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FICUS SYCOMORUS FRUIT PRODUCTION IN A SEMI ARID LAND IN NORTHERN KENYA: IMPLICATIONS FOR UNDERSTANDING A POSSIBLE FOOD RESOURCE OF EARLY HOMINIDS

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ABSTRACT Food production of riverine forest in semi arid land, or patchy vegetation in northern Kenya is much needed for discussing the habitat of early hominids. This study aims to estimate the fruit production of *Ficus sycomorus* along the Baragoi River in Nachola and Baragoi, northern Kenya, possible source for the Pliocene australopithecines. As the largest fruit producer in the forest, the population of *F. sycomorus* in this riverine forest is counted and the Basal Area of all individuals measured. The number of fruits and their weights are also measured. The total production can be estimated to know the carrying capacity of this forest. The energy yielded by *F. sycomorus* of this population calculated is at least 74,500 kcal per day. This amount of energy suggests enough for a small group of early hominids during the period of food scarcity.

Key Words: Arid land; Carrying capacity; *Ficus sycomorus*; Fruit production; Pliocene hominid; Riverine forest.

INTRODUCTION

Early Pliocene hominid habitats are known as open vegetation with seasonal fluctuation (Bonnefille, 1995; Macho *et al*., 2003; Wynn, 2000, 2004), where food availability is the key for sustaining their population, especially during periods of food scarcity. While many studies estimated diets of Pliocene hominoids, little study discussed keystone or staple foods of those hominids from extant plant ecology in semi arid land (Sept, 1984).

Ficus sycomorus, which has been known as the biblical sycamore fig (Noad & Birnie, 1989), is distributed from the African continent in the south (Palmer & Pitman, 1972) to the Arabian Peninsula (Muscher, 1912; Zohary, 1966) in riverine forests of arid and semi-arid areas. In East Africa, this species is distributed widely at altitudes from sea level to 1850 m (Dharani, 2002). The genus has 900 species in the tropics and sub-tropics of the world with a wide range of habit from tree to shrub, lianas and epiphytes (Janzen, 1979).

Makishima (2005) found that *F. sycomorus* is the most abundant fruit supplier for frugivorous animals in the riverine forest in the semi arid land of Nachola, northern Kenya. It is known that chimpanzees use *Ficus* spp. as a fallback and/or food during the period of fruit scarcity (Furuichi *et al*., 2001). Vincens (1987) reported *Ficus* pollen from the Turkana Basin of Plio-Pleistocene. *Ficus* fruits are available all the year round in Afirca fruiting 3-5 times per year (Kinnaird, 1992; Palgrave, 1988; Wharton *et al.*, 1980). This suggests that *Ficus* could have been a keystone or staple food of early hominids living in semi arid land. However, the productivity of *Ficus* in semi arid land has not been investigated. Thus, here I report data of *Ficus* production in the riverine forest in Nachola.

MATERIALS AND METHODS

Nachola village and Baragoi town is in the El Barta Plain, East of the escarpment of the Rift

Fig. 1. Riverine forest along the Baragoi River. Darker, rounder crowned trees are *Ficus sycomorus*. Flat crowned are *Acacia tortilis* ssp. *spirocarpa*.

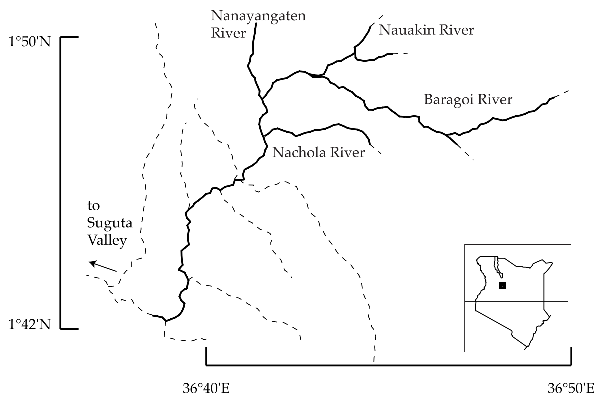

Fig. 2. Site of this study. Inset map shows Kenya and the equator. Solid lines are rivers of intensive study, dotted lines are other tributaries.

