THE POTENTIAL OF EDIBLE WILD YAMS AND YAM-LIKE PLANTS AS A STAPLE FOOD RESOURCE IN THE AFRICAN TROPICAL RAIN FOREST

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ABSTRACT Wild edible tuberous plants were assessed as a potentially reliable staple food resource for the Baka forest foragers independent of agriculture in South Cameroon. Using a belt-transect method, the density and biomass of wild yam and yam-like plants were surveyed in the semi-deciduous forest. Seven plant species with edible tubers grew throughout the forest surveyed, while more densely in the parts disturbed by human activity. The total biomass of wild edible tubers in a forest remote from the villages was estimated at more than 5 kg/ha, exceeding the value estimated in previous studies conducted in similar forest environments. The ubiquitousness, the considerably large biomass and the Baka gatherers' knowledge and technology for collecting wild tubers point to wild yam-like plants as one major staple food resource to support foragers independent of agriculture.

Key Words: African rain forests; Wild yam and yam-like plants; Biomass of wild edible tubers; Baka hunter-gatherers; Foragers independent of agriculture

INTRODUCTION

My study was greatly stimulated by the hypothesis proposed by Headland (1987) and Bailey et al. (1989), that human beings could never have led a life independent of agriculture in tropical rain forests. I have conducted anthropological surveys on the Baka hunter-gatherers inhabiting northern Congo and southeastern Cameroon since 1987. Like other modern hunter-gatherers, the contemporary Baka exchange forest products with, or work for farmers to obtain crops or money, and some Baka till their own fields, while they still hunt game and gather plant and small animal resources in the forests. Above all, wild yams are of great value as dietary food and are the major objective of the Baka women's gathering activity. For example, each adult female of a small group of the Baka in a sedentary settlement in northwestern Congo was observed to take half-day collecting trips for wild yams once or twice a week (Sato, 1991).

Headland (1987) asserted that tropical rain forests never had enough starch food resources to sustain forest foragers who were completely independent of agriculture. On the other hand, Bahuchet et al. (1991) and Endicott (1991) emphasized the reliability of the plant as a food resource for forest foragers, based on the ecological and ethnographical evidence in Africa and the Malay Peninsula respectively. The ecological data on wild food resources in the tropical rain forests are lacking, to say

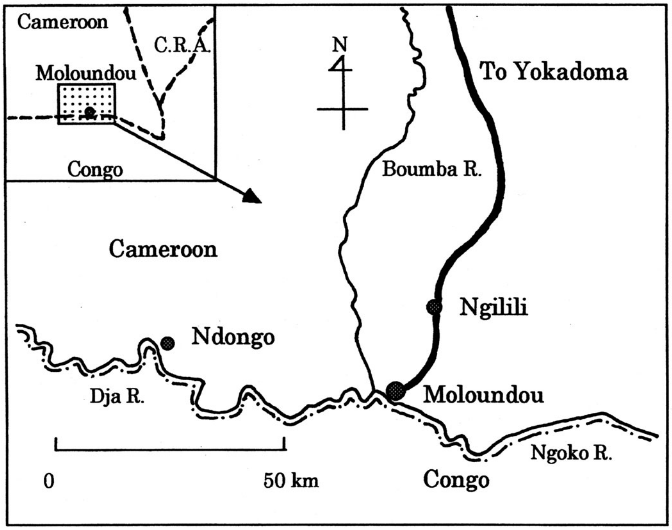

Fig. 1. The area surveyed.

nothing of wild yams. I have investigated the density and biomass of wild plants with edible yam-like tubers in the forests of southeastern Cameroon since 1995. Here I will assess the potentiality of wild yams and yam-like plants as a staple food resource for the Baka forest foragers.

AREAS AND METHODS

Field surveys were conducted around the two small villages of Ndongo village and Ngilili village, 50 km west and 20 km north of Moloundou, respectively, the capital of a sub-prefecture in southeastern Cameroon (Fig. 1). The Baka inhabit both areas. They live on mixed subsistence activities of hunting, gathering, fishing, and small-scale farming, and maintain a close socio-economical tie to such farmers as the Bakwele in the Ndongo area and the Bangando in the Ngilili area. Although the Baka obtain many food items from the forest, the bulk of their current diet is cultivated crops such as plantain bananas and cassava tubers.

