Fox-tail Millets (*Setaria*: Poaceae)—Abandoned Food in Two Hemispheres[1]

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Austin, Daniel F. *(Center for Sonoran Desert Studies, Arizona-Sonora Desert Museum, 2021 N. Kinney Road, Tucson, AZ 85743; e-mail: daustin@desertmuseum.org).* Fox-tail Millets (*Setaria* Poaceae)—Abandoned Food in Two Hemispheres. *Economic Botany 60(2): 143–158, 2006. A survey of anthropological, archaeological, botanical, and historical literature reveals that two species of fox-tail millet were domesticated in the Old World* (S. italica, S. pumila)*, and one may have been domesticated in the New World* (S. parviflora)*. Others were prehistorically and historically gathered and eaten as cereal starch sources, including* S. liebmannii, S. macrostachya, S. pallide-fusca, S. palmifolia, S. parviflora, S. pumila, S. sphacelata, S. verticillata, S. viridis, *and perhaps others. The American species are briefly discussed and compared with the Old World plants, and a synopsis of food changes is presented.*

Cola de Zorro (*Setaria*: Poaceae)—Una Comida Abandonado en Dos Hemispheros. *Una revisión de la literatura antropologica, archeologica, historica y botanica revela que dos especies de mijo (cola de zorro, cola de ardilla) fueron domesticadas en el Viejo Mundo* (S. italica, S. pumila), *y una especie* (S. parviflora) *quiza pudo haber sido domesticada en el Nuevo Mundo. Otras especies, tanto prehistoricamente como historicamente, fueron recogidas como cereales e ingeridas como fuentes de almidon, incluyendo* S. liebmannii, S. macrostachya, S. pallide-fusca, S. palmifolia, S. parviflora, S. pumila, S. sphacelata, S. verticillata, S. viridis, *y quiza otras especies. Las especies Americanas son brevemente comparadas y analizadas con respecto a las plantas del Viejo Mundo, tambien se presenta una sinopsis de los cambios en la alimentacion.*

Key Words: *Setaria*, cereals, change, domesticated, foods, grasses, harvested.

As I climb past the 3,800-foot elevation level in the Baboquivari Mountains of south-central Arizona, I begin to see *zacate tempranero,* or plains bristle-grass (*Setaria macrostachya*), along the slopes. Above 4,200 feet that fox-tail has disappeared, but still with me is *cola de ardilla* or Grisebach's bristle-grass (*S. grisebachii*) just as it is lower in the Altar Valley where I live at 3,200 feet.

Because many animals eat *Setaria* "seeds" (caryopses), I have wondered for decades if New World people used these grasses as food. Martin et al. (1951) went so far as saying that *Setaria* ". . . top[s] all other weeds in the [United States] in food value to wildlife." They found accounts at the time of 67 birds and 10 mammals that consumed the grains. I found no records of Florida species being eaten by people when I studied those plants (Austin 2004), although now I know that one there has been eaten.

Perhaps I was led astray in part by de Wet's (1995) treatment of the genus in Smartt and Simmonds's *Evolution of Crop Plants*. De Wet said simply that an unidentified *Setaria* had been used as a cereal in pre-Columbian Mexico; he gave no source. Similarly, Hedrick (1919), Uphof (1968), Purseglove (1972), Coon (1974), Hocking (1997), Moerman (1998) and Wiersema and León (1999) do not list American species as having been used. Even Fernald et al. (1958), who consumed and commented on numerous American plants most of us consider inedible, listed and discussed only Old World species. I learned long ago that people in one hemisphere are as likely as those in the other to use the same genus of plants (cf. Austin 2004). The story is much like other discarded wild and

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domesticated foods (cf. Nabhan 1985, Smith 1992, Austin 2004).

Old World Species

Today, about the only well-known human food among Old World species is *S. italica*. However, that and other species are used in Europe, Africa, and Asia (Table 1). *Setaria italica* was cultivated as an important food across southern Europe until the early 20th century. Since then it has declined in importance there, but remains an essential food for home consumption in parts of India, China, Korea, and Japan (Purseglove 1972; Facciola 1990; de Wet 1995; Ahanchede et al. 2004; Leff et al. 2004; Rengalakshmi 2005).

Setaria italica has been in cultivation for about 8,000 years in China. The first records come from ca. 6000 B.C. in the Peiligang and Cishan contexts, the oldest farming cultures in northern China's Yellow River Valley (Henan Province) (Li and Wu 1996; Zohary and Hopf 2000; Shelach 2000). Soon afterward, the species emerged farther south as the principal cereal in the Yangshao culture of the 5th and 4th millennia B.C. in Hunan Province (Ho 1969; Li 1970; Ebeling 1986; Crawford et al. 2005).

Millet was such an important food in China that the name of the legendary ancestor of the Chou tribe in the highlands was based on the plant. He was called *Hou Chi*, which means "Lord of the Millets" (Ho 1969).

There was either a wider application of Chinese words employed to indicate grains from *Setaria* and *Panicum*, or confusion in the older literature. Perhaps both occurred as they do with the English word "millet," now used to indicate an array of genera (Table 2). Ho (1969) commented on the ancient broad application of the Chinese names to *Panicum* and *Setaria*. Although the modern name of *Setaria* is *su* (粟), the old scribes sometimes used both *chi* (稷) and *shu* (黍) for that grain. The modern use restricts those two names to different cultivars of *Panicum*. Most literature says there are no ancient common names for *Setaria* in European languages, but Fuchs in 1542 [2003] and Cooper (2005) thought that Greek *elymos* and *meliuh* originally applied to *Setaria italica*. Certainly, the way Dioscorides, Galen, and Pliny discussed and compared it with *millium* (*Panicum*), it sounds like *Setaria*. Either way, European names have now subsumed both *Setaria* and *Panicum* as does the Arabic word *dokhn* and the cognate *dokhan* in Hebrew (Tables 1, 2).