System in Northern Kenya, altitude ca. 1200 m (Makishima, 2005). The Baragoi River is the major drainage river of the plain but flows only after heavy rains. Annual rainfall is 520 mm averaged from 1980 to 2000. Two rainy seasons and two dry seasons are apparent in most years, but the wettest month and the intensity of the rainfall are quite unpredictable (Makishima, 2005).

Vegetation of this area is reported elsewhere (Makishima, 2005), which is composed mostly of open vegetation with Labiatae spp. dwarf shrub settled in flat lands, and secondly major is riverine forest with *Acacia tortilis* ssp. *spirocarpa* (Mimosaceae) and *Ficus sycomorus* of this study. In some locations along the river, *F. sycomorus* is dominant in the plant community (Fig.1), and it produces the greatest amount of fruit.All fig trees along the Baragoi River from Nachola upward to Baragoi over a distance of 35 km, were measured except trees lower than 50 cm (Fig. 2) in August to September 2002, at the end of the dry season. The coordinate of each tree was measured by hand held GPS. The Girth at Breast Height (GBH) larger than 10 cm was recorded to assess the amount of fruit yielded by this population (Fig. 3a). GBH is then calculated into Basal Area (BA), which is considered to represent well relative importance of the tree in the total biomass.

(a) (b)

Fig. 3. *Ficus sycomorus* tree. (a) Stands, along the Baragoi River. (b) The largest individual, next to Nachola village. Two trees may have fused to make one stand.

The words “fertile” and “sterile” refer to the trees, where fertile trees stands for ones with branchlets which are the clusters of short leafless branches for fruits bearing, while sterile trees do not have such organs. Individual fertility is assessed, easily recognized from the existence of branchlets which are specialized branches bearing clusters of fruits (Fig. 4).

Fruit stages were recorded on individual trees. Fruit maturity was evaluated visually by the six grading system (0 to 5); 0: no fruit seen on branchlets, 1: very young and small fruits, 2: young fruits, 3: young fruits, but as large as mature fruits, 4: ripe, yellow and/or orange fruits, 5: few ripe fruits still remaining on branchlets but almost finished. Only individuals • † 60 cm GBH are included in the tree species biomass estimates for fruit availability because they appeared not to produce fruit until they were • † 60 cm GBH. Here sterile trees are classified as stage 0, due to the lack of fruits. “Ripe” and “mature” refers to the fruits which are colored yellow or orange with faint fragrance, soft to the touch and a sweet taste.

The numbers of fig fruits in 18 selected trees were counted from the ground, with the naked eye and hand held counter. These trees were chosen from the fruit stages 3/ 4 for the ease of visual recognition, and also to get a wider range of basal area variation.The last data necessary to estimate the entire production of this *F. sycomorus* population is the weight of fig fruits. Trees which have fruit branchlets accessible for collection from the ground consisted of 55 individuals. Bunches with more than 10 figs were collected, and dried in sisal bags in the wind and/or by the heat of light bulbs until the weight was constant. Weights of all figs were measured.

The fruit production of this fig tree population is obtained from: the BA of each tree, correlation of BA to the number of figs in a tree, and number of fruiting seasons per year.The energy of this fruit is calculated from the nutritional composition, then multiples the amount of fruit to show the total energy supplied by the fig tree population of this area. Nutritional analyses were conducted in Nihon Shokuhin Bunseki Center, Osaka.

RESULTS

F. sycomorus trees are scatted along the Baragoi River, in various sizes and fruiting stages over a distance of 35 km. Six hundred forty-eight sterile trees and 452 fertile ones were measured