Both of the areas surveyed are about 400-500 m above sea level and flat on the whole, although there is a small mountainous region about 700 m above sea level north of the Ndongo village. The areas surveyed have a similar vegetation structure: a mosaic zone around the sedentary villages, consisting of cacao fields, swidden fields of plantain and cassava, fallows, and undisturbed primary forests, and a primary semi-deciduous rain forest beyond the mosaic zone. Logging was practiced in both areas. In the Ndongo area it ended about 15 years ago and its marks are not particularly noticeable, except for a logging road which turned entirely into a bush belt. In contrast, in the Ngilili area where logging was abandoned

Table 1. Sites surveyed.

Site no.	No. of belts	Total area (ha)	Forest type	Distance from nearest village	Traces of human activities	Region	Survey periods
S1	1 (1 km)	0.4	mosaic*	ca. 2 km	fallows	Ndongo	Aug.-Sep.'95
S2	1 (2 km)	0.8	mosaic*	ca. 2 km	fallows	Ndongo	Sep.'96
S3	2 (1 & 2 km)	1.2	mosaic*	ca. 1 km	fallen trees	Ngilili	Sep.'97
S4	1 (1 km)	0.4	semi-deciduous**	ca. 4 km	rare	Ndongo	Sep.'95
S5	4 (4×1 km)	1.6	semi-deciduous**	ca. 10 km	an old logging road	Ndongo	Aug.-Sep.'96
S6	2 (2×1 km)	0.8	semi-deciduous	ca. 6 km	none	Ndongo	Sep.'96

mosaic*: a semi-deciduous forest including patches of fields, their fallows or logging roads

semi-deciduous**: a semi-deciduous forest including a few marks of fallows and an old logging road

ten years ago, several logging roads remain in use in the daily activities of the Baka and the farmers, and there are many fresh stumps of *Triplochiton scleroxylon*.

I adopted a belt-transect method (4 m in width× 1 or 2 km in length) counting all but seedlings of standing stems of wild tuberous plants which the Baka ate found within the belt. Forest yams with stolons found deeply rooted within a belt, were also counted because such stolons produced edible tubers, according to the Baka. Since it was very difficult to identify and count the wild tuberous plants in the dense forest, several adult men of the Baka were recruited as informants, all of whom were familiar with forest plants.

I investigated five Ndongo sites (S1, S2, S4, S5, and S6) and one Ngilili site (S3) (Table 1). Of the five sites in the Ndongo area, two (S1 and S2) near a sedentary settlement of the Baka were in a mosaic zone. The other three sites were situated in a remote forest from the above settlement. There was no field or fallow, although in the remotest site (S5), which was three to four hours' walk from the Baka settlement, the transect belts occasionally crossed the secondary forest, the mark of a past logging road. In the Ngilili area I surveyed only the mosaic zones consisting of primary forests and the diverse stages of secondary forests recovering from logging and agricultural activities. I investigated a total transect belt length of 13 km, of which 10 km was in the Ndongo area and 3 km was in the Ngilili area.

Considering the possible environmental factors influencing the distribution of wild yams (Hladik et al., 1984), I divided the research belts into sections (5 m long) and classified the vegetation of every section into two types, "manja" and "bi." In the Baka language, "manja" means a clean forest without shrub or liana obstructing the view, and "bi," a thicket consisting of dense herbs, shrubs or lianas. Doubtlessly, most "bi" in the surveyed areas, except for a few riverbanks or swamp bushes, are secondary vegetation originating from the gaps caused by naturally or artificially fallen trees, because I frequently saw fallen trees or boughs in or around the sections classified as "bi." I relied on the Baka assistants to classify the vegetation type. I also weighed tuber samples to estimate the biomass of wild edible tubers. All the edible tuberous portions of standing stems found

Table 2. Wild plant species with edible tubers collected by the Baka.