Literature records the pivotal nature of the "Five Grains of China" that are thought to date from emperor Chin-nong in 2700 B.C. when he commanded that subsequent emperors sow them in a public ceremony each year (de Candolle 1886; Ho 1969; Hsuan 1974; Davidson 1999). Although the number varies from five to nine, and the kinds listed sometimes include more than one genus under a single name, the "grains" usually cited are *su* (粟, *Setaria italica*), *chi* (稷, *Panicum miliaceum*), *keng* (粳, *Oryza sativa*; dozens of words are used for rice, including *tao*, 稻, which is rice growing in the field or paddy, cf. Hsuan [1974]), *mai* (麥, *Triticum*), and *shu* (菽, *Glycine*, now *huang tou*, 黃豆, yellow bean or *ta tou*, 大豆, great bean).

Cultivated *S. italica* is not as old in India as in China, but seeds gathered from wild plants are in archaeological sites dating from about 2800 cal B.C. in the states of Karnataka and Andhra Pradesh (Fuller et al. 2004). They are nearly as old in the Harappan area of northern India and Pakistan, where they date to 2400 B.C. (Weber 1998). Even less known in the Western world than the "Five Grains of China" are the *Navadhanyam* (nine grains) of India. This is a mixture, particularly of *ten-nai*, *varagu korali, adipul, kuthirai val pul, kurakkan, pani-varagu, samai, thirivaragu*, and *pil samai* (binomials in Tables 1, 2). This grain mixture is used in daily foods (P. Kamthe and N. Jeyakumar, pers. comm. Nov. 2005), and given as *pujas* (offerings for adoration) at shrines and temples in both India (e.g., Shiva temples in Kerala 2005) and the United States (e.g., Sri Shiva Vishnu Temple 2005, Sri Venkateswara Temple 2005).

Setaria italica is somewhat younger in Europe and the Middle East. Recovered grains date from the Bronze Age (2000 B.C.) in Greece, Italy, Switzerland, Turkey, and Yugoslavia, and in more recent sites there and in some other countries (Nesbitt and Summers 1988; Marinval 1992; Zohary and Hopf 2000; Kroll 2000; Arobba et al. 2003). Miller and Smart (1984) found *Setaria*, presumably this species, in the village of Milyan, Iran, in modern hearth sweepings and household debris. They also identified *Setaria* in burned dung in

TABLE 1. SOME *SETARIA* SPECIES USED BY PEOPLE HISTORICALLY AND CURRENTLY IN VARIOUS PARTS OF THE WORLD.[1]

BINOMIAL	USES	COMMON NAMES
S. italica (L.) P. Beauvois	**Europe to Asia**: Edible seed; forage crop (de Candolle 1886, Watt 1889, Wiser 1955, Burkill 1966, Ho 1969, Hsuan 1974, Marinval 1992, de Wet 1995, Manandhar 2002). **Food examples**: Seeds in Korea made into alcoholic beverages such as *dong dong ju* (a country sake), *soju, takju,* and *yakju* (Facciola 1990, Cho Yeun and B. Pemberton, pers. comm. Nov. 2005); in Japan to make *awa okoshi* cakes (Kitajima pers. comm. Nov. 2005). In the Comibatore District of India this is still the primary grain, eaten instead of rice. Used to make gruel, especially for pregnant and lactating women (Rengalakshmi 2005), and a primary ingredient in *Navadhanyam* (Kamthe, pers. comm. Nov. 2005).	*awa* (粟, Japanese), *boermanna* (Boer's manna, Afrikaans, South Africa), *Borstenhirse* (bristle grass, German), bottle-grass, *dari* (Turkey), durra (from Arabic *durah, durrah*), *dukhn* (Arabic), *faang haang maa* (dog tail straw, Thailand), fox-tail [German, Hungarian, Italian, Russian] millet, *giers* (Afrikaans, South Africa), fox-tail [Italian] bristle-grass, *gal* (Persian), *kangni* [*kángu, kakun*] (Hindi, from *kungú* [*kangu*], Sanskrit), *kaguno* (Nepali), *khaao faang* (white straw, Thailand), *khre* (Tibetan, Nepal), *lebelebele* (Sotho, South Africa; see also *Sorghum*), *milho-painço* (millet-panicum, Portuguese), *millet d'Italie* [*de oiseaux*] (Italian [bird] millet, France), pigeon-grass, *riz allemand* (German rice, France), *rókafarkú köles* (fox-tail millet, Hungarian; *muhar* in old stories), *rumput ekur kuching* (cat's tail grass, Malay Peninsula), *sěkoi* (Malay Peninsula), *su* (粟; also *chi* 梗; *shu*, 黍; *liang*, 粱 grain, food; and *siao mi,* 小米, little seed), *tana-hál* (*tana*, grass, *hal*, rice, Sinhalese, Sri Lanka), *ten-nai* [*thina*, *thinai*] (small grass, Tamil, India, Sri Lanka)
S. intermedia Roth ex Roemer & Schultes (syn. *S. tomentosa* (Roxburgh) Kunth)	**India:** Reddy (2003) found that farmers in the Gujarat/Rajasthan area used the grass as fodder. Although they did not plant it, they harvested and ate the grains. Arora (1991) lists the species as one of the widely distributed "cereals and millets."	*arranki gaddi* (Telugu), *birali* (Hindi), *dodda anta purlai hulla* (Kannada), *kari ottai hulla* (Kannada), *landgar* (Marathi), *pandar* (Marathi)
S. liebmannii E. Fournier	**Mexico**: Seri ate the seeds into the 1980s (Felger and Moser 1985). Bitter seeds used to treat toothache. Forage among Guarijío and Mayo (Yetman and Van Devender 2001, Yetman 2002).	*cola de* [*la*] *zorro* [*zorra*] (fox tail, because the spike resembles the upright tail of a running fox, San Luis Potosí, Sonora), *cola de ardilla* (squirrel tail, Guarijío, Sonora), *hayás guasia* (Sonora, Mayo) *wee ok* (fox tail, Huastec, San Luis Potosí), *ziizil* (Seri, Sonora)
S. macrostachya Humboldt, Bonpland & Kunth	**Mexico**: A pre-Columbian and historic Mexican cereal (Callen 1967a, b, Smith 1967, Felger and Moser 1985). **Food examples**: Seri toasted grains, ground them, and ate them as gruel.	[plains, summer] bristle-grass, fox-tail [wild] millet, *hasac* (Seri, Sonora), *ne-kuuk-suuk* (*neh*, animal's tail, *k'uk'uk*, young part of a plant, *sak*, white, Maya, Yucatán), *xica quiix* (globular things, Seri, Sonora), *zacate tempranero* [*temprano*] (early grass, Arizona, Chihuahua, Sonora)
S. pallide-fusca (Schumacher) Stapf & C.E. Hubbard [*S. pallidifusca*]	**Africa**: Grain harvested by the Xasonga [Kasonke] of Burkina Faso (Chevalier 1913 in Dalziel 1937, de Wet 1995). **Asia**: Used for fodder in Nepal (Manandhar 2002).	*buis* (Nepali), cat's tail grass (Fiji), *laki davangel* (dog's trail, Fulani, Mali), *pura barra* (dove's grass, Manya [Mandingo], Gambia), *gundul* (Arabic), *ko-tsubu-kin-enokoro* (small grain golden *Setaria*, Japan; *enokoro* may be a corruption of *inu*, dog, and *koro*, diminutive; "*inu*" refers to both dogs and foxes), *k'yasuwar rafi* (*k'yasuwar* = *Pennisetum*, Hausa, Nigeria), *yaa haang maa khaao* (white dog tail grass, Thailand)

