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Prologue

The Golden Age

First of all the immortals who dwell on Olympian homes brought into being the golden race of immortal men. These belonged to the time when Kronos ruled over heaven, and they lived like gods without care in their hearts, free and apart from labor and misery. Nor was the terror of old age on them, but always with youthful hands and feet they took their delight in festive pleasures apart from all evil; and they died as if going to sleep. Every good thing was theirs to enjoy: the grain-giving earth produced her fruits spontaneously, abundantly, freely; and they in complete satisfaction lived off their fields without any cares in blessed abundance.

Hesiod, eighth century BC
(Translated by R. M. Frazer, 1983)

Harlan's Crops and Man: People, Plants and Their Domestication, Third Edition.
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Crop Evolution

In this book, we shall be dealing with evolution. We shall try to describe the evolution of crop plants from their wild progenitors to fully domesticated races and the emergence of agricultural economies from preagricultural ones. We shall deal with the activities of man that shaped the evolution of crops and that influenced the shaping of crops as human societies evolved. Crops are artifacts made and molded by man as much as a flint arrowhead, a stone axe head, or a clay pot. On the other hand, man has become so utterly dependent on the plants he grows for food that, in a sense, the plants have "domesticated" *him*. A fully domesticated plant cannot survive without the aid of man, but only a minute fraction of the human population could survive without cultivated plants. Crops and man are mutually dependent and we shall attempt to describe how this intimate symbiosis evolved.

The word "*evolution*" means an opening out, an unfolding, a realization of potential as in the opening of a flower or the germination of a seed. It implies a gradual process rather than sudden or cataclysmic events, with each living thing being derived genetically from preceding living things. Evolution as a process means change with time and the changes may be relatively slow or rapid, the time relatively long or short. Thus, the differences brought about by evolution over time may be small or great. As we shall see, some cultivated plants differ very little, if at all, from their progenitors. The same can be said for the evolution of agricultural economies and the sociological changes that have occurred in the process of developing fully agricultural and industrial societies from hunting–gathering systems.

To develop a degree of understanding of what has happened and what agricultural systems mean to mankind, we need some sort of picture of what life was like before agriculture. We need to establish a baseline from which we can visualize the domestication of plants and the emergence of agriculture. What kinds of plants did man eat before today's crops were available? What did he know about plants, and what might have caused him to begin the process of domestication? The descriptions given here will necessarily be brief and sketchy, but will give an idea of the condition of man before he began to grow plants with the purpose of using them for food.

We also need to know something about man as a hunter to understand ourselves. Lee and DeVore (1968) have put it succinctly:

> Cultural Man has been on earth for some 2,000,000 years; for over 99% of this period he has lived as a hunter-gatherer. Only in this last 10,000 years has man begun to domesticate plants and animals, to

> use metals and to harness energy sources other than the human body.... Of the estimated 80,000,000,000 men who have ever lived out a life span on earth, over 90% have lived as hunters and gatherers; about 6% have lived by agriculture and the remaining few percent have lived in industrial societies. To date, the hunting way of life has been the most successful and persistent adaptation man has ever achieved.

As a matter of general education and self-understanding, it is important that we know something about this basic human adaptation. There are two general approaches to the problem: (a) we can study surviving nonagricultural societies and examine the ethnographic observations made within the last few centuries, or (b) we can attempt to interpret preagricultural life from the artifacts, refuse, and other clues left by ancient man and recovered by archaeological techniques. In this chapter, we shall deal primarily with the first approach but the archaeological record shall be touched on in later sections.

The Hunter-Gatherer Stereotype

Traditionally, agricultural people have looked down on hunting people who are described as "savage," "backward," "primitive," "ignorant," "indolent," "lazy," "wild," and "lacking in intelligence." Europeans applied the term "civilized tribes" to some eastern North American natives who lived in towns and cultivated plants, but these Native Americans themselves referred to the hunting tribes of the plains as "wild Indians." In Africa, farming groups that surround hunter-gatherers, ". . . did not merely assert their political dominance over the hunter-gatherers and ex-hunter-gatherers they encapsulated; they also treated them as inferiors, as people apart, stigmatized them and discriminated against them" (Woodburn, 1988, p. 37). Similar attitudes prevail in Asia, Oceania, and Tropical America. The prejudice is nearly universal.

The stereotype includes the idea that hunting–gathering people were always on the verge of starvation and that the pursuit of food took so much of their time and energy that there was not enough of either one left over to build more "advanced" cultures. Hunters were too nomadic to cultivate plants and too ignorant or unintelligent to understand the life cycles of plants. The idea of sowing or planting had never occurred to them and they lacked the intelligence to conceive of it. Hunters were concerned with animals and had no interest in plants. In the stereotype that developed, it

was generally agreed that the life of the hunter-gatherer was "nasty, brutish, and short," and that any study of such people would only reveal that they lived like animals, were of low intelligence, and were intellectually insensitive and incapable of "improvement."

Occasionally, an unusually perceptive student of mankind tried to point out that hunting man might be as intelligent as anyone else; that he had a sensitive spiritual and religious outlook; that he was capable of high art; that his mythologies were worthy of serious consideration; and that he was, in fact, as one of us and belonged to the same species with all its weaknesses and potentialities. Such opinions were seldom taken very seriously until recent years. It has finally become apparent that no part of the stereotype is correct and that widely held presuppositions are all completely false and untenable. Our ancestors were not as stupid or as brutish as we wanted to believe.

In 1966, Richard B. Lee and Irven DeVore organized a symposium on Man the Hunter held at the University of Chicago and published in 1968. Lee reported on his studies of the San !Kung of the Dobe area, Botswana. Over a three-week period, Lee (1968) found that !Kung Bushmen spent 2.3, 1.9, and 3.2 days for the first, second, and third week, respectively, in subsistence activities. He wrote, "In all, the adults of the Dobe camp worked about 2 ½ days a week. Since the average working day was about 6 hr long, the fact emerges that !Kung Bushmen of Dobe, despite their harsh environment, devote from 12 to 19 hr a week to getting food."

Among the Bushmen, neither the children nor the aged are pressed into service. Children can help if they wish, but are not expected to contribute regularly to the work force until they are married. The aged are respected for their knowledge, experience, and legendary lore; and are cared for even when blind or lame or unable to contribute to the food-gathering activities. Neither nonproductive children nor the aged are considered a burden.

To the !Kung Bushman, the mongongo nut [*Schinziophyton rautanenii* (Schinz) Radcl.-Sm] is basically the staff of life. These nuts are available year-round and are remarkably nutritious (Table 1.1). The average daily per-capita consumption of 300 nuts weighs "only about 7.5 ounces (212.6 g) but contains the caloric equivalent of 2.5 pounds (1134 g) of cooked rice and the protein equivalent of 14 ounces (397 g) of lean beef" (Lee, 1968). Lee found the diet adequate, starvation unknown, the general health good, and longevity about as good as in modern industrial societies. The average of 2140 calories per person daily (Table 1.1) compares favorably to the 2015 USDA recommendations of 2400–3000 calories for an adult male and 1800–2400 calories for an adult female (https://health.gov/dietaryguidelines/2015/guidelines/appendix-2/).

Table 1.1 Diet of the !Kung Bushmen.

	Protein (g/day)	Calories per person per day	Percent caloric contribution of meat and vegetables
Meat	34.5	690	33
Mongongo nuts	56.7	1,260	67
Other vegetable foods	1.9	190	
Total	93.1	2,140	100

Source: Adapted from Lee (1968).

Sahlins (1968) came in with almost identical figures for subsistence activities of the Australian Aborigines he studied and elaborated on his term "original affluent society." One can be affluent, he said, either by having a great deal or by not wanting much. If one is consistently on the move and must carry all one's possessions, one does not want much. The Aborigines also appeared to be well fed and healthy, and enjoyed a great deal of leisure time.

Gatherers can obtain food in abundance even in the deserts of Australia and the Kalahari Desert of Africa. The rhythm of food-getting activities is almost identical between the Australian Aborigine and the !Kung Bushmen of southern Africa. The women and children are primarily involved in obtaining plant and small animal materials. Hunting is reserved for males at the age of puberty or older but is more of a sport than a necessity. Meat is a welcome addition to a rather dull diet but is seldom required in any abundance for adequate nutrition. Both males and females tend to work for 2 days and every third day is a holiday (Figure 1.1). Even during the days they work, only about 3–4 hr per day are employed to supply food for the entire group (Australian data presented by Sahlins, 1968).