Baka name	Scientific name*	Biological cycle*	Species observed during the survey
"ngbi"**	*Dioscoreophyllum cumminsii*	annual stem and tuber	observed
"safa"	*Dioscorea praehensilis*	annual stem and tuber	observed
"suma"	*D.semperflorens*	annual stem and tuber	never
"ba"	*D.mangenotiana*	biennial stem and perennial tuber	observed
"keke"	*D.burkilliana*	perennial stem and tuber	observed
"kuku"	*D.minutiflora*	perennial stem and tuber	observed
"baloko"	*D.smilacifolia*	perennial stem and tuber	observed
"njakaka"	*D*.sp.	perennial stem and tuber	observed
"efange"	*D*.sp.	perennial stem and tuber	never
"booli"	*D*.sp.	perennial stem and tuber	never

*: after Hladik and Dounias (1993)
**: Menispermaceae

were counted in the sample sections 4 m wide × 25 m long selected every 100 m from the starting point of each belt. The sampling was repeated in the 90 sections spanning 9 km of the total surveyed transect belt length of 13 km.

RESULTS

I. Wild Yams and Yam-like Plants Collected by the Baka

There are ten species of wild plants (all lianas) with edible tubers used as dietary food by the Baka in southeastern Cameroon (Table 2). Of these plants, *Dioscoreophyllum cumminsii* (henceforth, *Dp.cumminsii*, "ngbi"), of which the sweet fruit is also eaten, belongs to the family Menispermaceae. The rest belongs to the family Dioscoreaceae. According to Hladik et al. (1993), *Dioscorea praehensilis* ("safa"), *D.semperflorens* ("suma"), and *Dp.cumminsii*, have a common ecological feature of an annual stem and tuber, *D.mangenotiana* ("ba") has a biennial stem and a perennial tuber, and the other six yams have perennial stems and tubers. The yams with perennial tubers usually have a particular shape formed by old fibrous tubers.

In my survey, stems with only such fibrous tubers or decayed tubers were not counted as edible tubers. The tubers of all ten species shown in Table 2 are nontoxic, and can be easily eaten after only boiling or roasting. *D.semperflorens* can be eaten even raw. Of ten species, seven, except *D.semperflorens*, "efange" (*D*.sp.) and "booli" (*D*.sp.), were observed during the survey period. The Baka are particularly eager to collect the four species of *D.praehensilis*, *D.mangenotiana*, *D.burkilliana* and *D.semperflorens*.

Table 3. Density of wild yams and yam-like plants in each site.

Site Species	S1 stems/ha	S2 stems/ha	S3 stems/ha	S4 stems/ha	S5 stems/ha	S6 stems/ha
Dp.cumminsii	70.0	165.0	151.7	30.0	42.5	3.8
D.praehensilis			5.0			1.3
D.mangenotiana	5.0	5.0	2.5		5.0	1.3
D.minutiflora	50.0	53.8	131.7	67.5	55.6	2.5
D.burkilliana	25.0	16.3	12.5	12.5	5.6	13.8
D.smilacifolia	37.5	38.8	64.2	45.0	19.4	23.8
"njakaka"					2.5	
Total	187.5	278.8	367.5	155.0	130.6	46.3

Table 4. Micro-vegetation composition in each site.

Site no.	Total area of "manja"* (ha)	%	Total area of "bi"** (ha)	%	Unidentified total area (ha)	%	Total area (ha)
S1	0.21	52.5	0.14	35.0	0.05	12.5	0.4
S2	0.38	47.5	0.42	52.5			0.8
S3	0.64	53.3	0.56	46.7			1.2
S4	0.20	50.0	0.20	50.0			0.4
S5	0.93	58.1	0.67	41.9			1.6
S6	0.71	88.8	0.09	11.3			0.8
Total	3.06	58.8	2.09	40.2	0.05	1.0	5.2

"manja"*: a clean forest without vines or shrubs in Baka language
"bi"**: a thicket consisting of dense herbs, vines or shrubs.

II. The Density

On the whole, *Dp.cumminsii* had the highest density, followed by *D.minutiflora*, *D.smilacifolia* and *D.burkilliana* (Table 3). Although *D.mangenotiana* was observed in almost all sites surveyed, its density was very low. *D.praehensilis* and "njakaka" were seldom observed in the survey series. However, the densities of *Dp.cumminsii* varied in the sites surveyed. It had very high densities in S2 and S3, but very low in S6. Its density tended to be higher in the sites in mosaic zones (S1, S2 and S3) than in those in a remote forest (S4, S5 and S6). As with *Dp.cumminsii*, the density of *D.minutiflora* also was very high in S3, but low in S6, whereas it varied little in the other four sites. Although the densities of *D.smilacifolia* and *D.burkilliana* were somewhat higher in the mosaic zone sites than in the remote forest sites, the difference was not striking.