TABLE 1. CONTINUED

BINOMIAL	USES	COMMON NAMES
S. palmifolia (J. König) Stapf	**Asia**: Harvested as cereal in the Philippines (Burkill 1966), and part of a religious festival of new rice harvest (Conklin 1967). Shoots cooked as green vegetable in New Guinea. Sections of the stem of the young plant are steamed in a bamboo tube and then eaten (von Reis-Altschul and Lipp 1982, French ca.1986, de Wet 1995).	*hailans pitpit* (highlands "grass" [*pitpit* also is the name of *Saccharum,* which in English is "coastal pitpit"], Tok pisin, Papua-New Guinea), *lachang* (Malay Peninsula), *liyáhan* (Ifugao, Philippines), *mai* (Agarabi, Papua-New Guinea), palm-grass (Okinawa), *reli tana* (*reli* = ?, *tana*, grass, Sinhalese, Sri Lanka), *sasa-kibi* (like *Panicum miliaceum*, Japanese, Okinawan), *yaa kaap phai* (grass with bamboo, Thailand)
S. parviflora (Poiert) Kerguélen (syn. *S. geniculata* (Lamarck) P. Beauvois)	**Mexico**: Seeds historically eaten (Callen 1963, 1967a, b). **United States:** See text.	*Amerika-enokoro-gusa* (American *Setaria* herb, Japanese, Okinawan), *cepillo de fregar botellas* (bottle brush, Puerto Rico), *deshollinador* (the husker, Puerto Rico), *ehtill week ok* (like fox tail, San Luis Potosi, Huastec), knot-root foxtail, *pajita cardosa* (little thistle grass, Chihuahua), *rabo de gato* (cat tail, Cuba), *rabo de zorro* (fox tail, Puerto Rico), yellow bristle-grass, *zacate amarga* (bitter grass, Mexico, *Swallen 2226* NY)
S. pumila (Poiret) Roemer and Schultes (syn. *S. glauca* of authors, *S. lutescens* (Weigel ex Stuntz) F.T. Hubbard)	**India/Asia**: Cultivated and domesticated for grains in eastern and western Ghats, India; gathered from wild plants elsewhere (Watt 1889, Datta and Banerjee 1978, Prasada Rao et al. 1987, de Wet 1992, 1995, Kimata et al. 2000, Dekker 2003). **Food examples:** Seeds in *Navadhanyam*, and to prepare *anna* (boiled grains), *roti* (unleavened bread), *sankati* (porridge), and *ganji* or *peja* (gruel) (Kimata et al. 2000, Kamthe pers. comm., Nov. 2005).	cat-tail millet, *haang maa* (dog tail, Thailand), *juk* (Sudanese), *kin-enokoro-gusa* (golden *Setaria* herb, Japanese, Okinawan), *korai* [*kora, korali*] (Bengali, Deccan, Hindi, India and Bangladesh), *kuching-kuchingan* (Java), *nakakora* (Telugu, India), *pajón blanco* (big white grass, Dominica Republic), pigeon grass, *bandra* (Hindi, India), *rumput jolong-jolong* (*rumput*, grass, Java), *varagu korali* (*varagu,* firewood, *korali*, ear of corn, Tamil; called firewood because the straw is burned after the seeds are harvested), yellow grass [fox-tail], *z'herbe quiquitte* (lowly herb, Haiti)
S. sphacelata (Schumacher) M.B. Moss ex Stapf & C.E. Hubbard	**Africa**: Harvested as wild cereal (Purseglove 1972, Prasada Rao et al. 1987, de Wet 1995).	*bábáchíí* (also a name given to *Sacciolepis*, Hausa, Nigeria), golden timothy, *oulounikou* (dog's tail, Bambara, Mali), *pasto gusanillo* (little worm grass, Honduras), *wicco wunduho* (monkey's tail, Fulani, Nigeria)
S. verticillata (L.) P. Beauvois	**Africa**: Seydel (775 NY) recorded "*Die Samen, von den Eingeborenen durch Reiben zwischen den Haenden von den Borsten befreit, liefern gekocht eine mehlige Feldkost*" (The seeds, after being separated from the bristles by the natives by rubbing them between the hands, yield—if cooked—a floury food). Topnaar people of Namibia use seeds in porridge and to brew beer (van Wyk and Gericke 2000). See also Dalziel 1937.	bur bristle-seed (South Africa)*, dora-byar* [*byara*] (Bengali, India), *ẽmŏ ĕiyĕ* (bird's bur, Nigeria), *kebbe tioffé* (*kebbe* = bur grass, Fulani, Mali), *pega-pega* (stickers, Cuba), rough bristle-grass, *sénorna* (adhering to the foot, Bambara, Mali), *ǂareb* (Nama, South Africa), *zaratsuki-enokoro-gusa* (rough *Setaria* herb, Japanese, Okinawan), *yaa haang krarok* (squirrel tail grass, Thailand)

