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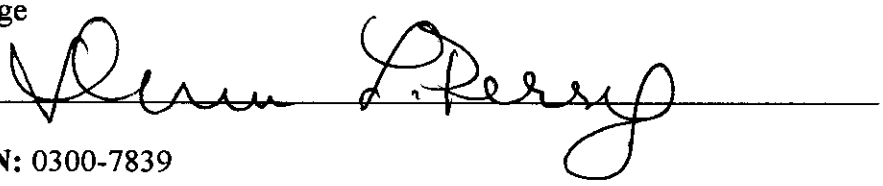
Signature 

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Political Ecology and Environmental Management in the Loess Plateau, China

Linda Hershkovitz[1]

This paper explores the changing political ecology of soil and water management—the articulation of physical and political-economic processes—in the Loess Plateau of north-central China. Market-oriented reforms and the shift from collective to household farming have created a diverse array of tenure, management, and financing arrangements. In the process relationships between farm households, the collective, and the state have been altered, with profound implications for land use and sustainability. The paper reviews the political ecology approach and its relevance to environmental management in China. An outline of the physical and economic context of soil erosion in the Loess Plateau is followed by examination of the impact of reform on rural environmental management. Local innovations in the organization of environmental management are highlighted. The conclusion comments on the utility of the regional political ecology approach and suggests some critical issues for further research.

KEY WORDS: China; rural environment; political ecology; Loess Plateau.

INTRODUCTION

> Before the reign of Cheng Te (1506–1521), flourishing woods covered the southeastern slope of the Shangchih and Hsiachih mountains, which were not stripped because people gathered little fuel . . . It was never seen dry at any time of the year. . . . At the beginning of the reign of Chiaching (1522–1566) people vied with each other to build houses and wood from the southern mountains was cut without a year's rest. The natives took advantage of the barren mountain surface and converted it into farms. . . . If heaven sends down a torrent, there is nothing to obstruct

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Historical Trends in Forager and Farmer Exchange in the Ituri Rain Forest of Northeastern Zaïre

David S. Wilkie[1] and Bryan Curran[2]

Using oral histories, archival materials, and observations of present behavior, a largely hypothetical historical reconstruction of the natural resource exploitation and subsistence practices of Lese farmers and Efe foragers in the Ituri Forest of northeastern Zaïre is presented. Distinct epochs associated with the advent of forest agriculture, Belgian colonization, and post-independence economic collapse have resulted in changes in local population density, the range of forest resources exploited, and the spatial distribution and intensity of resource use. Broadly speaking, there has been a historical trend toward sedentism, spatial clumping of settlements, localization of resource exploitation, reduced importance of forest carbohydrates in the diet, and an increased reliance on agricultural products. Over time the Efe and Lese exchange system has changed, in relation to the items traded and the relative dependence of each partner on the exchange relationship. Involvement in this alliance has had a considerable impact on Efe settlement pattern, diet, and probably fecundity. It ultimately placed the Lese in a position of power over the Efe, and provided the farmers with means to enter a transient monetary economy. By providing a retrospective on Efe and Lese subsistence, we hope to demonstrate that to decipher the relative benefits and constraints of this contemporary exchange relationship, we must understand their historical etiology.

KEY WORDS: Africa; hunter–gatherers; resource exchange; tropical rain forest; subsistence decisions.

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INTRODUCTION

The almost universal incidence of complex, interdependent exchange relationships between sympatric foragers and farmers within Old World tropical moist forests (Peterson, 1978; Headland and Reid, 1989; Bailey et al., 1989) suggests that exchange constitutes a vital component of their subsistence within these regions.

As tropical rain forests are considered to be marginal environments for humans, and as foragers and farmers ostensibly occupy two different niches, exploiting different resources, any redistribution of food-stuffs, commodities and labor through exchange is likely to affect both net returns to forager and farmer subsistence, and the density dependent constraints associated with each practice. Changes in constraints to subsistence as a result of exchange will concomitantly affect population size and distribution, which in turn will affect land-use and resource availability. It can thus be seen that the advent and evolution of an exchange relationship will have a profound, cybernetic effect on both forager and farmer populations, and the form and consequences of their subsistence practices. Given this, it is not surprising that forager–farmer exchange has attracted the attention of researchers interested in subsistence and resource use within rain forest ecosystems.

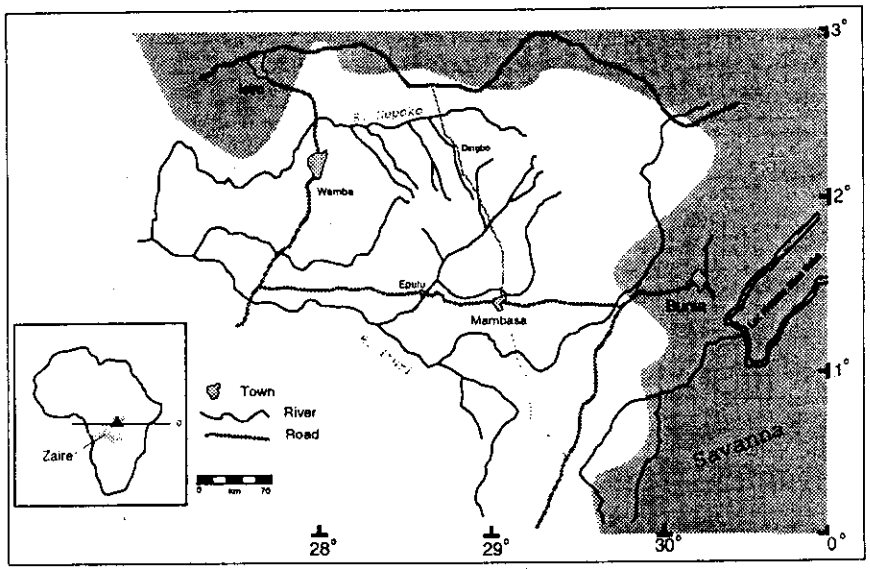

Fig. 1. The Ituri Rain Forest of Northeastern Zaire.

The Efe foragers (pygmies) and Lese farmers of the Ituri rain forest of northeastern Zaïre (Fig. 1) are presently involved in a complex exchange relationship that functions both at economic and social levels (Bailey and DeVore, 1989; Grinker, 1990). This relationship has been an integral part of Efe and Lese life for sufficiently long for them to share a common language,[3] affecting subsistence practices and settlement patterns (Bailey and DeVore, 1989). In order to determine the relative costs and benefits of involvement in the exchange relationship, we need to accrue information from a variety of sources.