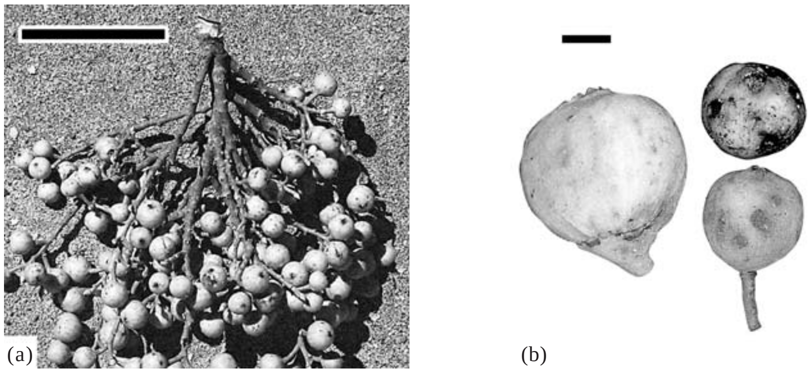

Fig. 4. (a) A fig cluster or branchlet detatched from a trunk. These figs are dried to measure weight and to analyse nutrition. Scale bar is 10 cm. (b) Various fig fruits from different trees. Left is one of the lagest figs, the dry weight of which is more than 2.5 g, others are slightly more than 1 g. Scala bar is 1 cm.

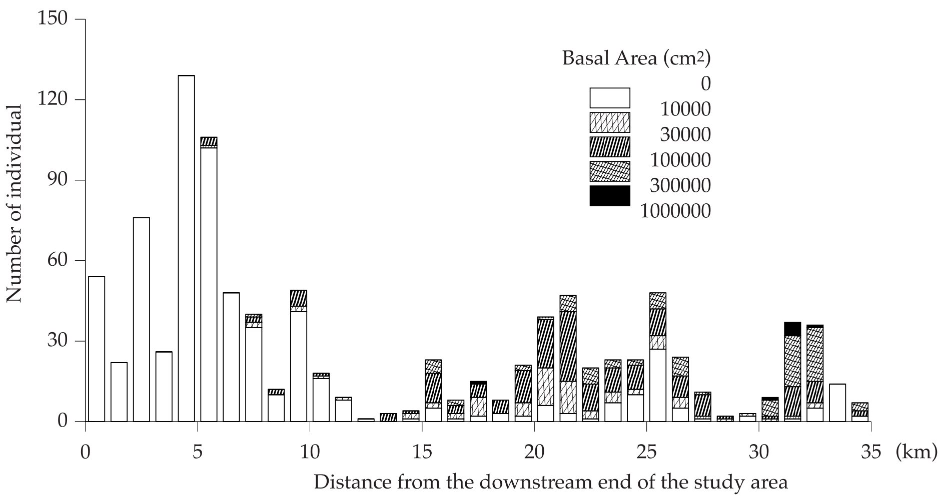

Fig. 5. Size distribution of *F. sycomorus* along the Baragoi River. There are two locations with dense stands of *F. sycomorus*.

(Fig. 5). A technical reason prevented field research east of the point at 1°48’22’’N, 36°49’33”E, though the range of the population extends further northeast in the Baragoi River. All other tributaries had no *F. sycomorus* tree. The only one exceptional individual, found out of the Baragoi River, is 229 cm in GBH, growing at the junction of Nauakin River and one of its tributaries. Environmental restriction of this distribution wholly along the Baragoi River can be explained by the higher level of groundwater than those of other small rivers such as Nachola and Nauakin Rivers, which is necessary for this species. Though any hydrological surveys were not carried out in this region, the Baragoi River certainly has the highest groundwater level in the El Barta Plain, because it is the trunk of the drainage system in this plain, going down to the bottom of the Rift, the Suguta Valley.

Size variation of this population is shown in Fig. 6. Among them, the largest 890 cm GBH, (ca. 280 cm in diameter) is next to Nachola village on the opposite side of the river (Fig. 3b), although the hairs of the fruits from each trunk suggest that more than one seedling fused into a single large standing. Most of large trees occur in two sites in this area, one is next to Baragoi town, the other is just downstream of Nachola.

F. sycomorus trees get mature to bear fruiting branchlets, which attach to trunks and large limbs, when they become 60 cm in GBH (Fig. 4). Sterile trees, especially smaller than 10 cm GBH, are more abundant downstream; on the contrary, near the upper end of the area of the research, most trees are large but dying in more than half of their trunks and limbs. Dying upstream and seedlings downstream suggests that the population of this species is moving downstream. The cause of this phenomenon would be a subject of population ecology.