TABLE 1. CONTINUED

BINOMIAL	USES	COMMON NAMES
	Asia: Used for fodder in Okinawa and the Ryukyu Islands (Walker 1976).	
	India: Seeds eaten.	
S. viridis (L.) P. Beauvois	**Europe, Asia**: Seeds harvested for centuries before *S. italica* was domesticated (Li and Wu 1996); still eaten boiled, roasted, or ground into flour (Facciola 1990). Chinese call this simply 狗尾草 (*gao wei cao*, dog tail grass) to distinguish it from cultivated *S. italica*. Other species are *gao wei cao* with various modifiers.	*almorejo* (from *amorejo*, diminuitive of *amor*, to love, because of the sticky fruits, Spanish), *Borstenhirse* [*Borstenhirz*] (bristle grass, German), *enokoro-gusa* (*Setaria* herb, Japanese, Okinawan), fox-tail [hay, wild] millet, green bristle-grass [fox-tail], *milha-verde* (green millet, Portuguese), *mushigawa-gusa* (*gusa* = herb, Okinawan), *neko-jarashi* (cat frisking [grass], Japanese, Okinawan), pigeon-grass, *sétaire verte* (green setaria, French)

[1] Sample common names are given from different parts of their ranges to indicate the regard with which people hold them. Single word names are typically simple and cannot be further translated. Reduplicated words are often plural forms. Proveniences are not given for English names as they tend to be traded throughout the world by speakers of that language. For more common names, see Hubbard (1915) and Porcher (1997–2000).

the "ancient" village of Milyan. During Roman times, *S. italica* as food was particularly associated with Pontus (on the Black Sea), Thrace (Balkan peninsula north of Aegean), the Po valley in northern Italy, and with Elymian Sicily (Purcell 2003).

Historically, it was thought that the grain was brought into cultivation in China and then traded west into Europe. There is a growing body of data suggesting that the species was perhaps domesticated in multiple localities across its wide Old World range (Blumler 1992; Wang et al. 1995; Li et al. 1998; Schontz and Rether 1999; Le Thierry d'Ennequin et al. 2000; Benabdelmouna et al. 2001; Fukunaga et al. 2002a, b; Fukunaga and Kato 2002).

De Wet (1992, 1995) considered *S. pumila* to have been domesticated in southern India. While the wild plants are harvested across tropical Africa and Asia, they are grown as a domesticated crop only by hill tribes in eastern and western Ghats (de Wet et al. 1979; Kimata et al. 2000; Dekker 2003). There seem to be no archaeological data on this species, and sparse modern literature on its use.

AMERICAN SPECIES

It is now clear that American *Setaria* species were consumed as food in several parts of their ranges. Not only was the most widespread species, *rabo de zorro* or knot-root fox-tail (*S. parviflora*), used, but at least one of the species I passed in the Baboquivari Mountains also was eaten (Table 1).

MacNeish, writing in Kaplan and MacNeish (1960), published the first piece of the record by noting fossil plants in the Ocampo region of Tamaulipas, Mexico, although they listed the remains as the similar *Panicum*. A short while later, Callen (1963, 1967a, b) reported that C.E. Hubbard at Kew had identified the material in 1961 as *Setaria* and not *Panicum*. Moreover, the plants they discussed were the widespread American *S. parviflora,* long known as *S. geniculata* (Gandhi and Barkworth 2003). Hubbard (in Callen 1967a) wrote that the plants were a larger-seeded form than the wild types. Both Hubbard and Callen interpreted the large seeds as being from domesticated plants. These grains appeared in the ^{14}C-dated 4000–3500 B.C. levels at the Ocampo Caves, and from the Sierra de Tamaulipas Caves at ca. 3000 B.C. (See Postlogue for caveat on dating.) The grass was still present in 50% of the coprolites at 1400 B.C.