Research on contemporary exchange systems certainly provides useful empirical data on the prevailing economic and social impact of exchange on forager and farmer subsistence (Bahuchet and Guillaume, 1983; Peterson, 1978; Tereshima, 1986; Grinker, 1989). However, human subsistence practices are seldom static over time. Settlement patterns change, new crops, weapons, and technologies are introduced, cultivation methods are altered, and market economies develop and collapse. Exchange relationships between foragers and farmers exist within this dynamic framework and must necessarily be responsive to environmental social, economic, and technological change (Headland, 1988). This concept of change is particularly important because past subsistence decisions have the capacity to constrain future subsistence options, and can thus be instrumental in shaping the exchange relationship. The social and economic costs and benefits of involvement in an exchange relationship are not only a function of present day conditions, they are related also to why the relationship first was established, as well as the causes and consequences of change over time (Headland, 1986). Thus, in order to fully understand present day forager and farmer exchange, we must place these subsistence practices within their dynamic, historical context.

The intent of this paper is to highlight the importance of a historical perspective when examining forager and farmer exchange. The paper is based on interview data with Efe and Lese men and women collected in the Ituri during a total of 24 months of fieldwork conducted between January 1982 and June 1983, and between January and June of 1988. These data were augmented with information gleaned by other members of the Ituri Project (Bailey and DeVore, 1989) during their fieldwork, and by reference to the literature. This paper is an attempt at reconstructing a chronology of human resource exploitation and land-use within the Ituri Forest, proposing how subsistence practices of Efe foragers and Lese farmers are

[3]The Lese-Dese and Efe speak mutually intelligible southern sudanic languages (KiLese and KiEfe respectively) that differ somewhat in pronunciation and use different names for some forest plants and animals.

likely to have changed over time, and describing how these subsistence practices were intimately connected through an exchange relationship. The reader should be aware that any attempt at reconstruction of past events, particularly within non-literate societies, is fraught with opportunities for misinterpretation. And more seriously, perhaps, this approach allows the author to impart a sense of the absolute nature of events rather than conveying to the reader that this constitutes but one plausible explanation for past events. The reader should thus understand that many statements made in this paper are by their very nature not factual, because no *facts* other than those remembered in oral traditions exist for these cultures prior to European and Arab contact in the late nineteenth century. Regardless of this caveat, even a largely hypothetical historical perspective on forager-farmer exchange is valuable because: (1) it reminds us that the accouterments and practices of subsistence level societies are not static, but have changed considerably over time, and (2) it demonstrates how the present form of the forager–farmer exchange relationship is a result of a dynamic process which has been driven and constrained by social, economic, and biotic factors.

This paper is divided into a series of plausible historical episodes spanning from preagricultural times to the present day. At each juncture we will attempt to reconstruct how and why human subsistence practices changed, and discuss how these changes are likely to have affected the forager–farmer exchange relationship.

PRE-HORTICULTURAL SUBSISTENCE

Although archeological evidence is slim and often conflicting (Fisher and Strickland, 1989, 1992; Van Noten, 1977, 1982), it is likely that farmers did not inhabit the Ituri forest until the first millennium A.D. (Alexander and Coursey, 1969; Birmingham and Martin, 1983; Ehret, 1982, 1984; Harris, 1976; Miracle, 1967, 1973; Purseglove, 1976; Shaw, 1976, 1977; van Zinderen Bakker, 1976; Vansina, 1986, 1990). Prior to this it is believed (Berry et al., 1986; Cavalli-Sforza, 1986; Turnbull, 1965, 1983) that the Ituri was populated by the predecessors of today's Efe (pygmies).

What resources were available to these tropical moist forest foragers? Unlike most rain forests which have a primarily arboreal fauna, the Congo Basin forests such as the Ituri also contain a diverse and abundant terrestrial fauna (Hart et al., 1986; Wilkie 1987). In fact, the Ituri may contain the highest faunal biomass of any lowland African forest (Hart, 1985a,b; Wilkie, 1987). In contrast to the Ituri's abundant, if exceedingly lean, faunal

resources, carbohydrates are relatively scarce (c.f. Hladik et al., 1984), patchy, seasonally available (Hart and Hart, 1986) and, in respect to forest yams,[4] are often difficult to harvest (Chikwendu and Okezie, 1989) and many contain toxic secondary chemicals that require elaborate processing before they are edible (Wilkie, 1988; Coursey, 1967; Burkill, 1939). The ancestors of today's Efe probably lived by foraging for, among other things, wild game, fish, honey, fruits, nuts, and tubers (Bailey and Peacock, 1988; Motte, 1980; Tereshima et al., 1988). Much as today, Efe men reported that their ancestor used bows and arrows to hunt,[5] either alone or in cooperative groups of 4–20 men. Men also extracted honey, and foraged for mushrooms, giant snails, tortoises, and forest fruits and nuts. Women practiced dam fishing, and gathered tubers and bulbils of forest yams, as well as forest fruits and nuts. Although the Efe exploited a wide variety of forest foods (Aroiti, 1985; Ichikawa, 1987; Tereshima et al., 1988) the paucity and spatial dispersion of carbohydrate resources is likely to have constrained fecundity and population density (Kelly, 1983), and forced foragers into small, mobile, wide-ranging groups (Fisher and Strickland, 1989)[6] that only coalesced during periods of relative abundance, such as honey season (Ichikawa, 1981).

Although shortage of carbohydrate resources may have made the Ituri a marginal habitat for foragers, it was likely capable of supporting small human populations (Bahuchet, et al., 1991), as recent radiocarbon dates of charcoal found in association with potsherds and quartz artifacts in rock shelters in the Ituri suggest that foragers preceded farmers into this region (Fisher, 1991; cf. Bailey et al., 1989; Hailey and Headland, 1991; Hart and Hart, 1986; Headland 1987; Headland and Reid, 1989a,b; Hutterer, 1982). Though Headland and Bailey (1991) hypothesize that human foragers could not live in tropical rain forest environments independently of horti-

[4]Hladik et al., (1984) have undertaken the only study to examine the composition, spatial dispersion and abundance of tuberous carbohydrate sources within an African moist forest. Their data show that open forest areas and forest edges contain the greatest abundance of *Dioscorea* spp. yams, but the majority of these are quite toxic. Closed forest typically contains a much lower biomass of tubers but they are usually palatable and have a high starch (80%) and protein (10%) content by weight. Hladik et al. estimate that in the Lobaye District of the CAR a 50 km^2 region occupied by Aka pygmies contained a standing crop of 5000 kg of wild yams that would be available throughout the year.