Other reports at the symposium tended to support these general findings. A picture emerged of leisure, if not affluent societies, where the food supply was assured even under difficult environmental conditions and could be obtained from natural sources with little effort. The picture described did seem to fit the golden age of Hesiod or the Biblical Garden of Eden.

The publication of *Man the Hunter* was a surprise to many who believed some version of the hunter stereotype. The stimulation was enormous. Between 1968 and 1992, there were at least 12 international conferences on hunter-gatherers as a direct result, but not all were published. A few of the early conferences included ones published by Ingold et al. (1988a, 1988b) and by Schire (1984). In addition, one may cite Bicchieri

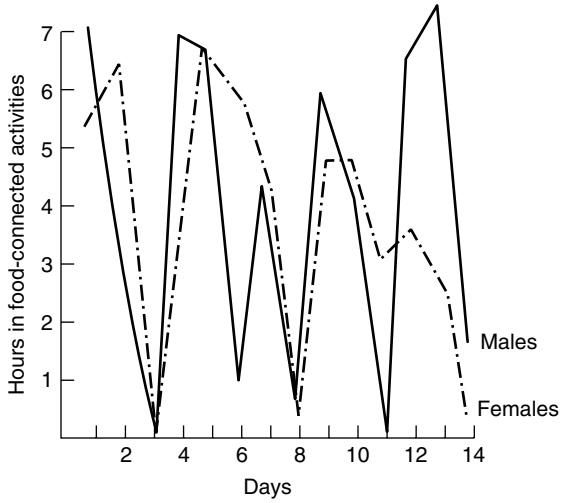

Figure 1.1 Food-gathering activities of the Australian Aborigines. *Source:* Adapted from Sahlins (1968).

(1972), *Hunters and Gatherers Today*; Dahlberg (1981), *Woman, the Gatherer*; Winterhalder and Smith (1981), *Hunter-gatherer Foraging Strategies*; Williams and Hunn (1982), *Resource Managers*: *North American and Australian Hunter-gatherers*; Koyama and Thomas (1982), *Affluent Foragers: Pacific Coasts East and West*; Price and Brown (1985), *Prehistoric Hunter-gatherers: The Emergence of Social and Cultural Complexity*; Harris and Hillman (1989), *Foraging and Farming: The Evolution of Plant Exploitation*; and such regional treatments as Hallam (1975), *Fire and Hearth: A Study of Aboriginal Usage and European Usurpation in Southwestern Australia*; Silberbauer (1981, p. 242), *Hunter and Habitat in the Central Kalahari Desert*; Riches (1982), *Northern Nomadic Hunter-gatherers*; Lee (1984), *The Dobe!Kung*; Akazawa and Aikens (1986), *Prehistoric Hunter-gatherers in Japan*; and there are many hundreds of additional research papers. There is now a vast amount of new material on the subject, but some of the oldest papers are still the most useful because observations were made before the hunter-gatherers were so restricted and encapsulated as they are now.

The biases of some of the investigators were often clear. Some set out to dispute the "affluent society" concept and others to support it. Some of the anthropologists were hung up on Marxist views of "history," since the egalitarian nature of most hunter-gatherer societies suggested Marx's view of communism: "No one starves unless all starve"; "no man need go hungry while another eats"; "rich and poor perish together," and so forth

(Lee, 1988). The quotes are from observers of Iroquois, Ainu, and Nuer, respectively, and seem to equate egalitarianism with hunger, which is probably not fair. Incidentally, Karl Marx took his model of basic communism from an agricultural Iroquois society, not from hunter-gatherers, who are not so likely to starve.

What do the new studies show? To no one's surprise, they show that the golden age was more golden for some than for others. Even a few examples of famine were found (Johnson & Earle, 1987, p. 374). Brian Hayden (1981) listed a number of tribes showing a continuum of work from "a few minutes per day" (Tanaina in Alaska) or 2 hr per day (Hadza in Tanzania) to "all day every day" or "too busy to visit relatives" (Birhor in India). Well, I have been too busy to visit relatives even when I wasn't doing much of anything. It also comes as no surprise that if processing and cooking time is added to collecting time, it takes longer to get a meal than some figures would suggest. Processing some foods is laborious and time-consuming. Grinding or pounding seeds into flour has always been drudgery, and boiling toxic foods in several changes of water takes a lot of time. Still, is watching a pot boil hard labor, especially if the kids make a game of picking up sticks to keep the fire going? And, of course, farmers must also process their food, too, so the addition of processing and cooking time does not necessarily change the comparison.

There are certain aspects of time and work that do not seem to receive due attention. Suppose you like your work? I always have, and have spent far more time at it than necessary for survival. Consider those men of industrial societies who spend endless hours cramped and freezing in a duck blind for little or no reward, or those who huddle in a shelter fishing through the ice in the middle of a Minnesota winter. The social aspects are what matter; after a few nips of whiskey, no one cares if the rod bends or not. I record two ethnographic notes from my own experience, both from farming societies, but the principles apply to anyone. Early one morning on a deserted road in Afghanistan, I came across a line of men dressed in colorful embroidered jackets, balloon pants, and pixie-toed shoes. They had two drums and were singing and dancing up and down with their sickles in the air. A group of women followed, shrouded in their chadors, but obviously enjoying the occasion. I stopped and asked in broken Farsee: "Is this a wedding celebration or something?" They looked surprised and said: "No, nothing. We are just going out to cut wheat." Harvest time is a good time of year even if it is hot and the "work" is hard. It is a time for socializing and, if the harvest is good, for celebrating.

A second observation was in eastern Turkey. My interpreter and I had seen a family harvesting a field and we stopped. He talked to the people

while I collected some samples. My interpreter later told me that he had commented to the farmer that he could harvest the field in half the time if he would use a scythe and cradle. The farmer looked at him in astonishment and said: "Then what would I do?" There is a certain amount of Parkinson's law in all these activities. One fills up the time available. What is the meaning of time if there is more of it than you know how to use? As for getting by with the least effort possible for survival, I do not think that is human nature. Sure, anyone can drink vin ordinaire, but why not work a little harder and drink Chateauneuf-du-Pape?

How do hunter-gatherers spend their leisure? Apparently they sleep a lot, but there are other diversions. Gambling is popular among many tribes; Woodburn (1970, p. 59) states that the Hadza people spend more time in gambling than in obtaining food. The most popular gambling stake is poisoned arrows. There are also music, dances, ritual and ceremony, rites of passage, playing cat's cradle, storytelling, creative arts, making useful and decorative articles, and similar activities. Life appears easy, but generally dull. Perhaps as a consequence there is a great deal of coming and going; the camp population is fluid and camps may be moved on the slightest pretext or for no reason at all. Understandably, there is a tendency to concentrate on the foods most easily obtained at a given time, and these are likely to change from season to season and, to some extent, from year to year. Groups of people in many gathering societies tend to be very fluid for that reason. When food is at maximum abundance, there is a tendency to gather in large bands. This is the season for rejoicing, celebrating, observing ancient tribal rituals, arranging marriages, and having naming ceremonies, coming of age ceremonies, and so on. The tribe is more fully represented at this time. During the most difficult season of the year, the people may break up into microbands to better exploit the gathering range and to avoid exhausting the food supply near the larger camps.

Many Australian Aborigines remain apart much of the yearly cycle even after becoming dependent on European agricultural–industrial systems. For most of the year they find jobs as ranch hands, laborers, mechanics, and so forth, but they may quit whatever they are doing, take off their store-bought clothes, and take a three-month "walkabout" during their traditionally festive season. Gathering is still easier than working at that time of year.

The study of hunting tribes that have survived long enough to have been observed by modern ethnographers is full of difficulties and pitfalls. Many tribes had become profoundly modified through contact with and by the pressures applied by agriculturalists. Some were reduced to the status of slaves or servants; others were restricted on reservations or their normal

ranges were constricted by pressures of stronger groups. The social and economic structures of many tribes were in an advanced stage of disintegration at the time of ethnographic description.

