments in literature this year for anyone searching for a ''new'' methodology book illustrating the role of ethnobotany in the documentation and conservation of biocultural diversity. I provide the following descriptions of the book in support of my opinion.

1) This work spotlights the interdependency and conservation of biological and cultural diversity, with case studies of innovative research and applied programs that are hypothesis driven, and/or where the authors demonstrate a marked expertise of the subject through extensive field research and supporting data.

2) The case studies and chapters represent a broad range of plant and people interactions, including ecological influences, folk taxonomy, and the use of plants for crafts, food, and medicine. More importantly, they represent advanced discussions of these traditional themes reflecting new ethnobiological research that considers the dynamics of indigenous knowledge due to the movement of people, economic reforms, globalization, and challenges us to think ethically and proactively in our approach to conducting research and disseminating results. [For the most recent and accepted intellectual imperatives and ethical standards in Ethnobiology today, I refer the reader to *Intellectual Imperatives in Ethnobiology* (Ethnobiology Working Group 2003)].

3) Although the majority of the case studies are from South American countries, the inclusion of articles representing research issues from African countries, Canada, and Vietnam is a contribution toward increased representation of these areas in the literature.

4) The venue for these articles, in an edited AEB text versus traditional journals, appears to be a benefit for both the authors and the readers. Not being constrained by the concise style of journal publication, the authors have provided detailed background information, descriptions of methods, results, and discussions of their research programs. As a result, the reader benefits by having an AEB volume that serves as an advanced methodology text with excellent, rich case studies at hand.

The above descriptions of *Ethnobotany and Conservation of Biocultural Diversity* are brief. I urge those whose interest has been stimulated to ''read on'' for a full appreciation of its demonstration of the connections between biological and cultural diversity, and current social and economic issues affecting and affected by those interactions. I genuinely recommend this book to anyone wanting a resource of ethnobiological research that includes innovative research methods, with hypothesis driven and applied research programs, provides examples of different economic uses of plants, and represents case studies from around the world. This 15th volume in the AEB series would serve very well as a methods book or general text for advanced ethnobiological courses. Lastly, the difference between the actual dates of the research programs and the availability of this book most likely is a factor of the inherent nature of book publication and is in no way a reflection of the relevancy of the research articles and arguments presented.

Literature Cited

Ethnobiology Working Group. 2003. Intellectual Imperatives in Ethnobiology. Missouri Botanical Garden, St. Louis, MO. (http://www.econbot.org/pdf/NSF_brochure.pdf).

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Erratum

The author affiliations were incorrectly identified in the article ''Shea Fruits in African Parklands'' by Steven Maranz and colleagues that was published in the Winter 2004 issue (*Economic Botany* 58(4) pp. 588–600). The correct affiliations appear below:

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