[5]For detail information on Efe and Mbuti hunting and foraging techniques, and plant and animal utilization please refer to Harako (1976, 1981); Ichikawa (1978, 1981, 1983); Tanno (1976, 1981); Tereshima (1983); and Tereshima et al. (1988).

[6]Oral histories suggest that traditional camp composition was not much different from that of present day Efe. Camps are composed of 1–8 families (6–30 people), and consist of set of domed, leaf-tiled huts set in a rough semicircle surrounding an open communal space (Fisher and Strickland, 1989). Camp composition varies widely with divisions occurring at the household level. Efe residence are primarily virilocal and most camps are made up of loose patriclans.

cultural products, recent archeological evidence (Endicott and Bellwood, 1991; Fisher, 1991), and for the case of central African pygmies, ecological, ethnohistorical, and linguistic evidence (Bahuchet et al., 1991) refute this. For the resource base of the Ituri to have precluded occupation by foragers, convincing evidence would have to demonstrate that: (1) returns from foraging were on average less than travel, search, handling and maintenance costs incurred by foragers; and/or (2) seasonal variance in food availability was such as to make net returns from foraging zero or negative for a period sufficient to adversely affect fecundity and mortality.

Although Hart and Hart (1986) took the first steps to examine this issue, we should be cautious in our interpretations of the results (Tereshima, 1987), as their study concerned only presently foraged foods within one small section of the Ituri. To truly determine whether foragers could sustain themselves solely from forest resources, the abundance, nutritional composition, net foraging returns, and seasonal availability of historically important food species must be assessed within forager designated areas. The extent and spatial dispersion of such areas must then be mapped for the Ituri in general. Only with these data can we ascertain if, and how many, foragers could be supported by forest resources in the absence of agricultural crops.

Prehorticultural occupation of the Ituri, if it were indeed possible, would likely have seen small groups of Efe foraging widely throughout the forest, to exploit a broad range of spatially dispersed, seasonally available resources. Although protein sources were readily available and may even have been used as important sources of calories, carbohydrates were limited and probably placed severe constraints on population growth and density.

THE ADVENT OF HORTICULTURE IN THE ITURI

Efe subsistence practices and their impact on the forest probably did not change much until the expansion of horticulturalists into the forest. Extensive occupation of the Ituri by farming societies could have occurred at two or three different times in history, depending upon what one considers are the essential criteria for establishment of rain forest cultivation (Clark, 1976; Clark and Brandt, 1984; Harlan et al., 1976a,b). Widespread farming within Africa's rain forests requires suitable crop plants, and the availability of iron tools. The former is obviously essential. Absence of the latter probably did not preclude agriculture (cf. Clark, 1962, 1967; David, 1976) in the Neolithic, but must certainly have limited what areas could have been effectively cleared and cultivated (Carneiro, 1974, 1979; Colchester, 1984; Coles, 1979; Coursey, 1976).

Indigenous Versus Introduced Crops of Africa

Africa is relatively species poor in its set of indigenous domesticated plants (Norman et al., 1984). Of those domesticates, *inter alia*: millet, sorghum, and eleusine, most are suited to seasonally dry climates and cannot tolerate conditions prevalent in the Congo Basin forests. Only oil-palm (*Elais guineensis*), legumes of the Vigna genus such as cowpea,[7] watermelon (*Cirtrullus vulgaris*), several species of Dioscorea yam (*D. rotundata, D. cayensis, D. preussii, D. dumetorum,* and *D. bulbifera*), bambarra nuts (*Voandzeia subterranea*), and coffee (*Coffea spp.*) are both indigenous to Africa, and rain forest tolerant.[8] Modest farming could thus have theoretically commenced in Zaïre's forests in the early Neolithic (5–10 thousand years BP), using stone tools, and cultivating oil-palm, cow-peas, and yams.

The major invasion of the forest by farming societies probably did not occur, however, until some time in the first millennium AD. This was facilitated by the introduction of bananas (Vansina, 1990) and several genera of starchy tubers/corms by Arab traders (*Dioscorea, Colcasia,* and *Xanthosoma*) from southeast Asia (Clark, 1962; Harris, 1967; McMaster, 1919; Murdock, 1959; Purseglove, 1976; Shaw, 1976, 1977), and the advent of iron tools (Oliver and Fagan, 1975; Van Noten, 1985).

A further expansion of agriculture is likely to have occurred in the seventeenth century when the majority of Africa's present day crops, *inter alia*: maize, cassava, sweet potatoes, peanuts, beans, squash, and papaya, were brought from the Americas by the Portuguese, who had established trading/slaving settlements along the Atlantic Coast (Miracle, 1973; Normal et al., 1984).

Farming in the Ituri may therefore have been possible as early as 5–10 thousand years ago. However, only with the introduction of bananas (approximately 2000 years BP), and the spread of their cultivation from East Africa is it likely that the forest become a viable landscape for horticulturalists.[9]

Farming in the Ituri Forest Up to the 1900s: Precolonial Land-Use

The souther Sudanic-speaking Lese and Mamvu are presently the most widely distributed horticulturalists within the Ituri (Fig. 1), and based

[7]Cowpeas are presently grown in association with millet and sorghum in drier parts of Nigeria, but are considered somewhat moist tolerant.

[8]As all these species are most abundant on the forest/savanna ecotone, they are most likely rain forest tolerant and not rain forest dependent (Harlan et al., 1976a,b).

[9]Vansina (1990) writes that the northeastern forests of the Congo Basin were the last to be occupied by Bantu and Southern Sudanic speaking farmers.

on linguistic divergence of the many subtribes, were probably the first farmers to have inhabited the Congo Basin's northeastern forests (David, 1982; Ehret and Saxon, 1991; Joset, 1949; Van Geluwe, 1957). The Lese are virilocal, with fathers and sons living within the same village. Oral histories mention that prior to the 1940s, the Lese were dispersed throughout the forest, with each village usually situated close to a perennial stream or river. Village size ranged from a single family unit (4–6 individuals) to not more than four or five families (20–30 individuals). Each family lived in a circular or rectangular lattice work house constructed of saplings bound with vines, and tiled on the roof and sides with large *Marantaceae* leaves (Schebesta, 1933, 1936; Schweinfurth, 1969). Patriclans lived in discrete areas within the forest, with acknowledged title over the land. Internecine conflict was reportedly common (Waehle, 1986; Schebesta, 1933) and the walls of houses were often fortified against spears and arrows, with boards made from the split sections of young *Musanga cecropioides* trees—a soft-wood that hardens when dry. In some cases houses were built contiguously in a rough circle, producing a protected social area in the center and only one entrance to defend (Stanley, 1891).