The geographic distribution of surviving hunters results in a serious bias. By and large, hunters have survived where agriculture is unrewarding. We find them in the Kalahari Desert and adjacent dry savanna in southern Africa, in small pockets of tropical rain forest, in the frozen wastes of the Arctic, or in western North America, but there are no examples left in the more productive agricultural lands of the world.

At the time of European contact, the eastern forests and woodlands of North America were largely populated by native agriculturalists; the people living in the plains and westward mostly maintained hunting–gathering economies. There were enclaves of farmers, such as the Mandan on the Missouri River in North Dakota, and a highly sophisticated agriculture had developed in the Southwest USA where people practiced irrigation on a large scale and often lived in towns. Some farming was practiced along the Colorado River watershed and into southern California, but most of the California natives and other tribes of western North America lived by hunting, fishing, and gathering. A substantial body of information has been assembled about them, but we must remember that they did have contact with farming people and some of their cultural elements could have been borrowed.

Data for hunter-gatherers in South America have been accumulating during the late 20th and into the 21st centuries. In the review by Scheinsohn (2003), she indicates distinct areas occupied by hunter-gatherers in the grasslands of Argentina and southern Chile, farming communities in the highlands of western South America, and mixed hunter-gatherer and farming societies in more mid-to-low land areas of Bolivia, Brazil, and Venezuela by about 6000 BP (Before Present). There is some evidence of man in South America by at least 30,000 BP (Scheinsohn, 2003), and these peoples were certainly hunter-gatherers. The Bushman of southern Africa has been studied in some detail, but we know historically that they had long contact with the livestock-herding Hottentot and farming Bantu tribes. The Congo pygmies often spend part of each year with agricultural people. The Ainu of Japan have taken up some farming in the last century or so. Many of the hunter-gatherers of India are so constricted by agriculturalists that they have virtually become members of a nonfarming caste.

The Andaman Islanders succeeded in preserving a greater degree of isolation, partly by killing off strangers who landed or were shipwrecked on their shores. Still, we know they borrowed some customs from outsiders. Both pottery and pigs seem to have been introduced about 1500 AD

(Coon, 1971). It is even possible that they were agriculturalists when they arrived and abandoned the practice when they found it unnecessary.

Perhaps our most reliable data come from Australia. At the time of European contact in the early 19th century, there was an entire continent populated by an estimated 300,000 people without a single domesticated plant and no genuine agriculture. Although it is true that for some centuries before European contact there were Malayan traders visiting northern Australia on a fairly regular basis, there is little evidence that this resulted in significant changes in use of food resources and it did not induce the Aborigines to take up the cultivation of plants. The Torres Strait is also rather narrow and some contact with agricultural Melanesians occurred. That this would influence the whole of Australia very much seems doubtful.

I shall, therefore, rely more on ethnographic data from Australia than elsewhere, but will remind the reader that any reconstruction of a way of life of some thousands of years ago, based on a small, biased sample of living people, is full of hazards and sources of error. The earlier accounts may have more value than some of the later ones because the effects of European contact were rapid and profound.

Woodburn (1988) and in a series of papers, outlined an important distinction between immediate return strategies and delayed return strategies. The former live from day to day, or at most a few days at a time on current returns. Delayed return groups have longer-term goals; these include manufacturing of boats, nets, weirs, traps, and deadfalls, tending bee hives, the capture and keeping of animals to be eaten later, the replacement of the tops of yams at digging time, sowing of seeds, managing vegetation with fire, water spreading, irrigation, flooding of forests, arranged marriages, and so forth. The Australian Aborigines were delayed return strategists of great skill, and as such were closer to agriculturalists than to immediate return hunter-gatherers such as the Bushmen and Hadza. Great Basin and West Coast Native Americans and the Jomon of Japan were also delayed return strategists.

As more and more data have accumulated, a consensus has developed that present day and recent hunter-gatherers, whether of immediate or delayed return, have evolved in parallel with agriculturalists and no longer represent the original condition before agriculture. They are not the "pristine" hunger–gatherers of 10,000–12,000 years ago. In addition, the diversity among hunter-gatherers is such that no single model can represent them. There is not even a single model for Australia, let alone the other hunter-gatherers in the world. Our extensive field studies will not tell us all we want to know about preagricultural societies, but they are suggestive.

The oldest remains of *Homo sapiens* L. were left in Morocco about 315,000 years ago (Hublin et al., 2017a, 2017b), which is much older than previously

thought. Foley (1988) reserved the term "human" for anatomically modern man who appeared on earth as early as 100,000 years ago and as late as 30,000 years ago in some regions, but many intermediate fossil remains define the evolution within the genus *Homo*. However, early species of *Homo* were not "human." Late Pleistocene man was anatomically modern, but larger, heavier, and more sexually dimorphic. Foley suggests reduction in size and dimorphism was a response to a change in food procurement systems. With the extinction of many large mammals and general impoverishment of the fauna at the end of Pleistocene, men and women began to share more evenly in food procurement, and the broader spectrum of plants and animals exploited was accompanied by morphological changes in humans.

What Do Gatherers Eat?

Lee (1968) classified 58 tribes according to the percentage of dependence on hunting, fishing, or gathering. The data were taken from the Ethnographic Atlas (Murdock, 1967), but adjusted somewhat by transferring the pursuit of large sea mammals from fishing to hunting and shell-fishing from fishing to gathering. The food obtained by gathering is predominantly of plant origin. The class does include small animal foods such as mice, rats, lizards, eggs, insect grubs, and snails. Tortoise and shell-fishing is important to a few gathering tribes. In several cases where detailed analyses were made, however, plant foods contributed 60%–80% of the intake of gathering people.

In his *List of Foods Used in Africa*, Jardin (1967) compiled an extensive and complex list of species. I have attempted to remove cultivated plants and introductions and reduce the synonymy as much as possible. There still remain more than 1,400 species that could be grouped into classes as follows:

Grass seeds approximately 60 spp.
Legumes approximately 50 spp.
Roots and tubers approximately 90 spp.
Oil seeds approximately 60 spp.
Fruits and nuts >550 spp.
Vegetables and spices >600 spp.
Total >1410 spp.

Most of Jardin's reports concerned agricultural tribes and only a small fraction of the list represented foods of gatherers. This suggests that (a) many more species have been gathered from the wild than have ever been domesticated, (b) even after agriculture is fully developed, gathering wild

plant foods is still a worthwhile effort, and (c) wild plant resources are of the same general kinds as domesticated plant resources. See also Fox and Young (1982) for southern Africa.

Yanovsky (1936) in his *Food Plants of the North American Indians* lists 1112 species of 444 genera belonging to 120 families. About 10% of these are crops or imported weeds; the rest are native American plants. The bulk of the plants listed were gathered by nonagricultural tribes. Fernald and Kinsey (1943) listed about 1000 species for eastern North America alone. Plants gathered in Central and South America have not been conveniently compiled, but the number of species is very large. A partial listing is given by Lévi-Strauss (1950) in *The Use of Wild Plants in Tropical South America*.

Our most reliable information again might come from Australian areas where agriculture was not practiced and where none of the plants had been domesticated. Lists compiled by Cribb and Cribb (1975), Irvine (1957), Levitt (1981), and Maiden (1889), are of help here, although no list is complete; there are problems of identification and synonymy, and many of the early ethnographic records contain native names because the observers were not botanists and could not identify the plants. Even so, Australians were recorded as having gathered and used over 400 species belonging to 250 or more genera.

Some observations are grouped below according to general kinds of plant food resources.

Grass Seeds (Potential Cereals)

Seeds of wild grasses have long been an important source of food and are still harvested on a large scale in some regions. A.C. Gregory (1886) commented:

> On Cooper's Creek (Australia), the natives reap a Panicum grass. Fields of 1000 acres (405 ha) are there met with growing this cereal. The natives cut it down by means of stone knives, cutting down the stalk half way, beat out the seed, leaving the straw which is often met with in large heaps; they winnow by tossing seed and husk in the air, the wind carrying away the husks. The grinding into meal is done by means of two stones—a large irregular slab and a small cannon-ball-like one; the seed is laid on the former and ground, sometimes dry and at others with water into a meal.