Callen (1967a) concluded that *Setaria* represented the "first New World cereal." In spite of that claim, few subsequent references have discussed this early food. Ebeling (1986) and Lentz (2000) seem to be among the few biologists who have discovered Callen's (1967a) paper, while more anthropologists and archae-

TABLE 2. SOME OF THE "MILLETS" EATEN BY PEOPLE.[1]

MILLET		From Middle French *millet* (in Old French by ca. 1256). In English by about 1425, ultimately from Latin *millium*, having a thousand grains. Cognates: *miglio* (Italian), *milho* (Portuguese), *millo* [*mijo*] (Spanish)
OTHER MILLETS		
Guinea millet (gold from the region made into coins called *guineas;* in English by 1664)	*Brachiaria deflexa* (Schumacher) C. E. Hubbard ex Robyns (syn. *Urochloa deflexa*)	animal fonio, *paguiri* (Songhai, Mali)*, yagué yagué ba* (Bambara, Mali)
Fundi [millet] (*fundi* in English by 1858), hungry rice	*Digitaria exilis* (Kippist) Stapf	*acha* [*achcha*] (Hausa, Niger), *fondo* (Guinea-Bissau), *fonio* (Bambara, Malinké, Mali, Senegal), *funde* (Dominican Republic), *fundi* [*fundungi*] (hungry rice, Creole, Sierra Leon), *petit mil* (little millet, French), *po* (Dogon, Mali)
Sawa millet (*sawa* from Hindi), jungle rice (in English by 1886)	*Echinochloa colona* (L.) Link	*adipul* (*adi*, summer [June to August], *pul*, grass, Tamil, India, Sri Lanka), *bulo* (Uganda), *chargari* (Fulani, Niger), *giratana* (*giri*, parakeet, *tana*, grass, Sinhalese, Sri Lanka), *hie* (稗, Japanese), *ko-hime-hie* (small delicate *Echinochloa*, Japanese), *padi burong* (bird's millet, Java), *sawa* [*sama, sawánk*] (Hindi), *sami-dhan* (*Echinochloa* grain, Bengali), *sawuk* (Urdu, Sind), *telebun* (Sudan), *wase-bie* (early maturing *Echinochloa* [稗], Japanese), *wimbi* (Swahili)
Japanese millet, barn-yard grass [millet] (in English by 1843)	*Echinochloa crus-galli* (L.) P. Beauvois	bai (稗, Chinese), *báo'báo'* (Ifugao, Philippines), *bharti* (Hindi), *inu-bie* (dog [false] *Echinochloa* [稗], Japanese), *kuthirai val pul* [*kurirai val pul*] (*kuthirai,* horse, *val,* tail, *pul,* grass, Tamil, India, Sri Lanka), *maratu* (*ma*, big, *aratu*, backbone, Sinhalese, Sri Lanka) The cultivated form sometimes called *E. frumentaceum* is *hu nan bai zi* (湖南稗子, south lake millet's son, Chinese)
Finger millet (branches of inflorescences resemble fingers)	*Eleusine coracana* (L.) Gaertner	*kurakkan* (Tamil, Sinhalese, India, Sri Lanka), *mandal* (Punjabi), *mandwah* (Persian), *maruá* (Bengali), *nangli* (Urdu, Sind), *rági* [*rájika, ragee*] (Sanskrit)
Teff [millet] (*teff* in English by 1790), love-grass	*Eragrostis tef* (Zuccarini) Trotter	*taf* (Tigrigna, Ethiopia), *tahf* (Arabic), *tef* [*t'ef*] (Amharic, from an older *teffa*, lost, because the grains are so small, Ethiopia), *tafi* (Oromo, Ethiopia)*, mil éthiopien* (Ethiopian millet, French)
Sauwi millet (from the Guarijío *sagui;* in English by 1940s)	*Panicum hirticaule* J. Presl var. *millaceum* (Vasey) Beetle (syn. *P. sonorum*)	*shimcha* (Tohono O'odham, Arizona), *heshmicha* [*šimča*] (Cocopa, Arizona), *sagui* [*sauwi, sahuí*] (Guarijío, Sonora)
Proso millet (from Russian *proso* by 1917), broomcorn [common, little] millet	*Panicum miliaceum* L.	*chena* (Hindi), *chi* (稷; one variety is *shu*, 黍), *chiná* [*china*] (Bengali, Sanskrit), *dokhan* (Hebrew), *dokhn* (Arabic), *kegchros* (Greek), *kibi* (黍, Japanese), *köles* (Hungarian), *kosaejb* (Arabia), *menéri* (Sinhalese, Sri Lanka), *millium* (Latin), *proso* (Russian, but an ancient Slav word, Poland, Russia), *sora* (Lithuanian), *pani-varagu* (*pani*, dew, *varagu* firewood, because the straw is burned, Tamil), *varikora* (striped grass, Tamil)