Traditional Lese Horticultural Practices

How did Lese farmers' subsistence practices differ from those of the foragers, and what was their effect on Efe subsistence? As one might expect, the annual cycle of Lese activity would be tied to the needs of preparing and cultivating fields, rather than to tracking the availability of spatially dispersed forest resources.

Traditionally, each Lese clan held tenure over a certain region of the forest, and although the location of villages was changed episodically, clans tended to remain within their own sections of the forest. Resources such as mature forest, springs and rivers were the common property of all members of the clan. However, once a piece of land was cleared by a family within the clan, members of that family retained the right to use the land unless they stated explicitly that they were no longer interested in it. At that time, the land once again would become the common property of the clan.

Although precolonial agricultural practices of the Lese are not known with certainty, interview data and recent observations suggest the following scenario for the annual cultivation cycle.

Each year, during the heavy rains of October to December, all adult males would search within the clan's usufruct for a new area to clear for cultivation. Fields were selected according to the absence of sand in the soil (high proportion of humus), the ease with which small saplings could be uprooted, and the presence of Sini (*Ataenidia conferta*), a Marantaceae herb; these criteria were reported to be characteristics of fertile areas. If several suitable areas were found the Lese would pick those areas closest to the village or to the previous year's fields, thus minimizing travel distance and the need to clear new trails (Wilkie and Finn, 1988). In general, a section of mature/uncut forest or post-cultivation successional forest that was at least 15–20 years old would satisfy these criteria.

Starting in November, understory vegetation was cleared using small machetes and axes.[10] Once understory saplings, small trees, and herbaceous vegetation were cleared, work began on the large canopy trees. Canopy trees in the Ituri are often 100–150 feet tall with buttresses that extend from the ground to about 15 feet up the bole (Germain and Evrard, 1956; Lebrun, 1936; Lebrun and Gilbert, 1954). To help cut these down, farmers constructed vine and sapling scaffolds at the top of the buttress. As work progressed on the largest trees, smaller ones in its fall zone were partially cut, with the hope that the weight of the large tree would topple the rest as it fell.[11] Tree cutting is likely to have continued through the month of December. This coincides with the beginning of the Ituri's only dry season, where rainfall diminishes or is absent from January to March (Bailey and Peacock, 1988). Once the trees had been felled, major branches were pruned and banana suckers/sprouts planted among the debris. The cleared field continued to dry until just prior to the onset of rains, at which time it was torched. Burning was seldom complete, and soil temperature never became very high, so the preplanted bananas were scorched but not killed (Lacomblez, 1918; Miracle, 1967). At this stage further pruning and reburning often occurred and planting continued. Bananas, several varieties of yams, colcasia, a climbing curcubid grown for its seeds, and several varieties of cassava grown primarily for their edible leaves were intercropped (Lacomblez, 1924). Sesame was often planted in pure stands beside other crops, or in cleared areas near the village.[12] Weeding in traditional Lese

[10]Interviewees repeatedly noted that the Lese were once able to smelt iron from local ore. Although this skill has apparently been lost, many Lese still hot-work metal tools on charcoal fires fanned by ingenious leaf bellows attached to clay tuyere that funnel the air to the center of the fire.

[11]The Lese technique of "serial toppling" is common among all tribes in the Ituri. As this was apparently one of the most important methods used by stone-axe wielding farmers (Colchester, 1984) the Lese may have entered the forest prior to the advent of iron tools.

[12]It is interesting that sesame was reported to be an important traditional crop of the Lese because its cultivation is primarily associated with horticulturalists like the Zande and Mangbetu (De Schlippe. 1956) who inhabit the savannas north of the Ituri. This may confirm that the Lese were practicing horticulture in the savannas relatively recently, or that communication networks with the savanna horticulturalists existed throughout their occupation of the forest.

fields was reported to be minimal, as the weed seed bank in uncut or old successional forest was small. Most crops were harvested as they ripened over the 12–18 months subsequent to burning. Bananas, with some minimal tending, were expected to continue to clone and produce fruit for 3–5 years. Gradually as fields became less productive they were tended less frequently and were recolonized by successional herbs and shrubs. Stump resprouting often quickly reestablished the woody vegetation.

Important Factors Associated with Traditional Farming Practices

The annual clearing cycle, with bananas being harvested up to 5 years after planting, must have served as an effective risk-management system. Failure of a year's crop through the vagaries of weather or pests may have been somewhat offset by the existence of several spatially separate fields that harbored, at least, the remnants of previous banana crops. Bananas might therefore have acted as a living larder for the Lese. Oil palms and raphia palms which are not exploitable until 4–7 years after planting might also have contributed to an hedge on crop failure, with the Lese consuming the oil rich fruit, or sweet fermented sap. However, Schweinfurth (1969) reports that neither oil nor raphia palms were common among the Lese, and that tapping of raphia palms was supposedly unknown until introduced by the Arabs in the late nineteenth century. Bitter cassava may remain in the ground for 18–24 months and is used as a living larder by farmers in rainforest Central African Republic. The Lese plant only sweet cassava which becomes woody and inedible 6–12 months after maturation and is therefore less effective as an old field food source.

Traditional Lese crops, specifically bananas, are well suited to cultivation in fields cleared from mature forest or late *Musanga cecropioides* secondary forest. Bananas, although able to grow in relatively poor nutrient conditions, prefer high organic soils, and if planted in such will continue to clone and produce substantial fruit heads for several years (Martin, 1984). In addition, the use of mature forest, with its characteristically small weed seed bank, minimizes competition with crops for soil nutrients, and reduces labor required for weeding (Miracle, 1967; Vasey, 1979). Another factor associated with the traditional Lese practice of clearing mature forest: most of the curcubids and yams grown for their oily seeds or starchy tubers are climbers and use the fallen trees as support. Without an extensive network of unburned trees and branches, much of the gourd crop would rot on the ground. The Lese, unlike other forest farmers (Vansina, 1990) apparently did not build sapling lattices upon which the yams could climb.

Both planting and harvesting of these traditional crops is relatively non-synchronous. Crops are planted episodically during and after field clearing. Similarly, crops are harvested according to need, and as plants mature. Thus, horticultural labor costs are spread over the productive life of the field. This is very unlike the labor intensive synchronous planting and harvesting associated with the commercial monocultures of temperate agriculture.

Traditional Lese horticulture was most likely characterized by: (1) a long fallow system that ensured restoration of soil nutrients; (2) high labor costs only during the brief months associated with field clearing; (3) asynchronous planting and harvesting of crops over the productive life of the field; (4) access to several spatially dispersed fields in various stages of abandonment that were still yielding bananas for up to 5 years after planting; and (5) production of climbing crops such as the curcubids and yams that depended upon unburned trees and branches for support.