Stickney (1896) described methods of the wild rice (*Zizania palustris* L.) harvest by the Ojibwa of Wisconsin late in the 19th century:

> Two women, working together in a canoe, took a large ball of cedar bark twine and tied up sheaves just below the panicles when the seed was in the milk stage. Later, they went back when the seed was ripe and beat the sheaves over the canoe. Each woman knew her own bundles and the right of ownership was scrupulously respected. Sometimes sheaves were not previously prepared and the woman in the back would pole slowly forward while the other reached out with a curved stick and bent a bunch of stalks over the canoe and hit them with a straight stick held in the other hand. About a gill is attached at each blow. When the canoe became heavily laden in the front, the women exchanged implements as they kept their places and the canoe was poled back in the opposite direction. When the canoe was fully loaded and low in the water it was beached and the wild rice removed. The wild rice was dried in the sun or on a platform over a fire. Dehulling was done by men who placed the seed in a skin bag and treaded it in a pit dug in the soil. Dehulled seed was stored in bark boxes or large skin bags; sometimes so much seed was stored that it lasted until the next harvest.

Wild races of common Asian rice (*Oryza sativa* L.) were once harvested on a considerable scale in northern Australia (Bancroft, 1884):

> The wild rice of the Carpenteria swamps (*Oryza sativa*), however, needs to be carefully cleaned from its spiny chaff, which may be done by rubbing in wooden troughs. This must be the most important grass-food in Australia, being little inferior to cultivated grain. The plant grows six feet (1.8 m) high, and produces a good crop even in the latitude of Brisbane. The "paddy" is black with long awns. It is interesting, in Australia, to find one of the original sources of a cereal that has been cultivated in Asia for thousands of years.

The wild races are still harvested in India despite the cultivation of domesticated forms for six or seven millennia (Roy, 1921):

> In the Central Provinces the Gonds and Dhimars harvest this rice by tying the plants together into clumps and thus preventing the grains from falling. These grains have also got a certain demand in the market as they are often used by devout Hindus in these parts on fast days besides being sold to the poorer classes.

Burkill (1935) makes a similar observation:

> The poor do not ignore it (wild rice), but tying the awns together before maturity save the grain for themselves, or they collect the fallen grain, which is made an easier process by the length of the awns.

Ping-Ti Ho (1969) documented the harvesting of wild rice over much of southern and central China during a span of an entire millennium. One report, dated 874 AD, from Ts'angchou, Hopei Province, to the emperor may be paraphrased: "Wild rice ripened in an area of more than 200,000 mu (13,000 ha), much to the benefit of the poor of local and neighboring counties" (Ho, 1969). It is to be noted that rice had been a major crop in China for over 6000 years at the date of this report, but that the gathering of seeds of wild rice was still worth the effort.

I have observed other species of rice, *O. barthii* A. Chev. and *O. longistaminata* A. Chev. & Roehr., that are regularly harvested in Africa, sometimes in sufficient abundance to appear in the markets. The Africans sometimes also tie wild rice into clumps before harvest (Harlan, 1989). Claude Lévi-Strauss (1950) reports the harvesting of *O. subulata* Nees [syn. *Rhynchoryza subulata* (Nees) Baill.] in Uruguay, Rio Grande do Sul, and the marshes of the upper Paraguay and Guaporé Rivers in South America. He also reports the technique of binding before harvest:

> The Tupí-Cawahíb of the upper Madeira River gather the seeds of an unidentified wild grass that grows in the forest, and to facilitate the harvest they tie together several stems before they are ripe, so that the seeds of several plants fall on the same spot and pile up in small heaps.

Panicum has been a favorite grass seed of gatherers the world over. In North America, *P. capillare* L., *P. obtusum* Kunth [syn. *Hopia obtusa* (Kunth) Zuloaga & Morrone], and *P. urvilleanum* Kunth have been listed as harvested in the wild (Yanovsky, 1936), and *P. hirticaule* J. Presl var (syn. *P. sonorum* Beal) was domesticated in Mexico (Gentry, 1942; Nabhan & deWet, 1984). Seven species are listed for Africa (Jardin, 1967), with the most important being *P. laetum* Kunth and *P. turgidum* Forssk. Four species are recorded for Australia, with *P. decompositum* R. Br. occurring in 1000-ha fields. Two species, *P. miliaceum* L. and *P. antidotale* Retz. were domesticated in Eurasia and India, respectively. It appears that food gatherers are attracted to similar plants.

At least five wild species of *Sporobolus* were harvested in North America, three in Africa, and three in Australia. Species of *Eragrostis* were gathered in North America, Australia, and Africa. For Africa, six wild species are listed and one was domesticated as a cereal, *Eragrostis tef* (*Zuccagni*) Trotter in Ethopia. *Eleusine* and *Dactyloctenium* were harvested in Australia, India, and Africa with one species (*E. coracana L. Gaertn.*) being

Table 1.2 Analysis of wild and cultivated wheats.

	Ether extract (%)	Crude fiber (%)	Crude protein (%)	NFE (%)[a]
Wild einkorn	2.64	2.33	22.83	60.04
Modern wheat	1.50	1.33	10.79	75.01

Source: Adapted from Harlan (1967).
[a]Nitrogen-free extract or carbohydrates other than fiber.

domesticated. Species of Digitaria were harvested in Australia, India, Africa, and Europe. Digitaria exilis (Kippist) Stapf and D. iburua Stapf were domesticated in Africa, D. cruciate Nees ex Hoff. f. in India, and common crabgrass [D. sanguinalis (L.) Scop.] was cultivated as a cereal in central Europe until the 19th century without actually being domesticated (Körnicke, 1985). The differences between cultivation and domestication will be discussed in Chapter 3.

Mannagrass [*Glyceria fluitans* (L.) R. Br.] was harvested in substantial quantities from the marshes of central and eastern Europe as late as 1925 (Szafer, 1966). The seed was even exported from the port of Danzig to countries around the Baltic. Yanovsky (1936) reports that the same species was harvested by Native Americans in Utah, Nevada, and Oregon. Wild oats (*Avena barbata* Pott ex Link and *A. fatua* L.) were harvested by the Pormo tribe in California after these weedy plants had been introduced from the Mediterranean (Gifford, 1967). As late as 100 years ago, wild grass seeds were harvested on a commercial scale in central Africa and exported by camel caravans into the desert and other food deficit areas (Harlan, 1989).

I once studied the amount of grain that could be harvested from wild einkorn wheat (*Triticum monococcum* L. subsp. *boeoticum*) in Turkey (Harlan, 1967). I found no difficulty in collecting over 2 kg of head material or the equivalent of 1 kg of clean grain per hour. On analysis, the grain contained about 23% protein as compared to about 11% for modern cultivated wheat (Table 1.2).

In all, Jardin (1967) lists about 60 species of wild grasses that have been harvested for their seeds in Africa within recent decades. Yanovsky (1936) lists approximately 38 for North America, and Irvine (1957) and others mention about 25 for Australia. The exact number cannot be given because of problems with synonyms and identification. Relatively little is known about wild grass harvesting in Europe and Asia although *Oryza, Panicum, Digitaria,* and *Glyceria* have been mentioned.

Legumes (Potential Pulses)

Gathering peoples are evidently attracted to Leguminosae of various kinds. Whole pods may be used, as well as seeds only, pods only, or even the tissues inside the pods surrounding the seeds. Some legumes have edible tubers and others have leaves or young shoots suitable for pot-herbs. Not infrequently the material harvested is poisonous and must be detoxified before use. Poisonous materials can be used for stunning fish, stupefying emus, or making poison arrows.

As with the Gramineae, certain genera appear frequently on plant lists and several distinct species of a given genus may be used in different parts of the world. Genera with wide distributions may be very widely used. For example, many species of Acacia are exploited in Australia, several are used in Africa and Asia, but only a few are used in the Americas. More species of *Prosopis* (mesquite) are used in the Americas, however, than in Africa, Asia, and Australia. Different species of *Canavalia* are harvested in Central and South America and in Southeast Asia and Australia. *Vigna* and *Dolichos* are widely exploited in Africa, Asia, and Australia while several species of *Phaseolus* are harvested in the Americas. *Tephrosia* spp. have been used for fish poisons on five continents.