TABLE 2. CONTINUED

OTHER MILLETS (CONTINUED)		
Sama millet (from Tamil *samai*), little millet	*Panicum sumatrense* Roth ex Roemer and Schultes (syn. *P. miliare* of authors)	[*hin*] *menéri* (*hin*, small, *menéri*, proso, Sinhalese, Sri Lanka), *kungu* (Hindi), *kútki* (Hindi, Punjabi), *samai* [*sama*, *shamai*] (to cook, Tamil, India, Sri Lanka)
Kodo [khodo] millet (probably from Javanese *kodoan*)	*Paspalum scrobiculatum* L.	*amu* (Sinhalese, Sri Lanka), *hai-suzume-no-hie* (creeping sparrow's *Echinochloa*, Japanese), *kapie* (Mende, Sierra Leon), *kodoan* (Java), *ǒkànli* (Yoruba, Nigeria), *tumbia jaki* (donkey's belly, Hausa, Niger), *thirivaragu* (*thiri*, wick, maybe from shape of grains, *varagu,* firewood, because straw burned; also translated as "twisted grass" by Rengalakshmi 2005, Tamil, India, Sri Lanka)
Pearl millet (from the white, almost-globular grains, in English by ca. 1890)	*Pennisetum glaucum* L. Richard (syn. *P. americanum, P. typhoides*)	*babala* (Afrikaans), *bájra* [*bajri, bajera*] (Hindi, Punjabi, etc.), *emeye* (Yoruba, Nigeria), *gero* (Hausa, Niger), *jadouri* (Fulani, Cameroon), *kambu* (Tamil, from Dravidian **kampa*, loanword in Sinhalese, India, Sri Lanka), *manna* (Afrikaans; allusion to *Digitaria sanguinalis,* the original European "manna"), *mattari* (Malay), pearl [African, bulrush, candle, cattail, spiked] millet, *pedda-gantee* (*pedda*, bird, *gantee*, grain, Telegu, India), *unyaluthi* (Zulu)
Sorghum millet (*sorghum* probably from Italian *sorgo*, based on Latin *suricum granum*, grain from Syria; in English by 1597)	*Sorghum bicolor* (L.) Moench (syn. *S. frumentaceum, S. vulgare*)	African [black, great, Indian, Turkey] millet, *amabele* (Zulu), *baba* (Yoruba), *cholam* (Tamil), *daodhan* (god's grain, Hindi), broom [Guinea] corn, *durrah* (Arabic), *graansorghum* (grain sorghum, Afrikaans), *imphee* (from *imfe*, or possibly from Swahili, *wimbi,* Natal), kafir (from Arabic *kafir*, infidel), *mtama* (Swahili), *jagong* (Malay), *jowar* [*joar*] (Bengali, Hindi, Punjabi, etc.), *kao-liang* (tall grain, China), *mabele* (Sotho, South Africa), milo (from *maili*, Sotho), *nami-morokoski* (common sorghum, Japanese), *zúrna* (Sanskrit, from Arabic *dhura, durrah*)
Browntop millet	*Urochloa ramosa* (L.) T. Q. Nguyen (syn. *Brachiaria ramosa, Panicum ramosum*)	*chusara mata* [*gusara mata*] (Orissa, India; the weedy type, not cultivar), *pedda sama* (*pedda*, bird, *sama*, *Echinochloa*, Telegu, India), *pil samai* [*pil same*] (*pil*, grass, *samai*, to cook, Tamil, India)

[1] Common names are taken largely from de Candolle (1886), Watt (1889 [1972]), Dalziel (1937), Burkill (1966), Walker (1976), Dassanayake et al. (1994), de Wet (1995), and Van Wyk and Gericke (2000). The Arabic *dokhn* and Hebrew *dokhan* are listed only under *Panicum miliaceum*, although in practice they are used to indicate several of the more widespread millet genera. See de Wet (1992) for details on origins and cultivation regions.

ologists cite his study (e.g., Flannery 1973, Coe 1994, papers cited below). Although most have thought that the seeds of American *Setaria* were food only for wildlife, they were in fact the dominant cereal for many New World humans for at least 1,500 years.

The same year that Callen's paper appeared, a companion report was published by Smith (1967). His study was of all the plant materials found in the Tehuacán Valley archaeological sites during research initiated by Richard S. MacNeish (cf. Byers 1967). Smith identified *S.*

Fig. 1. Two of the *Setaria* species known to be eaten in the Americas. (Left) *S. macrostachya* Humboldt, Bonpland & Kunth. From Gould (1951). Artist: L.B. Hamilton. (Right) *S. parviflora* (Poiert) Kerguélen. From Leithead et al. (1971). Artist: Unknown.

macrostachya in most of the cave levels in both caches and in the refuse. The species was the only cereal present in levels radiocarbon dated at 5500 B.C., but declined in importance by about 4500 B.C. following the rise of maize (*Zea mays*) cultivation. Although the *Setaria* had been eaten in quantity, there was no increase in seed size.

Following 4500 B.C., *S. macrostachya* decreased in importance and was rarely used in the valley by the time of the Spanish entrada (Smith 1965, 1967). Callen (1967a) reported these grass seeds present in 71.5–77% of coprolites from the earlier levels in Tehuacán. Between A.D. 700–1500, *Setaria* had dropped to 20% in his samples, and continued to decline up to the Spanish arrival.

Setaria parviflora in Tamaulipas, on the other hand, was a more important part of the human diet much later (Callen 1967a, b). Some have explained the difference by noting that maize did not appear in Tamaulipas until about 2200 B.C. Since maize arrived later than in the Tehuacán valley, *Setaria* remained an important cereal for longer in Tamaulipas.

Prehistoric use of the genus has now been extended from Tamaulipas and Tehuacán to people farther north and south in Mexico, the southwestern and eastern United States, and the Caribbean. None of those reports speculate on the species or how many species were consumed.

People in central and southern Mexico are thought to have been gathering and eating seeds of *Setaria* between 6000 and 8000 B.C. (Brumfiel 2003–2004). Brumfiel specifically noted the Coxcatlán Cave in Tehuacán that was reported by both Callen (1967a, b) and Smith (1967). Flannery (1986) assumed that the genus was being used in the Guilá Naquitz of Oaxaca in his model, although there were no archaeological remains as a basis for that view. If *Setaria* was used in Oaxaca, it extends the use of the genus markedly to the south during this period. Both *S. macrostachya* and *S. parviflora* grow in Oaxaca, although there are other American species (Zuloaga et al. 2003).

Reinhard et al. (2003) found *Setaria* seeds in the digestive tract of a desiccated body from the Río Grande river border between Coahuila, Mex-

ico, and Texas. The individual was carbon-14 dated to have died about 1,150 years ago (A.D. 850). Not far away, another dried body in the lower Pecos River region of southern Texas had *Setaria* seeds in its intestines (Turpin et al. 1986). The grains appeared to have been processed with a mortar and pestle, and the remains were radiocarbon dated between A.D. 1080–1220. There are eight native species in the area: *S. adhaerens, S. grisebachii, S. leucopila, S. macrostachya, S. parviflora, S. scheelei, S. texana*, and *S. villosissima* (Correll and Johnston 1970).