Use of Forest Resources by Lese Farmers

Traditionally the Lese also made use of forest resources to supplement their cultivated foods. Fish and crustaceans were captured with woven fish traps, dams and traditional poisons (*Tephrosia vogelii*), and bushmeat was trapped using *Raphia vinifera* vine snares. Limited foraging for fruits, tubers (*Dioscorea* spp.), nuts (*Irvingia* spp., *Ricinodendron heudelotti, Fagara macrophylla*; the latter was used as a source of cooking oil), etc. also occurred.

Impact of the Establishment of Agriculture on the Efe Foragers

What were the new subsistence opportunities available to Efe foragers with the establishment of farming in the Ituri? As a diet low in calories will adversely affect the fecundity of Efe women, increasing access to carbohydrates and fats would have accrued fitness benefits to both Efe men and women. Thus, farmers' fields with their high density of calories relative to the forest were likely to have constituted potentially profitable new foraging patches for individual Efe.

Bananas, the traditional staple of Ituri forest farmers (Lacomblez, 1924), mature throughout the year and can be stored for several days prior to consumption. Bananas are thus a transportable, more predictable, less seasonal source of carbohydrates than most of the wild foods foraged by the Efe (Hart and Hart, 1986). In addition, unlike many wild sources of carbohydrates that contain physical and chemical anti-herbivory defenses

which require considerable processing to remove, bananas have no such mechanisms and they are easily processed. We might therefore predict that cultivated crops quickly would become favored foods, and that farmer's fields would constitute a preferred foraging patch for the Efe.

How might the Efe have obtained these new carbohydrate resources? Three options were open to them: (a) become farmers; (b) steal from the farmers; (c) trade with the farmers.

At low population densities adoption of farming by individual Efe would be unlikely. Why would the Efe incur the learning cost associated with adoption of a new subsistence practice when other less costly ways of obtaining cultivated crops are available?

Travel and search costs associated with stealing cultivated crops from farmers' fields were likely to be considerably less than those associated with gathering dispersed, patchy forest resources, and processing costs are certainly less for cultivated carbohydrates. Thus, the proximate costs of theft were likely to be quite low in comparison to the cost of gathering. However, theft would be tolerated by the farmers only up to the point where the costs to increase production equal the risk associated with defending the resource.[13] If a Lese was dependent almost solely on the cultivated crops within his own fields for subsistence, whereas an Efe could raid several fields and gather in the forest, it is reasonable to expect that a Lese would be willing to risk more to protect his crops than the Efe would be willing to risk to steal them. Thus the ultimate costs of stealing would be higher than the proximate costs, but they would still likely be lower than those associated with gathering.

What did the Efe have available to trade? As the packet size of currently foraged items is variable and often quite large (Bailey, 1985; Tereshima, 1983; Wilkie, 1987, 1989a,b), occasional surpluses were likely to have existed that could be traded for cultivated crops. Efe women could also trade labor or sexual favors.[14] Although the proximate costs of trading were likely to have been higher than those of stealing, the risk involved in the latter would suggest that an equilibrium would have developed where the Efe would have differentially employed both methods of procuring cultivated carbohydrates from the farmers. Thus, the Efe would been expected

[13]Schebest (1933, p. 214) notes that "the pygmies plundered the banana plantations . . . with the result that on this score alone many fierce encounters took place between the races."

[14]Efe women (and men) presently work in Lese fields during labor intensive periods such as clearing. Lese oral histories say that Efe exchange labor started only as recently as the colonial period. Although it has not been empirically shown that Efe women trade sexual favors for access to cultivated crops, many Efe women do leave the camps to live in villages and eventually marry Lese men (Bailey, 1985; Tereshima, 1987). This may be motivated by the higher availability of carbohydrates in the village.

to have stolen *and* traded for cultivated crops. Based on oral histories and direct observations this is exactly what the Efe did, and still do.

Ready access to carbohydrates was probably the most important consequence of the invasion of the forest by horticulturalists, at least as far as Efe womens' workloads were concerned. Yet, if occupation of the forest by farmers coincided with the advent of iron making technology, Efe men and women would have been able to replace their stone tools with those forged by the Lese. Although no direct evidence exists in this case, we can be fairly sure that the efficiency of any activity in which stone tools were replaced by iron implements would be enhanced (Carneiro, 1979; Salisbury, 1982). Increased hunting/foraging efficiency would probably have allowed Efe men to increase the surplus they had available for trade, and would have reduced the time Efe women spent foraging. Both of these factors would, as previously suggested, most likely have had cybernetic impacts on subsistence practice, the exchange relationship, and population size and distribution.

For the Efe, the most significant result of trade with the Lese would likely have been an increase in population size and a reduction of nomadism. Once the Efe population had grown beyond what could be sustained solely from foraging forest products, they would have become dependent on trade with the Lese for subsistence and could not expected to go back, en masse, to a foraging lifestyle.

Willingness of the Lese Farmers to Trade with the Efe

Although the Efe had much to gain from trading with the Lese, why would the farmers have wanted to provide cultivated crops, iron implements, and pottery to the foragers? Willingness to trade depends on whether there was a demand among the Lese for Efe trade items, and what the costs of not trading might have been.

If the Lese did not trade with the Efe, the foragers would undoubtedly have raided the farmer's fields. Theft of cultivated crops by the Efe was a source of strife in the past (Schebesta, 1933) and is still a component of the present day forager–farmer relationship. By not trading, the Lese would have incurred the costs of lost production and of investment in defense, yet would have gained no obvious benefits. Thus, one would predict that not trading would have been an unlikely strategy for the Lese.

Cultivated crops that characterize agriculture in rain forests throughout the world tend to be high in carbohydrates but poor in protein, fat, and essential vitamins and minerals (We Leung, 1968). It is therefore possible that forest resources such as meat, insects, honey, fruits, and nuts

might have constituted important dietary supplements for the Lese, and thus would have been in demand. However, the Lese traditionally used a variety of leg and neck-hold snares, dead-falls, and spear traps to capture forest antelope, primates and birds, and would thus only be likely to trade for meat if the cost of trading was less than the cost of trapping.

Although it is possible that protein acquisition for the farmers was less costly through trade than through trapping,[15] we believe that the farmers either were: (1) merely tolerating the exchange system, as it incurred lower costs than not trading; (2) employing Efe labor during peak times in the farming cycle to compensate for crop production loses; or (3) including reproductive access to Efe women in their decision to continue trading despite higher subsistence costs.