Root and Tuber Plants

Roots, tubers, rhizomes, and bulbs have been widely harvested for untold millennia. The choice depends more on what is abundant and available than anything else. The genus *Dioscorea* is very large and includes about 600 species distributed throughout the warmer parts of the world. Many produce tubers that are edible or rendered edible after detoxification. About 30 species are harvested in the wild in Africa (Jardin, 1967) and several have been domesticated. Wild yam harvests are important in India, Southeast Asia, the South Pacific, Australia, and tropical America.

Tubers and rhizomes of the Araceae are widely harvested in the tropics and a few are found in the more temperate zones. Bulbs of the Liliaceae are popular where they occur. Yanovsky (1936) lists about 90 species belonging to the lily family (Liliaceae) that supplied food for North American natives. No less than 17 species of wild onion (*Allium*) were listed, and even the death camus *Zygadenus* was eaten after suitable detoxification. Tuberous legumes in the genera *Solanum, Ipomoea, Nymphaea,* and *Eleocharis* have been widely harvested, and *Cyperus rotundus* L. has supplied food in North America, Africa, Asia, Australia, and Europe.

Oil Plants

Most gatherers had periodic access to animal fats, but sources of vegetable oil were also sought. In the wetter tropics, the fruits of various palms (Palmaceae) were especially attractive. The African oil palm (*Elaeis*

guineensis Jacq.) is still exploited in the wild as is its counterpart in South America [*E. guineensis* Jacq. (syn. *E. melanococca* Gaertn.)]. Other palms also supply oil in quantity including, of course, the coconut (*Cocos nucifera* L.). Seeds of Compositae, Cruciferae, and Cucurbitaceae are harvested on every continent, partly for their oil content. Many nuts and some fruits are high in oil and are still harvested in the wild. Some familiar ones are *Aleurites* (Candlenut or tung-oil tree), *Persea* (avocado), *Theobroma* (cacao), *Pistacea* (pistachio), *Olea* (olive), and *Butyrospermum* (shea butter tree or karité). Several species of *Sesamum* and *Linum* are harvested for their oily seeds.

Fruits and Nuts

Long lists of fruits and nuts can be compiled, but it is not necessary to go into much detail here. We need only point out that the same patterns prevail as for grass seeds, legumes, and oil plants in that different species of the same genera are exploited almost everywhere they occur. In temperate zones, for example, species of walnut (*Juglans*), hickory (*Carya*), hazelnut (*Corylus*), chestnut (*Castanea*), beech (*Betula*), oak (*Quercus*), hawthorn (*Crataegus*), hackberry (*Celtis*), plum-cherry (*Prunus*), bramblefruits (*Rubus*), grape (*Vitis*), elderberry (*Sambucus*), pine-nuts (*Pinus*), and others were popular with gatherers in Europe, Asia, North America, Africa, and Australia. In the tropics, some of the popular genera were (and are) *Ficus*, *Citrus*, *Musa*, *Syzygium*, *Pandanus*, *Spondias*, *Adansonia*, *Artocarpus*, *Annona*, and *Carica*. If a plant appeals to one gathering tribe, a similar plant is probably used by another tribe, even on another continent.

Vegetables

Because the same general pattern is operative, it might be worthwhile to call attention to repetitive patterns in two families whose produce appeals to gatherers.

Solanaceae. The genus *Solanum* is found on every continent and includes several hundred species. About 15 species are gathered for food in Africa, 9 are listed for North America, and several are found in South America, India, and Australia. Some must be detoxified before being eaten. The fruits are the parts eaten in most cases, but leaves may be used as pot-herbs and a number of species have edible tubers. *Physalis* is another genus widely exploited with at least 10 species gathered in North America plus others in South America, Africa, Europe, Asia, and Australia. Species of wild *Capsicum, Cyphomandra,* and *Lycopersicon* were gathered in the Americas. The genus *Nicotiana* was a favorite of gathering tribes in the Americas and Australia. Several distinct species were involved and they were utilized almost wherever they occurred. In the Americas, the tobaccos were both

chewed and smoked, while it was a masticatory only in Australia. Lime of some sort was often mixed with the quid. *Datura* was used as a drug, medicine, or hallucinogen in both eastern and western hemispheres.

Cucurbitaceae. Plants of this family were often attractive to gathering peoples and in some cases were very important because of their abundance. In Australia, Maiden (1889) observed that *Cucumis trigonus* Roxb. was sometimes "growing in such abundance that the whole country seemed strewed with the fruit." In southern Africa, the landscape may be almost cluttered with wild watermelon [*Citrullus colocynthis* (L.) Schrad.] where it may serve as the only source of water for man and animals alike over extended periods of the dry season (Story, 1958). Tropical *Cucumis* and *Mamordica* species are still gathered in the wild in Africa and Asia. The genus *Cucurbita* is confined to the Americas and was extensively exploited by the Native Americans; several species were domesticated. The white-flowered bottle gourd [*Lagenaria siceraria* (Molina) Standl.] has been widely exploited, primarily for the hard shells of the fruits which make excellent containers. Its use has been recorded in the Americas, Africa, Asia, Europe, and Australia, but its distribution as a wild plant is not well known. The fruits of the Australian races are said to be purgative or even poisonous according to Maiden (1889) but are eaten by the Aborigines after being processed. The fruits of some domesticated races may be eaten when young without special precautions. *Luffa* is also widely used in Asia and Africa as a vegetable or medicine, but is a fish poison in Australia (Palmer, 1883).

Summary

Finally, we might return to the plants gathered by Australian Aborigines as, perhaps, representing a most authentic selection by surviving nonagricultural peoples. A short list of genera that include one or more species harvested in the wild by native Australians is given in Table 1.3. I have attempted to indicate where species of each genus are harvested in the wild in addition to Australia. It seems evident from these data and the foregoing discussion that gatherers exploit about the same range of plants wherever they find them.

It is not surprising, therefore, to find independent domestications of different species of the same genus, and if the genus is widespread, the different domesticates may have originated in different continents. Examples of such vicarious domestications occur in the following genera, among others:

1) Mesoamerica and South America—*Amaranthus, Annona, Canavalia, Capsicum, Carica, Chenopodium, Cucurbita, Gossypium, Opuntia, Pachyrrhizus, Phaseolus,* and *Physalis*;

Table 1.3 A short list of genera that include one or more species harvested for food by native Australia.[a]

Acacia (Af, Am, As)+	*Lepidium* (Am, Af, As, E)+
Adansonia (Af, As)+	*Linum* (As, E)+
Aleurites (As, 0)+	*Loranthus*
Alocasia (As, 0)+	*Lucuma* (Am)+
Amamnthus (Am, As, Af)+	*Luffa* (As)+
Amorphophallus (Af. As, 0)+	*Lycium* (Af)
Antidesma (As)	*Macadamia* (#)
Araucana (Am, O, #)	*Manikara* (Af)
Austromyrtus	*Marsilia*
Boerhaavia (Af, Am, As)	*Mimusops* (Af, As)
Bowenia	*Mucuna* (As)+
Calamus	*Musa* (As, 0)+
Canavalia (Af, Am, As)+	*Nasturtium* (As)+
Capparis (Af, As)+	*Nelumbium* (Af, As)+
Carissa (Af)	*Nymphaea* (Am, Af, As)+
Cassia (Af, As, O)	*Ocimum* (Af, As)+
Chenopodium (Am, Af, As)+	*Oryza* (Am, Af, As, O)
Citrus (As, O)+	*Oxalis* (Am, Af, As)+
Clerodendrum (Af)	*Pandanus* (As, O)+
Cordia (Af, As)	*Panicum* (Am, Af, As, E)+
Cucumis (As, Af)+	*Parinari* (Af)
Cyperus (Am, Af. As)	*Phragmites* (Af, Am, As, E, O)
Dactyloctenium (Af)	*Physalis* (Am, Af, As, E)+
Digitaria (Af, As, E)+	*Piper* (Am, Af, As, O)+
Dioscorea (Am, Af. As)+	*Podocarpus* (Af, As, O)+
Diospyros (Am. As, O)+	*Polygonum* (Am, Af, As. E, O)
Dolichos (Af. As. O)+	*Portulaca* (Am, Af. As, E)+
Eleocharis (Am. Af, As)+	*Rubus* (Am, Af, As, E)+
Eleagnus (As, E)+	*Rumex* (Am. Af, As, E)
Eleusine (Af. As)+	*Sambucus* (Am, Af. As, E)+
Eragrostis (Am, Af)+	*Sesbania* (Am, Af. As)+
Eriochloa (Af, As)+	*Solanum* (Am, Af, As, E, O)+
Eucalyptus (#)	*Sorghum* (Af, As)+