Huckell and Toll (2004) record that *Setaria* inflorescences and seeds were found in the Salado culture sites in the Tonto Basin of central Arizona east of Phoenix. These sites are from the Classic period that began in A.D. 1250. There are at least two native species in that region, including *S. leucopila* and *S. parviflora*. Perhaps *S. grisebachii* and *S. macrostachya* are also there, although no specimens in the herbaria at the University of Arizona or Arizona State University verify that.

Bonzani et al. (2002) found a few carbonized *Setaria* grains in the Hart Site (Big Sandy River, Lawrence County) in eastern Kentucky. The Hart site is part of the Late Archaic through Woodland periods, with different segments ^{14}C dated from 1600 B.C. to A.D. 600. Although *Setaria* and other plants were present in level F24 (upper), the majority of materials were from *Chenopodium* (62 grains vs. 5 of *Setaria*). The only native species now in Kentucky is *S. parviflora* (Browne and Athey 1992).

Crawford and Smith (2003) found archaeological data on *Setaria* uses among people in the northeastern United States. The quantity of seeds was small, with the highest being part of the 10% grass seeds (without counting maize) in the late precontact Iroquoian Seed-Barker site on the northwestern end of Lake Ontario radiocarbon dated ca. A.D. 1500. Grains were also found in the Memorial Park site in central Pennsylvania dated A.D. 800–1350. The only native American species known from the northeast are *S. magna* and *S. parviflora* (Fernald 1950; Hitchcock and Chase 1950).

Adair (2003) found that the genus had been eaten in the Correctionville phase of the Oneota in northwestern Iowa ca. A.D. 1000 among the Northeastern Plains Village sites. There are no native species currently known from that region, but both *S. leucopila* and *S. parviflora* occur to the south and east (Barkley 1977, 1986). *Setaria leucopila* is distinguished with difficulty from *S. macrostachya*, and they sometimes grow in mixed populations (Emery 1957; Roeminger 1962).

The only known site with *Setaria* in the Caribbean is on San Salvador Island, Bahamas. Newsom and Pearsall (2003) included the site in the Ostionoid culture series that lasted from 4000–5000 B.C. to ca. 200 B.C. These authors suspected that this genus, and others, may have historically been used more often, and that absence from some records does not mean an absence of use. The low grass frequency may not have been due only to sampling error, but also complicated by poor preservation and handling techniques within wet tropical areas (Berman and Pearsall 2000). The native species now in the Bahamas are *S. macrosperma* and *S. parviflora*, although only the latter is documented from San Salvador (Correll and Correll 1982).

There appear to be records of only two historic American tribes consuming seeds of *Setaria*. Castetter and Bell (1951) wrote that a few Cocopa on the Colorado River were growing and eating seeds of the alien *S. italica* in the 1930s and 1940s. For some unexplained reason, Doebley (1984) reported the plants as *S. viridis*, although the voucher (*Castetter 2755*, 20 September 1932, UNM) is *S. italica*. Otherwise, Doebley (1984) reconfirmed that the Cocopa were devoted agriculturists who also consumed the grains of numerous kinds of wild and cultivated grasses.

Recently, the Seri of the Sonora coastal region along the Gulf of California ate both *S. liebmannii* and *S. macrostachya*, although the latter was a more abundant and important species (Felger and Moser 1985). This was still an important food for the Seri in the 1980s (Table 1). As with several other plants, the Seri seem to have retained a number of the old foods long after they were abandoned by more acculturated and/or agricultural groups (cf. Austin 2004).

Thus, it is known that *Setaria* was gathered and consumed by people from southern Canada and New England south to the Bahamas and southern Mexico. The American species known to be eaten are *S. liebmannii, S. macrostachya*, and *S. parviflora.* Both former species were eaten into the 1980s by the Seri of Sonora, and *S. parviflora* has been recorded only in archaeo-

logical sites. It is compelling that *S. parviflora* occurs in all of the places where *Setaria* is known in archaeological context. Superficially, that suggests that the species may have been the one eaten most widely across its North American range. However, in comparison to other species in those areas, it would be more efficient to harvest from *S. leucopila, S. macrosperma*, *S. magna*, or others when available, because they are larger plants bearing more grains. A more reasonable hypothesis is that the various cultural groups gathered grains from all available species.

It is easy to understand why indigenous American people gathered and ate *Setaria* grains. Each plant produces numerous seeds that may be collected by simply cutting or breaking off the spikes, and the grasses are often abundant at least locally. Both *S. liebmannii* and *S. parviflora* are said to have bitter seeds (Table 1), although those of *S. grisebachii* and *S. macrostachya* that I have eaten are not. It is harder to understand why *S. parviflora* may have been domesticated.

Setaria parviflora is an unlikely domesticate—spikes are smaller than other species, spikes have relatively few grains, and plants are perennial. Although comparable figures are not available for *S. parviflora*, the similar and related *S. pumila* produces about 180 seeds per panicle (Dekker 2004). Numbers in *S. macrostachya* are probably more nearly like those of *S. viridis* that produces 350–12,000 seeds per panicle.

There are two possible advantages for using *S. parviflora*: 1) like few other American species, it tends to be weedy around humans (Vélez 1950, Dekker 2003), and 2) it comprises a polyploid series (2n=36, 72, tetraploid and octaploid, Dekker 2004). Weeds are a notorious part of human diets. If indeed *Setaria* was domesticated, maybe the perennial *S. parviflora* was handled as an annual in cultivation as some other genera are now.