Other Consequences of Trade Between Foragers and Farmers

Although speculative, it is likely that once the nomadic foragers began to trade with the much more sedentary farmers, diseases associated with sedentism became much more prevalent among the Efe (Cohen, 1975, 1977). Intestinal parasites, malaria, schistosomiasis, and scabies are a few of the diseases whose incidence might have increased among the Efe. How severe an impact they had on Efe health is difficult to assess, when at the same time Efe dietary sufficiency was changing. Regardless, the spectrum of diseases that afflicted the Efe probably increased as a consequence of contact with the Lese.

CHANGES ASSOCIATED WITH THE ARAB SLAVING PERIOD

During the latter half of the nineteenth century, Arab traders/slavers made increasing forays into the savannas north and south of the eastern sections of the Congo Basin forest (Gray, 1961; Schweinfurth, 1969). With the aid of the Mangbetu, slaving and ivory raids expanded into the forest. Although the Arab influence in the region was short-lived, spanning from the 1850s to the 1890s when slave traders were crushed by the army of the Congo Free State led by Baron Dhanis (Johnston, 1913), they had a profound impact on the demography, economy, and language of the Ituri. The Arabs brought the Swahili language with them, from which developed the KiNgwana dialect, which was used to communicate with the linguistically varied tribes of the area. Advent of a trade language, when coupled with access to trading routes, would have substantially opened up the region to long distance exchange of commodities and ideas. New hut designs and village arrangements were introduced, as were firearms and several new crops *inter alia*: rice, peanuts, beans, lemons, tobacco, and avocados (De Schlippe, 1956; Lacomblez, 1924; Van Geluwe, 1957). Miracle (1967) comments that "little is known about the Arab's methods of establishing new crops, but in some instances they used coercion to effect the adoption of rice." This contention is supported by Tharin (1915) and Hargot (1955), who worked in Arab occupied forests and savannas south of the Ituri. Tharin (1915) also credits the Arabs with introducing palm oil extraction and distillation. During this period, the Efe were used extensively as guardians/watchmen for the Lese, forewarning them of the approach of strangers.

[15]The Boyela farmers of the central Congo Basin do not have an exchange relationship with sympatric forest foragers. In order to obtain protein they set snares proximal to their villages and organize bow hunting trips that often last 4–6 weeks (Sato, 1983). Although it is difficult to determine whether game densities and hunting techniques are equivalent to those available to the Lese in the Ituri, it does show that at least in some sections of the Congo rain forest ecosystem farmers are capable of supplying their own bushmeat.

THE BELGIAN COLONIAL PERIOD

As soon as Henry Morton Stanley traversed the region between 1875 and 1877, changes in traditional subsistence practices of the indigenous population began to accelerate. With the creation of the Congo Free State in 1884, the roadless terrain of the Ituri was extensively exploited for wild rubber (*Landolphia* spp. and *Funtumia elastica*), and ivory. This and the subsequent establishment of the Belgian Congo in 1908 signalled the beginning of an ever-increasing European influence on Lese subsistence practices.

The dispersed settlement patterns of Ituri forest horticulturalists were considered "a hindrance to the development of *permanent* villages and towns, central political bodies, advanced societies, and *an agriculturally based market economy*" (Ruthenburg, 1976; Anonymous, 1949). Belgian colonial policy (1920s–40s) resulted in the resettlement of forest farmers, such as the Lese, alongside roads that were built with their labor.

Impact of the Colonial Period on the Lese

From 1908 to 1933, the Belgian government under the Colonial Charter attempted to provide "native autonomy" by recognizing traditional chiefs as legitimate agents of local government in the colony. However, the Belgians had great difficulty in balancing the goals of indirect rule with

the realities of direct administration. As a result, in 1933, the Belgians reorganized the colony's administrative structure, creating regional chiefdoms as part of a new hierarchical political structure, designed to coordinate extraction of wild rubber, development of a road infrastructure, and planting of new crops for external markets. These new chiefdoms reflected an external rather than internal political structure and de-emphasized the importance and power of the traditional chefferie (chiefdoms). The new political structure with Belgian rules and regulations enforced by a police force recruited from farmers rather than foragers established the political dominance of the Lese over the Efe.

Once moved to permanent villages on the roads, the Lese were forced to plant crops such as cotton and peanuts (Leplae, 1929, 1933). These new market crops were grown for sale to the state as export items and to feed the Congo's growing urban populations (Anonymous, 1949).

Enforced resettlement and planting of "les culture obligatoires" had a profound effect on Lese farming practices and subsistence economy. Population density must have changed dramatically as dispersed villages were resettled along the three roads that traverse the forest (Fig. 1). Farmland previously selected by the Lese and passed on from generation to generation within the same patriclan was now selected, *de facto*, by Belgian engineers who were more interested in determining the best routes for road construction.

Introduction of cotton, rice, and peanuts as market crops most likely resulted in increased labor costs, seasonal labor shortages, and the shortening of fallow periods. According to the Lese, the larger fields necessary to produce crops sufficient for both subsistence and market production led to Efe employment from November through January of each year to help clear the fields. Labor demands for clearing larger fields also reportedly resulted in a shift from cutting labor expensive mature or old/fallow forest to clearing much easier shrub/fallow vegetation.[16]

The shift from old to young fallow fields results in an increase in weed growth, and must have been associated with higher weeding costs (Miracle, 1967; Vasey, 1979). The reduced humus and nutrient content of short fallow fields also affects banana productivity, such that they are only able to clone and produce for 1 or 2 years (Martin, 1984). Low soil fertility,

[16]The shift to creating fields from shrub/fallow vegetation may also have been in response to the introduction of peanuts. Peanuts produce a subterranean indehiscent pod attached to a well-developed lateral root system. Once ripe the pods are extracted from the soil by drawing on the sensescing surface stems. If peanuts are planted in fields cut from mature or old/fallow forest the root mat snags most of the subterranean pods making harvest losses excessive. Peanuts must therefore be planted in old/fallow forest fields that have already undergone one years cultivation, or in fields cleared from 3–5 year-old shrub/fallow vegetation both of which have a loose friable soil with either a decomposed or poorly developed root mat.

associated with clearing young fallow vegetation, is likely to have resulted in a progressive shift from bananas to cassava as the staple starch crop. Cassava is more tolerant of poor soils, and although the tuberous roots can remain in the soil for some months, they become progressively fibrous, and the parent plant does not clone for extended production like bananas. It is certainly possible that reduction in banana productivity and an increased reliance on sweet cassava greatly diminished the Lese's living larder and hedge on periods of food shortage. This shift in major crop may contribute to the nearly annual hunger season experienced by present day Lese (Jenike 1989), which was apparently unheard of in the past.