(*Continued*)

Table 1.3 (Continued)

Eugenia (Af, As, O)+	*Spondias* (Am, Af, As, O)+
Ficus (Am, Af, As, O)+	*Sporobolus* (Am, Af)
Gardnia (Af, As, O)+	*Tacca* (Ac, O)+
Gastrodia	*Terminalia* (As, O)+
Geranium (Am, As, E)+	*Trigonella* (As)+
Glycine (As, O)+	*Typha* (Am, Af, As, E, O)+
Grewia (Af, As. O)	*Vigna* (Af, As, O)+
Haemadorum	*Vitex* (Am, Af, As, O)+
Hibiscus (Am, Af, As, O)+	*Vitis* (Am, As, E)+
Ipomoea (Am, Af, As, O)+	*Zamia* (O)
Lagemyia (Am, Af, As, O)+	*Zizyphus* (Af, As)+

[a] Abbreviations in parentheses indicate species harvested in the wild in addition to Australia: Am = America, Af = Africa, As = Asia, E = Europe, O= Oceania, # = modern domestication, + = one or more cultivated species somewhere in the world, but not in Australia.

2) Africa and Asia—*Amorphophallus, Cucumis, Digitaria, Dioscorea, Dolichos, Hibiscus, Oryza, Piper, Solanum,* and *Vigna*;
3) Old and New Worlds—*Amaranthus, Canavalia, Dioscorea, Gossypium, Ipomoea, Lepidium, Lupinus, Panicum, Prunus, Setaria, Solanum,* and *Spondias*.

Understanding Life Cycles of Plants

What do nonagricultural people know of the life cycles of plants? Do they know that flowers lead to seeds and that seeds can be sown to produce more plants? Is this something that must be learned or discovered to commence the domestication of plants or is this a part of the general botanical knowledge of gathering peoples?

A look at the ethnographic evidence shows that some gatherers do plant seeds. Seven of 19 groups studied by Steward (1941) in Nevada sowed seeds of wild plants (Downs, 1964). No tillage was practiced; the seedbed was generally prepared by simply burning the vegetation the previous fall and seeding in the spring. The seeds sown were of entirely wild plants; the most frequently mentioned were species of *Chenopodium, Oryzopsis, Mentzelia,* and *Sophia* (Steward, 1941).

The Paiute tribe of Owens Valley, California, practiced irrigation and also broadcast seeds to thicken up stands of desired plants, but none was domesticated. Irrigation was designed to increase production of wild plants such as *Nicotiana attenuata* Torr. ex S. Watson, *Salvia columbariae* Benth., *Chenopodium fremontii* S. Watson, *Chenopodium album* L., *Helianthus bolanderi* A. Gray, *Eriocoma hymenoidsis* (Roem. & Shult.) Rydb. and *Eleocharis* spp. The earthen dams were simple, but the rather extensive canals required considerable labor to build. One block covered about 5 km^2 and another close to 13 km^2 (Steward, 1934). As previously pointed out, however, Natives of the Great Basin could have been influenced by neighboring agriculturalists and their botanical knowledge may not be typical of gatherers in preagricultural times. Let us look elsewhere.

To the Andamanese, the goddess Puluga symbolizes the southwest monsoon that brings violent winds and rains from April to October (Coon, 1971):

> Puluga owned all the wild yams and cicada grubs that the people ate, and all the beeswax that they used in hafting, calking, and cordage. Women who dug yams had to replace the tops to fool Puluga...
>
> Indeed, if Puluga caught the people misusing her property she would get angry and send bad weather. Here we see the practice of planting reinforced by a religious belief. The practice is useful to the people, but does not of itself prove understanding.

An early observation of Sir George Grey (1841) concerning Australian Aborigines is more revealing:

> The natives have, however, a law that no plant bearing seeds is to be dug up after it has flowered; they then call them (for example) the mother of Bohn, the mother of Mud-ja (*Haemadorum* spp.), etc.; and so strict are they in their observance of this rule that I have never seen a native violate it, unless requested by an European, and even then they betray a great dislike to do so.

The practice is confirmed by Gregory (1886):

> The natives on the West Coast of Australia are in the habit among other things of digging up yams as a portion of their means of subsistence; the yams are called "ajuca" in the north and "wirang" in the south. In digging up these yams they invariably re-insert the head of the yams so as to be sure of a future crop, but beyond this they do

> absolutely nothing which may be regarded as a tentative step in the direction of cultivating plants for their use.

There seems to be little doubt that the life cycles of plants were well understood by native Australians. The Aborigines were equipped with all the knowledge necessary to practice agriculture, but did not do so.

Klimek (1935) recorded 11 tribes of California peoples that grew a local species of tobacco, but no other crop. Some tribes in Oregon, Washington, and British Columbia followed the same practice (Drucker, 1963). The tobacco was usually either *N. attenuata* or *N. quadrivalvis* Pursh. Harrington (1932) made a very detailed study of tobacco among the Karuk, and found the extent of botanical knowledge remarkable. The Karuk burned logs in the forest and sowed seeds in the ashes. A tobacco garden was called "to plant" or more literally "to put seed." The Karuk had terms for cultivated tobacco, wild tobacco, roots, stems, bark, leaves, branches, leaf branches, pith, gum, flowers, buds, seedpods, flower stem, clusters of flowers, sepals, and calyx. No standard word was used for petal, but descriptive terms were used, for example, the white-flowered *N. quadrivalvis* was said to have "five white ones sticking out." The stamens and pistil were described as "sticking out in the middle of every flower where the seeds are going to be." Stamens are "flower whiskers," "flower threads," or "flower hairs." Pollen is "flower dust." Nine stages of flowering to seed setting were recognized with descriptive terms. There was a classification of seeds, grains, seeds in the midst of a fruit (pit), seeds inside a shell (nut), and so on.

The translation of an informant's description of germinating tobacco seed is botanically accurate and detailed (Harrington, 1932, p. 61):

> Its seeds fall to the ground. The dirt gets over them. Then, after a while, when it gets rained on, the seed sprouts. Sometimes all the seeds do not grow up. They say sometimes some of the seeds get rotten. Its sprouts are small white ones, pretty near the size of a hair. Whenever it is just peeping out, its seed is on top of it. Then they just have two leaves, when they first peep out of the ground. They grow quickly when they grow; in a little while they are tall ones.

The Karuk fertilized with ashes, sowed, weeded, harvested, selected for strength, cured, stored, and sold tobacco, but grew no other crop. Clearly, the concept of planting seeds was in no way revolutionary and did not lead to food production (Harrington, 1932). Where did people ever get the idea that hunter-gatherers did not know about life cycles of plants? The egocentricity of agriculturalists is extraordinary. The situation is summed

up succinctly by Flannery (1968): "We know of no human group on earth so primitive that they are ignorant of the connection between plants and the seeds from which they grow. . . ."

General Botanical Knowledge

We should not be surprised if gathering peoples know a lot about plants. They are the real "professional botanists"; for them, life depends on an adequate knowledge of plants. We have seen that gatherers are familiar with hundreds of species and their uses for food. We have noted that many are poisonous and must be detoxified before they can be eaten.

Since "ignorance" is part of the stereotype developed by agricultural people about gatherers, I would like to call attention to an episode described with some apparent pleasure by Sir George Grey (1841). Some of the crew of Captain Cook's expedition of the 1770s observed the Aborigines eating seeds of *Zamia* (a cycad). The crew tried some of their own harvest of *Zamia* and became very ill. They concluded that the Aborigines must have very strong constitutions to be able to live on such food. Later, on shipboard, they fed *Zamia* seeds to some pigs, and a few died. Their admiration for the physical stamina of the natives increased substantially. The Aborigines, of course, had removed the poison before eating their seeds, and were, no doubt, amused at the "ignorance" of their European visitors.