The sum of BA of this population is 3.87 x 10^7 cm^2, only 0.14 % (5.54 x 10^4 cm^2) is BA of sterile trees (Fig. 6). The biomass contributing to the fruit supply is therefore 3.86 x 10^7 cm^2 BA (Fig. 7).

The distribution of fruit maturity is not significantly different along the river. The chance of finding ripe fig fruits is almost the same throughout the 35 km length of this riverine forest, where fertile fig trees are present (Fig. 8).

The bearing numbers of F. sycomorus tree to the basal area has a significant correlation (Fig. 9), from the result of 18 trees, ranging from 602 cm^2 to 11,800 cm^2 in BA (from 87 cm to 365 cm in GBH): Number of figs = 2.622 x (BA in cm^2) + 1916. The minimum estimate of the weight of one fig is 1 g of dry matter, although it could be heavier according to the weight distribution of ripe figs (Figs. 4b; 10). Thus, the production of fig of this forest is then estimated to be 101,211 kg dry weight if these trees make fruits once a year. This figure refers to the sum of the fruit quantity of all trees when each tree becomes stage 4.

The nutritious composition of fig fruits and energy calculated are shown in Table 1. As it is an ordinary juicy “fruit”, fig of *F. sycomorus* is rich in nitrogen-free extract (48.5 %, i.e. sugar and starch). The energy supplied by fruits of this species is then calculated to be 2.71x10^7 kcal per year in total from the above fruit production.

DISCUSSION

Sept (1984) shows an assumption of the daily energy requirement of early hominids: adult male 2000 kcal, adult female 1500 kcal, child and infant 1000 kcal. The average energy supply of the figs is 74,500 kcal per day in this forest, which can theoretically sustain 37 adult males on caloric basis. It is apparent, however, that this estimation is quite rough neglecting several important factors, which may affect either overestimation or underestimation. Although figs are available all the year, there is seasonal variation of fruit production. According to the local people, the major fruiting season is November and December. The estimated production seemingly represents a medium value and it should be fewer in a few months of a year. Large quantities of fruits are left uneaten by animals as many fruits drop off naturally to the ground. Interspecific competition with other frugivorous animals such as birds is not considered. Primates often discard fruits only partially eaten. All these factors affect an overestimation of the number of sustainable individuals. On the other hand, *Ficus* produces ripe fruit 3 to 5 times per year (see Galil, 1968 and references therein). Thus, the real production should be much larger than the calculated value. By no means the above estimation is substantial. However, it would be safe to conclude that *Ficus* fruits are an important keystone food item. In addition to

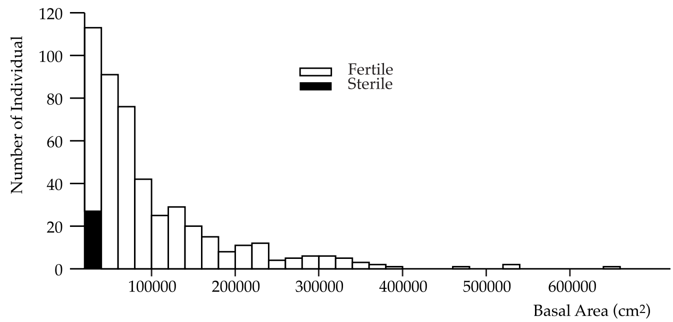

Fig. 6. Basal area histogram. Trees •...10 cm GBH are excluded. Sterile trees are smaller then fertile trees, which suggests that individual maturity of this species is defined by tree size.

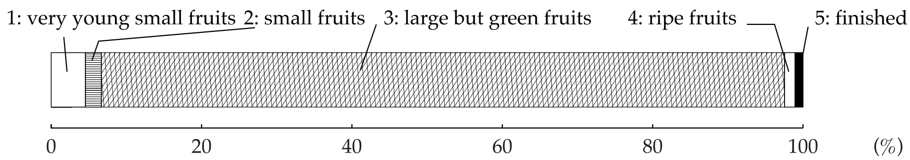

Fig. 7. Basal Area composition in fruit stage. Dominance of stage 3 trees suggests that the period of the study is slightly before their fruiting season.