Unlike traditional staples such as bananas and cassava, crops such as rice and peanuts require the storage of seeds for subsequent planting (Johnston, 1958). Cultivation of these crops demands the construction of containers, and pest and rot-proof storage areas to preserve the seed. During periods of food shortage, rather than being able to depend on the extended production of cloned bananas, the Lese at present often have to eat part of their seed stores. The lack of a traditional hedge on food scarcity produces a cycle of moderate crop failure, food shortage, consumption of stored seeds, subsequent reduction in field size and crop yield, which lead back to food scarcity (Jenike, 1989; Martorell and Arroyave, 1988; Miracle, 1961; Ogbu, 1973; Pagezy, 1982). The prevalence of this cycle is difficult to assess, although since 1980 shortages of varying severity have been evident each year. Each period of food shortage results in consumption of stored seeds, and reduces crop production in the subsequent year (Jenike, 1987; Kumar, 1988).

Just as market cultivation placed heavy demands on available labor during field clearing, so too did the synchronous planting and harvesting of cotton, rice, and peanuts (Fox, 1953). The Lese once again found it necessary to employ the Efe to assist in these short-duration, seasonally labor-intense activities.

Impact of the Colonial Period of the Efe

Resettlement of communities dispersed throughout the forest to permanent villages bordering a few roads is likely to have caused an increase in local population density. This would have reduced the area in which an Efe band could forage while still avoiding conflict with proximal groups. Assuming that the Efe still desired to retain access to cultivated crops through trade, a reduction in foraging area or exclusive use of a foraging area likely would have resulted in increased hunting pressure within the area. As empirical data have shown that more intensive hunting surround-

ing permanent settlements causes local changes in game diversity and density (Wilkie and Finn, 1990),[17] we might expect the Efe to have obtained a tradeable surplus of meat less frequently. Therefore, while the Efe were likely pursuing a way to maintain their supply of cultivated crops as foraging became increasingly costly, the Lese were probably seeking a way to increase their labor force. It is not very surprising that at this historical juncture, the Efe, and Efe women in particular,[18] reportedly began working more regularly as field laborers.

Incorporation of field labor as a regular, daily exchange item would have changed the constraints of Efe subsistence to something more like that of the farmers, as Efe costs became more labor, and less natural resources limited. It would also have further diminished the importance of forest resources in the diet of both Efe and Lese, and conversely placed cultivated crops at a new level of importance in sustaining both foragers and farmers.

Advent of a Monetary Economy

Although market cultivation certainly must have increased the annual workload of both Lese and Efe, the returns on that investment came largely to the Lese, who sold and were thus paid for the crops. While the advent of market cultivation infused substantial amounts of cash into Lese households, this was not the case for the Efe. Rather than receiving cash for their contribution to the market economy, Efe field labor simply replaced traditional forest commodities in the exchange relationship with the Lese. Thus, whereas the Lese were able to purchase commodities such as cotton cloth, cookware, tools, salt, and soap that were previously unavailable in the region, the Efe were only able to obtain these items through the "largess" of the Lese. Therefore the Lese not only had control over 60% of the Efe's annual calories (Bailey, 1985), they also monopolized all the new commodities that appeared with the advent of the cash economy. Efe dependence on the Lese therefore must have concomitantly increased as a result.

[17]Bahuchet and Guillaume (1983) document a similar transition for the Aka of the CAR: decreased nomadism, foraging from village rather than forest camps, reduction in the travel distance and duration of hunting trips, an increased dependence on agricultural crops in the diet, a decrease in "big game," and a focus more on small duikers, rodents, and porcupine (see also Eder, 1978, 1984).

[18]Efe women have the most to gain from all types of trade that might secure a reliable supply of palatable carbohydrates, as gathering carbohydrates was traditionally their responsibility (Peacock, 1985).

Impact of the Exchange Relationship

The dramatic changes in settlement patterns, population density, subsistence behavior, and market economy that were a consequence of Belgian colonial policy must have had an equally profound impact on Lese and Efe dependence on exchange. Although Lese farmers required the labor input of the Efe in order to clear and cultivate the much larger fields associated with market production, they were also the primary beneficiaries of the financial and material profits from commercial agriculture. The Lese, maybe for the first time, were gaining substantially from the exchange relationship. The Efe on the other hand, were rapidly moving toward a position of servitude, being dependent on trade but having little control over the value of their major trade item, labor.

As foraging forest foods became more expensive as a result of resettlement, the Efe would have had to depend more on labor as an exchange item in order to secure a reliable supply of cultivated carbohydrates, which by now were essential dietary items. However, labor inputs by the Efe were not rewarded with profits from the new monetary economy; they continued to be paid by the Lese with traditional commodities such as food, cloth, and implements. The Belgian colonial period therefore saw a rapid divergence of the forager's and farmer's access to labor saving and prestige commodities.

The financial solvency of the farmers and advent of a regional system of taxation further placed the Lese in a position of power over the Efe. As the Efe were unable to pay the annual "hut"tax, their Lese exchange partner would do so. This effectively indentured the Efe to their partners until the debt was paid off. The Lese could, of course, establish a repayment schedule so as to keep the Efe permanently in debt, and thus constantly obliged to them.

The Belgian colonial period resulted in a dramatic shift in the wealth of the Ituri's foragers and farmers, and the relative benefits of the exchange relationship. The Efe were no longer merely taking advantage of Lese cultivated crops as a more economical source of carbohydrates, they were by now dependent on them for daily subsistence, and thus were effectively indentured to the Lese. The Lese, conversely, were now profiting monetarily from the relationship, and had attained considerable political power over their exchange partners.

POST-INDEPENDENCE AND HENCE

The years that followed independence in June of 1960 were rife with political unrest in the capital in Kinshasa, and economic and social turmoil

in the Ituri (Young and Turner, 1985). The Simba secessionist rebellion that swept through the Ituri in the early 1960s resulted in the disruption of food production, as farmers fled into the forest and village seed stocks were pillaged. Nationalization of businesses in 1972 precipitated a decline in the market economy and the further demise of the rural infrastructure (Kikassa, 1986).

How did this affect the Efe and Lese subsistence, and how did it alter their exchange relationship? Decrease in the market economy meant that it was no longer necessary or astute for the Lese to cultivate rice or coffee at a colonial scale. Lese labor requirements and income dwindled, as did the value of Efe labor. Yet, even in the absence of a market economy, the Lese neither returned to their historical forest interior villages nor reverted to traditional, pre-colonial cultivation practices that focused on banana production.