Detoxification is required for a considerable number of plants used by the native people of North American, the Australian Aborigines, and gatherers in tropical zones. Some plants are deadly poisonous without treatment, others only unpleasant. Several acorn species are sweet and need no treatment, while others contain various amounts of tannins. Among California Native Americans, some of the bitterest oaks were the most popular; when properly leached, the original tannin content did not cause any harm. Tribes on the edge of the "acorn belt" were often more selective since they did not depend much on acorns and did not want to go to the trouble of leaching. Leguminous seeds, Solanaceous fruits, *Dioscorea* spp., and Aroid tubers are still among the more common poisonous foods consumed by gatherers.

Detoxification is usually by heat, leaching, or both. The plant material is frequently reduced by grinding or pounding in a mortar to facilitate treatment. Boiling water may be poured through the meal, the material may be boiled in several changes of water, or sometimes prolonged soaking in cold water is enough. Some foods are roasted, pounded, and then leached. Sieves, strainers, cloth sacks, wooden troughs, or sandbeds may be produced

for the purpose. Pottery is not necessary; water may be boiled in baskets, hides, wooden boxes, or pits in the ground by dropping fire-heated rocks into the water.

Gatherers not only know how to make poisonous foods safe, but they also know a great deal about drugs, narcotics, medicines, fish poisons, arrow poisons, gums, resins, glues, dyes and paints, bark cloth, and woods for spears, arrows, bows, shields, fire sticks, and canoes. They have also used their botanical knowledge in spinning and weaving, basket-making, and constructing household utensils, fish traps and weirs, masks, figurines, and ceremonial objects.

The Australian Aborigine was fond of chewing a wild tobacco (mostly *Nicotiana suaveolens* Lehm.). Wood of *Acacia salicina* Lindl. was burned to provide ash to mix with the quid. Why this particular species out of dozens of *Acacia?* Johnston and Cleland (1933) analyzed the ash and found it extraordinarily high in calcium sulfate, "sulfuric anhydride 30.09% and lime 40.70%." The alkaloids are more soluble in alkaline solutions. Perhaps any source of lime would do, but the practice reminds one of the custom in India of burning heartwood of *Senegalia catechu* (L. f.) P. J. H. Hunter and Mebb (syn: *Acacia catechu* (L.f.) Wild, Oliv.) to obtain "cutch" which is mixed with other ingredients and used when betel nuts are chewed.

Another masticatory of the Aborigines was *Duboisia hopwoodii* (F. Muell) F. Muell. This is of a different order of drug potency and contains hyoscyamine and norhyoscyamine, with scopolamine in the younger leaves (Johnston & Cleland, 1933). Both narcotics were confounded under the general name "pituri" and were important articles of trade over great distances; "shields, boomerangs, spears and other articles being sent in return for them."

In the late 19th century, Father Trilles, a French missionary to Gabon, West Africa, observed pygmies making arrow poison. The process was long, complex, and dangerous, for the poisons were extremely potent. Ingredients of 10 different plants were used; eight were poisonous and two were gums to be impregnated with poison and stuck to the arrow heads. Two animal poisons were also included: beetle larvae and venom of a horned viper. The procedure is described in *The Hunting Peoples* by Coon (1971) who added this comment:

> A tourist driving along a forest-lined road, seeing an elderly, diminutive black man clad in a bark-cloth breechclout, would have no reason to suspect that this child of nature knew the properties of many medicinal plants, some still undescribed in Western science, and how to combine them for their greatest effect. With the forest

> and marsh his pharmacy, his laboratory a secret nook in the shade of tall trees, and a minimum of equipment, the Pygmy poison-maker performs a delicate, dangerous, and highly skilled sequence of operations as exacting as some modern professions.

An indication of ecological sophistication is reported by Levitt (1981) for Aborigines of Groote Eylandt. Some common grasses were used as "calendar plants"—when grains of *Chrysopogon* spp. are ripe, it is time to dig yams; or when grains of *Heteropogon triticerus* R. Br. start to shatter, it is time to dig yams; and when all grains have fallen, it is time to stop. When *Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult. begins to flower, the rainy season will soon be over. Other hunter-gatherers receive similar signals from their knowledge of plant growth and reproduction.

The more one studies the wealth of plant lore of gathering peoples the more one is impressed by the extent and coverage of their botanical knowledge. Man knows what he needs to know or learns what he must or else he dies. The security and stability of gathering economies are from necessity, rooted in an extensive body of information about plants.

Manipulation of Vegatation

Kangaroo Island lies off the south coast of Australia. It had once been inhabited by Aborigines, but they left or died out long before European contact. The woody vegetation had become a virtually impenetrable thicket, while the nearby mainland with the same climate supported an open, grassy woodland. This comparison gives us some understanding of the extent of Aboriginal control over the vegetation. To this day, if areas are uninhabited for an extended period, the woody vegetation thickens up, and the Aborigines find the landscape uncomfortable and spiritually dangerous (Chase, 1989). After repeated burnings, the land again shows the stamp of human occupancy and the Aborigines feel more comfortable and spiritually safe. The Aborigines have more or less domesticated the landscape by skillful use of fire and complain that the white man lets the land get "dirty" (Lewis, 1989). Jones (1969) called it "firestick farming."

The Aborigines did more than clear land by burning. They diverted water to flood forests in the dry season: "We like to see plenty of water in the jungle all the time, for birds of all kinds gather near it, and the food plants that we like grow better" (Campbell, 1965). They constructed water-spreading devices for the rainy season (Lourandos, 1980), and they ditched to increase the supply of eels and other fish (Walters, 1989). In the course of

digging up wild root crops, they churned up large areas to the point they resembled plowed fields. Sir George Grey wrote (1841):

> In the Province of Victoria, as already stated, I have seen tracts of land several square miles in extent, so thickly studded with holes, where the natives have been digging up yams (*Dioscorea*) that it was difficult to walk across it. Again, in the sandy desert country which surrounds for many miles, the town of Perth, in Western Australia, the different species of *Haemadorum* are very plentiful.

The borderline between gathering and farming becomes very hazy at this point. Douglas Yen referred to such activities as Aboriginal agronomy (Yen, 1989). Perhaps the key difference here between foraging and farming is that no native Australian plant was actually domesticated, otherwise hunter-gatherers do about everything farmers do.

The Great Basin Native Americans did about the same, burning vegetation, sowing seeds, and irrigating tracts of land (Downs, 1964). Indeed, fire was used to modify vegetation just about anywhere that vegetation could be burned, and the practice may well have gone back to Acheulean times (Hallam, 1975). There are some immediate returns from the practice; animals fleeing fires are more vulnerable to the spear and the bow, but the major returns are delayed. New shoots, unencumbered by old growth attract grazing animals; the ash provides some fertility for regrowth; heat renders phosphorus more available; woody vegetation is retarded and herbaceous plants increase; wild seed harvests are enhanced; roots and tubers escape injury in the dry season and thrive as competition is reduced. The landscape is tamed, but the plants and animals were not.

Food Plants in Ritual and Ceremony

Some California tribes, heavily dependent on acorns for food, conducted an annual spring ceremony, usually in April, for the purpose of increasing the crop. The participants went out at night, visited specified trees, and implored them to yield abundantly. The trees were supposed to respond (Loeb, 1934).

First-fruit ceremonies are practiced by the African Bushmen. When the fruit of a certain species begins to ripen at the onset of the big rainy season (usually February), a day is appointed and the women go out and ceremonially gather fruit from previously designated trees. The men stay in camp and all the camp fires are extinguished. When the fruits are brought to camp, a composite sample is carefully selected and presented to a head

man, who kindles a special fire and ceremonially appeals to the fire for a plentiful harvest. He then eats the fruit. After the ceremony both men and women can partake of the fruits, but it is offense to eat them before the ceremony (Marshall, 1960).

Among various Bushmen tribes at least simple first-fruit ceremonies are performed for a dozen or more different plants. Each of the major veld foods (plants in open grasslands of South Africa) has its own choa ceremony (Thomas, 1959). The !Kung observe a first-fruit ceremony dealing with tubers. The rite is performed by the head man on a selected day. One of the prayers translates: "Father, I come to you, I pray to you, please give me food and all things that I may live" (Schapera, 1951). The tubers must not be touched until the ceremony is performed.