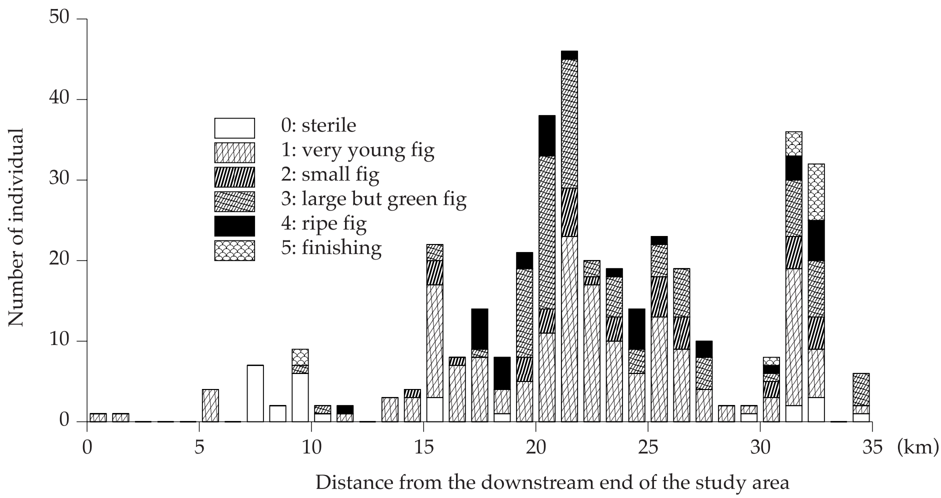

Fig. 8. Maturity distribution along the Baragoi River. Ripe fruits are obtainable through the river.

Table 1. Nutritional analysis of dried fig fruits.

	Water	Crude protein	Crude fat	Crude fibre	Crude ash	Nitrogen-free soluble extraxt	Energy (kcal/g)
composition (%)	12.2	6.9	5.3	18.4	8.7	48.5	2.66
index (kcal/g)			3.47	8.37		4.07	

kcal/g standard conversion ratios are from Kagawa (1986), based on FAO guideline.

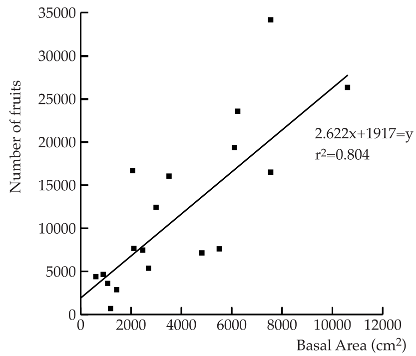

Fig. 9 Relation of tree size and number of fruits, from 18 individuals.

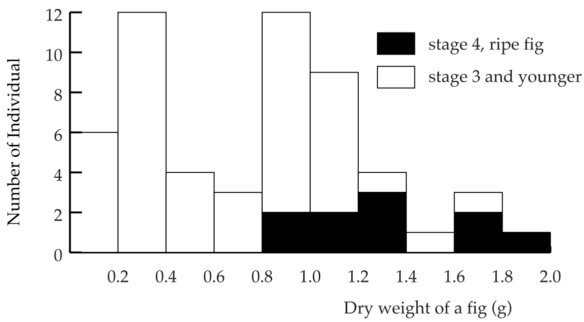

Fig. 10. Average dry weight of fig "fruits" of individual trees are shown. Ripe fruits are slightly more than 1 g.

the riverine forest fruits, other types of plant food should be considered for understanding the sustainability of semi arid land such as tuberous root (e.g. *Ipomoea* spp.), young and mature leaves (Idani *et al*., 1994; Tutin *et al*., 1994; Yumoto *et al*., 1994). It could be possible for a few small groups of early hominids to survive on largely *Ficus* fruits for a short period of food scarcity along a similar-scaled riverine forest.

The present study indicates an importance of extant plant productivity in semi arid land to infer paleo-foraging ecology of Pliocene hominids.

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