De Wet (1992) and Dekker (2003, 2004), among others, accepted "an unidentified *Setaria*" that earlier authors called *S. parviflora* as a domesticated species without obvious hesitation. Others remain skeptical. No one seems to have addressed the simple possible answer that the large-seeded *Setaria* noted by Callen (1967a) might have been from octaploid wild plants. One of the things that happens when polyploidy is involved is that the whole plant or at least parts of it grow larger. Many of the commercially important plants are polyploids, including wheat, cotton, tobacco, sugar cane, bananas, and potatoes (Raven and Johnson 1996). An alternate possibility is that it represented a "pre-domesticated" stage as discussed by de Wet (1992), Smith (2005), and others. If the materials from the Tamulipas sites have been preserved, they should be studied in more detail.

Changes in Importance

No one knows why *Setaria* has been popular in some periods and not in others. Typically, there are multiple factors involved with different foods.

Davidson (1999) thought that the Old World *Setaria* was becoming less popular because "The flavour of the seeds is less good than that of common millet [*Panicum miliaceum*]." As a European, perhaps he was just voicing local preference for their "native" *Panicum*, because the Chinese favor their "native" *Setaria*. This should not suggest that *Panicum* is any more native than *Setaria* in southeastern Europe, but it may be that people think that.

Panicum was domesticated in China by about 5000 B.C., and between 5000 and 4000 B.C. in Europe (Ho 1969; de Wet 1995; Zohary and Hopf 2000). By comparison, *Setaria* cultivation in Europe dates to about 2000 B.C., but both have been there much too long for people to remember any differences in origin. Besides, both are native as wild plants in Europe.

Perhaps more pertinent is why *Setaria* continued being popular in Europe until about 50 years ago and then declined abruptly. Globalization is a more likely part of the reason for the recent change than simple grain preference. Until comparatively recently, foods were grown and consumed locally even in many parts of Europe (cf. Nabhan 2002). Now many foods are shipped so widely and inexpensively that they are more easily obtained from distant sources. Moreover, there is pressure everywhere on local farmers to grow crops for which there is a greater monetary return (e.g., Maikhuri et al. 2001, Swaminanthan 2002, Saxena et al. 2004). There is even a cultural stigma associated with some of the old foods. They are often considered the food of poor or backward people and eating them conveys that image.

Yet, even that can not be the whole source of change. *Panicum miliaceum* is a more temperate species while *Setaria italica* is more tropical, and until the recent mixing of these cultures and sharing of their foods, many Europeans tended to reject stronger tastes. There are local differences within all regions, but some groups in Asia prefer strong tastes, whether from different grains, chiles (*Capsicum*) and other spice mixtures, bitter gourd (*Momordica charantia*), seaweed, fermented fish and soy condiments, or whatever local variations are available. There are even distinctive flavors to the fermented beverages made from different grains that played more important roles in the past (Fredriksson 1984; Appa Rao et al. 1998). All those factors, and probably others, are part of change.

All cultures tend to prefer what they are accustomed to and resist new foods. It sometimes takes hundreds of years for new foods to be accepted. For example, *S. parviflora* was still in 50% of the Tamaulipas coprolites in 1400 B.C., although maize had been eaten there since 2000 B.C. (Callen 1967a). Similarly, *S. macrostachya* in Tehuacán was still in 20% of the samples by A.D. 700, almost 3,000 years after maize use began in 2200 B.C. (Callen 1967a).

A similar slow change in foods occurred in eastern North America. Maize was present in the Mississippi Valley of Illinois between 170 B.C. and A.D. 60 (Riley et al. 1994). According to Fritz (2000a), "Middle Woodland farmers apparently did not perceive maize to be a superior food, since they ate very little of it." It was not until after A.D. 1200 that *Zea* assumed ascendancy over the native seed crops (Fritz 2000b).

Callen (1967a) speculated that the wealthier classes in Mexico had shifted to eating maize while the poorer people continued eating the old food. That divergence in foods is documented in the Mississippi Valley people (Fritz 2000a). There maize became prominent only with the rise of Mississippian chiefdoms and what has been argued to be a demand for surplus crops to fill the granaries. An impoverished maize-dominated farming system became "entrenched in the Central Valley by A.D. 1400," and the old cultigens were largely abandoned (Fritz 2000a).

Perhaps the world is undergoing yet another shift in grain use that is parallel to those from ancient Mexico and the Mississippi Valley. At least in the developed world, smaller farms continue being engulfed by large corporation-owned agribusinesses or turned into housing developments. Businesses as producers are progressively controlling and altering the germplasm that is cultivated everywhere (Warman 2003; Parry 2004). The result is a narrow germplasm base grown in the farming areas and genetic erosion on small farms and in the wild. There will be continuing changes in future foods as large businesses dictate the majority of available resources.

Postlogue on Dates

More recent studies of maize using AMS techniques (e.g., Long et al. 1989, Smith 2005) indicate that the dates at Tehuacán should be 1,500 to 2,500 years later than originally reported. The "corrected" dates are not used for *Setaria* because they are not available.

However, simply shifting the dates is not enough. As Gayle Fritz says (pers. comm. Jan. 2006), "Some items hadn't been displaced much if at all, but so far all of the dated corn and beans had been disturbed" in Tehuacán. Smith (2005) pointed out that parts of Coxcatlan cave were more disturbed than others. Without direct dating of the paleofeces from the "1400 B.C. zone" of Tamaulipas and the "A.D. 700 zone" of Tehuacán, there is no way to be sure of the dates of those samples. If this was done, they might even turn out to be older than previously thought. Without a new dating of materials from both sites, we cannot know the chronological sequence. Happily, Fritz's student Kevin Hanselka is working on doing just that.

Regardless of the exact dates of materials in those two Mexican sites, it seems certain that a wide array of people in a diverse series of language groups were eating the *Setaria* seeds from historical contact times into the deep past. Moreover, data from the United States indicate that they were eating *Setaria* long after maize was being grown.

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