Impact on Lese Subsistence

How have the last 20 years affected the Lese farmers? The gradual collapse of local and regional agricultural markets for cotton, rice, peanuts, and most recently, coffee, have certainly changed the cultivation practices, workload, and income base of the Lese. Cotton cultivation was abandoned almost as quickly as the market foundered. This is not surprising, given the intensive labor required for cotton farming, and how returns for those labor inputs are only obtained through its sale. Conversely, although markets for rice and peanuts no longer exist, most Lese continue to cultivate subsistence quantities of both crops. As production of upland rice is usually 1/2 to 1/8[19] of that expected from plantains or cassava (Tshibaka, 1989), continued cultivation of this crop may be a component in the annual hunger season experienced by the Lese (Jenike, 1989). Peanut cultivation may, as already mentioned, promote the clearing of early fallow vegetation, with a concomitant reduction in overall production. Peanuts are, however, a good source of protein and oils, both of which are otherwise scarce in the Lese diet. Agricultural sources of protein, such as peanuts, are likely to become increasingly important to the Lese, particularly if the Efe switch to farming, leaving fewer full time foragers to secure tradeable surpluses of bushmeat.

Coffee, once cultivated only on large plantations, is now produced primarily by "petite-planteurs" who manage small fields of less than one

[19]Outputs of crops in forested regions of the Zairean Basin in kilograms of cereal-equivalents/hectare were: rice = 902; maize = 1121; cassava = 7673; and, plantains = 1665. Cereal equivalents were calculated using the following conversion factors: 1.00 for maize-grains, 0.60 for rice, 0.303 for cassava, and 0.22 for plantains (Tshibaka, 1989).

or two hectares. Although a few Lese still grow coffee, the majority of these "petite-planteurs" are Nande, Bira, or Budu entrepreneurs, who have moved into the area and bought and renovated portions of abandoned plantations. A growing number of small coffee holdings are worked by Lese and Efe laborers who are employed by non-Lese managers who, in turn, oversee the plantations for absentee owners. The collapse of agricultural markets has almost eliminated the cash economy which flourished during the colonial period. Lese are able to make money by offering their labor to coffee entrepreneurs, or by selling items such as snared gamemeat or palm wine, at an intermittent local market. Lack of money has made commodities such as salt, soap, metal cookware, and cotton cloth highly coveted. These are now luxury items for the Lese, and are generally unobtainable by the Efe. As a consequence, possession of these luxury items is often hidden from relatives and from members of other villages and camps.

Impact on Efe Subsistence

At this juncture, Efe foraging costs were high as a result of increased local population density and concomitant competition for limited resources. In addition, because of the reduction of banana cultivation and the declining value of their labor, the Efe may have been at much greater risk of a serious annual food shortage. The Efe are particularly vulnerable when Lese field crops fail or are scarce, because existing food is often stored in protected areas from which it cannot be easily expropriated. The Lese, of course, will also preferentially feed themselves, and may thus renege on long-term exchange obligations with their trading partners. Surprisingly, although the Lese show clear weight loss during hunger seasons (Jenike, 1989), Efe body weights show little change at this time. When food is short in a given area, the Efe are apparently able to maintain their dietary intake by increasing their forest foraging activities, and perhaps more importantly, by shifting their trading allegiance to those villages that still have a reasonable supply of food (Jenike and Bailey, 1989).

In order to reduce the variance in carbohydrate availability, we might expect to see the Efe switch to farming as the most economical and reliable means of obtaining cultivated carbohydrates. In fact, in the last 8 years, many Efe groups have indeed started to clear their own fields. This switch to farming further constrains their ability to exploit forest resources that are seasonally available, and patchily distributed, and thus continues the long trend toward dependence on cultivated crops for the majority of their diet. Switching to farming also places the Efe in direct competition with

the Lese for prime agricultural lands. The consequence of this, although difficult to assess at present, might be surmised by reference to Headland's work (Headland, 1986; Headland and Reid, 1989a,b), which shows that Agta forager/farmers are very often displaced from their recently cleared fields by co-resident Palanan farmers. Whether the Lese will demonstrate such despotic behavior remains to be seen.

Impact on the Exchange Relationship

How has the exchange relationship responded, over the last 20 years, to the decline in market economy, and the return to subsistence level production? Once again, the relative reliance of the Efe and Lese on the exchange relationship has changed.

Many Efe are investing their labor into growing their own cassava and plantains, reducing labor available to the Lese, and perhaps affecting Lese field productivity. As more Efe begin to clear and cultivate fields on a regular basis, dependence on Lese for carbohydrates will decline, not only for the Efe cultivators themselves, but also for other foragers who may now trade within their kin group rather than with the Lese. The ability of Efe foragers to obtain carbohydrates from within their kin group will reduce the amount of meat and forest products that are available for trade with the Lese. The Lese may therefore have to make up the resulting protein shortfall through trapping or through greater reliance on cultivated sources such as peanuts and beans.

Interestingly, although cultivation of carbohydrates may lower Efe reliance on the Lese at some level, those Efe who have cleared and cultivated fields typically have done so with the permission and within the usufruct of their Lese exchange partner. How the "leasing" of secondary forest to Efe cultivators contributes to the modern exchange relationship has not yet been established. Overall there appears to be a shift toward the Efe becoming more economically independent of the exchange relationship. Whether progressive economic independence will result in social independence remains to be seen. In the Dzanga forest of southwestern C.A.R., BaAka pygmies not only cultivate sufficient crops to meet their subsistence needs but produce a surplus that they sell to workers at the local logging company. Yet, this economic independence from the bilos (villagers) has not brought with it social equality, as the BaAka are still considered second class citizens both at the local and state level, are less well educated than their bilo neighbors, and have no decision-making power in community organizations dominated by bilos (Sarno, personal communication).

CONCLUSION

Lese farmers and Efe foragers of Zaïre's Ituri Forest have engaged in a dynamic social, political, and economic relationship for perhaps 2000 years. Much as development of new genotypic characteristics constrains future evolutionary pathways, the historical relationship between Efe and Lese has determined, in part, what subsistence choices are available to individuals in the present. By gleaning information from direct observations and a variety of written and oral sources, a largely hypothetical chronology of changing subsistence options and practices has been offered that demonstrates how present subsistence behavior of the Ituri's foragers and farmers is a function of past decisions.

Zaïre continues to struggle with self-determination, causing considerable political and economic turmoil. Moreover, the recently established Okapi Wildlife Reserve will impose wide-ranging resource exploitation restrictions on the inhabitants of the Ituri Forest (Curran, 1992). Understanding the historical relationship between Efe and Lese, the social, ecological, and economic constraints they are facing, and the subsistence decisions they have made and are still making, is essential if development aid associated with Reserve management is to be delivered effectively and equitably.

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