Spencer (1928, 1967) describes, in some detail, yam ceremonies on Melville Island, Australia. These are celebrated as rainy season initiation rites. One particular yam, called Kolamma or Kulemma, has small rootlets (like whiskers) all over it. It is supposed to make whiskers grow on boys and so is involved in growing-up rites. Girls may be initiated at the same time, but no female can touch the yam or the ceremonial fire until the rites are completed. One of the lines chanted is: "Yams, you are our fathers!" The natives assert that after the ceremony all kinds of yams will grow plentifully.

It might be mentioned here that the New Yam ceremonies are the most important in the ceremonial calendar of yam-eating tribes of West Africa. It is important not to dig some species of *Dioscorea* too early in the season and this sound agricultural practice is reinforced by religious ritual. A similar protective ritual is observed by the nonagricultural Andamanese (Coursey, 1972).

The Warramunga tribe of Australia has a yam totem; the Kaitisha tribe has a grass seed totem and celebrates a grass seed dance and ceremony. Rain dances are performed by both Bushmen and Australian natives to increase food resources. These are but a few of the many examples that could be given to show how plants that are important sources of food or well-being are venerated and intimately woven into the religious and ritual life of gathering peoples.

On Sharing the Bounty

Much has been made by some social anthropologists of the more or less egalitarian nature of hunter-gatherer societies. Game brought in by a hunter is shared by usually strict rules; the hunter himself has little to say about it. Produce gathered by the women and children is normally shared by the

whole camp. One may own personal items like digging sticks, bows, arrows, spears, boomerangs, carrying nets, bowls, pots, and so forth, but if someone asks for something, it is very difficult to refuse. There is, in many tribes, a sense of community ownership, but this is likely to vary by degrees of relationship. Nearly all items might be shared by the immediate family or even within an extended family, but sharing becomes diluted with more distant relations. Lee (1988) pointed out that there are strong peer pressures to share freely and to prevent an individual from dominating or even showing pride. Egos are continuously being deflated by bawdy jokes and condescending comments.

The sharing rules may, in fact, cause the fragmentation of large camps. When a game animal is divided into so many shares that each person receives only a tiny scrap of meat, the better hunters are likely to fission off with their immediate families in order not to share with all. People may also resort to hiding personal items in order not to share. The social ideal of sharing freely has appeal, but seems to work best in small intimate groups.

Unharvested resources have a different set of rules. In many areas tribal territories are clearly defined, and even foraging microbands or families may be allotted specified regions, groves, or stands of useful plants. They very rarely harvest on land reserved for other bands. Springs and water holes may be owned by specified groups and the outsider must ask permission even to drink. This is true in both South Africa and Australia. In Australia, land ownership was respected during the burning season. It was considered a serious offense to burn another's foraging range. The time and place of a burn were carefully chosen and serious attempts were made to keep the fires within prescribed bounds (Warner, 1958).

If a pygmy finds a bee tree, he can mark it, and he alone is entitled to harvest the honey. To steal from a marked tree is a serious offense. Among Bushmen the same holds true for ostrich nests as well as bee trees and stealing either one can be punished by death. Some of the hollow trees of Bushmen ranges fill with water and provide an important source of water in a semidesert land. The trees may be individually owned and inheritance may pass from father to son (Marshall, 1960).

Tree marking is also observed in Australia (Gregory, 1886):

> A native discovering a *Zamia* fruit unripe will put his mark on it and no other native will touch this; the original finder of the fruit may rest perfectly certain that when it becomes ripe he has only to go and fetch it for himself.

Property rights are demonstrated by the custom of breaking off the top of the "grass tree" (*Xanthorrea*), which will then rear large edible grubs. The one who breaks off the top owns the grubs that will be produced later (Grey, 1841).

At least one Aboriginal family is reported to have owned a rock quarry. The head of the family removed slabs of rock, broke them into appropriate pieces, and shaped them crudely as blanks from which ax-heads could be made. The blanks and spears entered into the long-distance trading routes established by the Aborigines long before European contact (Coon, 1971).

A number of tribes of the Pacific Northwest kept slaves. These were captured in raids on neighboring tribes, purchased, received as gifts in potlatch celebrations, or sometimes generated by voluntary servitude to settle debts. During the extravagant pot-latches of the 19th century, slaves were sometimes killed as a show of wealth. These rather sedentary tribes had a surplus of goods and commodities which were either distributed or simply destroyed. Such a luxuriant economy does not fit the stereotype of the starving savage (Suttles, 1968).

Also in the same region, houses, not necessarily made of skin or bark, were often individually owned, and some tribes built solid plank houses that were intended to be permanent structures. The Modoc (California–Oregon border) maintained a scheduled round of nomadic movements to exploit various resources at different times of the year. In winter camp, they lived in plank houses that were dismantled and carefully stacked each spring when they moved to summer quarters. The houses were reassembled on their return in late fall or early winter (Ray, 1963).

It would appear that private ownership of resources was well understood by nonagricultural people and probably by preagricultural people as well. The concept of ownership was, and still is, widespread and deeply ingrained in many gathering societies.

Population Control and the Aged

As previously indicated, the evidence seems to show that populations of hunter-gatherers are maintained well below the carrying capacity of the range. This is, in part, what keeps the system so stable and durable. When crops fail, farmers die of starvation, but famine is not recorded among gatherers except where there has been a drastic disturbance by outside agents (Coon, 1971):

> In every well-documented instance, cases of hardship may be traced to the intervention of modern intruders. Starvation came to the

> Caribou Eskimo only after a few Cree Indians, armed with automatic rifles, had slaughtered a whole migration of caribou to cut out their tongues to sell to white canners.

What methods are used to keep the population stable? There seems to be little consistency in methodology; the only generality seems to be that some method or combination of methods is employed by each group. Infanticide is common, but far from universal. Since males are usually preferred to females, the practice may result in markedly displaced sex ratios in the population. Invalidicide is widespread, although some tribes treat the sick and injured with consideration and do not withhold customary medicines. Delayed marriage, late weaning, and wide spacing of children are among the most common methods of population control, and computer studies have shown that these alone can adequately stabilize a population (Skolnick & Cannings, 1972). Geronticide (killing of the aged) is also practiced in some tribes. In addition, warfare, raids, feuds, and similar activities often affect population size.

In general, there seems to be no model that has very wide application. Lee (1968) specifically investigated the situation of the aged among the Bushmen: "In a total population of 466, no fewer than 46 individuals (17 men and 29 women) were determined to be over 60 years of age, a proportion that compares favorably to the percentage of elderly in industrialized populations."

It is evident, then, that the "nasty, brutish, and short" stereotype of the hunting–gathering life styles was a product of an egocentric sense of superiority and that all features of it are demolished by serious anthropological studies.

Conclusions

The ethnographic evidence indicates that people who do not farm do about everything that farmers do, but they do not work as hard. Gatherers clear or alter vegetation with fire, sow seeds, plant tubers, protect plants, own tracts of land, houses, slaves, or individual trees, celebrate first-fruit ceremonies, pray for rain, and petition for increased yield and abundant harvest. They spin fibers, weave cloth, and make string, cord, baskets, canoes, shields, spears, bows and arrows, and ritual objects, recite poetry, play musical instruments, sing, chant, perform dances, and memorize legends. They harvest grass seeds, thresh, winnow, and grind them into flour. They do the same with seeds of legumes, chenopods, cucurbits, crucifers,

composites, and palms. They dig roots and tubers. They detoxify poisonous plants for food and extract poisons to stun fish or kill game. They are familiar with a variety of drugs and medicinal plants. They understand the life cycles of plants, know the seasons of the year, and when and where the natural plant food resources can be harvested in greatest abundance with the least effort.

There is evidence that the diet of gathering peoples was better than that of cultivators, that starvation was rare, that their health status was generally superior, that there was a lower incidence of chronic disease (Lee & De-Vore, 1968), and not nearly as many cavities in their teeth (Angel, 1984).

The question must be raised: Why farm? Why give up the 20-hr work week and the fun of hunting to toil in the sun? Why work harder for food less nutritious and a supply more capricious? Why invite famine, plague, pestilence, and crowded living conditions? Why abandon the Golden Age and take up the burden?

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