The micro-vegetation structure of the sites surveyed is shown in Table 4. There

Table 5. Density of wild yams and yam-like plants by the type of micro-vegetation.

Micro-vegetation Species	"manja" stems/ha	"bi" stems/ha	unidentified stems/ha
Dp.cumminsii	17.0	174.5	180.0
D.praehensilis	2.0	0.5	
D.mangenotiana	3.3	3.3	20.0
D.minutiflora	40.5	101.0	80.0
D.burkilliana	7.8	18.2	20.0
D.smilacifolia	32.0	43.5	40.0
"njakaka"	1.0	0.5	
Total	103.6	341.6	340.0

"manja"*: a clean forest without vines or shrubs in Baka language.
"bi"**: a thicket consisting of dense herbs, vines or shrubs.

was no great difference between the percentage of "manja" and "bi" in all the sites except for S6, which had a strikingly low percentage of "bi." I encountered no field, fallow nor the mark of logging in S6. The forest where S6 was situated had seldom been disturbed by human activity such as slash-and-burn agriculture or logging. In contrast, the three sites in mosaic zones (S1, S2 and S3) contained many "bi" areas that might have been caused by such human activities. Although the two sites, S4 and S5, were remote from the villages and showed no traces of agriculture, there were as many "bi" areas as in S1, S2 and S3. One clue for some "bi" vegetation in S4 and S5 was that there was a defunct logging road in S5 although I did not encounter it frequently. Another possible reason is that natural forest gaps and subsequent secondary bushes probably occurred quite frequently, and most "bi" in S4 and S5 were successive vegetation.

As shown in Table 5, all four species, except *D.praehensilis*, *D.mangenotiana* and "njakaka" had higher densities in "bi" vegetation than in "manja." Above all, the density of *Dp.cumminsii* in "bi" was ten times as high as in "manja." However, the difference between the density of wild yam species in "manja" and "bi" was not so great as that of *Dp.cumminsii*. It should be noted that the total density of six species of wild yam reached 86.6 stems/ha in "manja."

III. The Weight of Tubers

I weighed all the tubers dug up in ninety sample sections. Although the environmental condition of the sites surveyed possibly influenced the growth of tubers or their weight, I totaled the number of sample stems and the weight of edible portions of tubers dug from all the sites because of the small number of samples (Table 6). It was difficult to distinguish whether a sample stem had edible tubers or not. This varied with the kinds of species. Most sample stems of *Dp.cumminsii*

Table 6. Weight of tubers dug from 90 sample sections (1 section: 4m×25m)

Species	Total sample stems (I)	Stems with edible tubers (II)	Total weight of edible tubers (III) g	Percentage of stems with edible tubers 100×(II)/(I) %	Mean weight of edible tubers per stem (III)/(I) g
Dp.cumminsii	97	75	3,869	77.3	40
D.praehensilis	3	3	666	100.0	222
D.mangenotiana	6	1	14	16.7	2
D.minutiflora	74	4	544	5.4	7
D.burkilliana	11	2	5,974	18.2	543
D.smilacifolia	31	4	169	12.9	6
"njakaka"	0				

and all three stems of *D.praehensilis* had edible tubers, whereas this was not the case for *D.burkilliana*, *D.mangenotiana*, *D.smilacifolia* and *D.minutiflora*. This suggests that the reward for seeking the former two species is more predictable than seeking the latter four species.

The total weight of edible portions of tubers varied from species to species. Edible portions of *Dp.cumminsii* and *D.burkilliana* were markedly heavier, because *Dp.cumminsii* had both the high density of standing stems and the high proportion of standing stems with edible tubers, and of 11 sample stems of *D.burkilliana*, one had the biggest edible tuber weighing over 5 kg. The mean weight of edible tubers per sample stem for *D.burkilliana* and *D.praehensilis* were much larger than those of *Dp.cumminsii*, *D.minutiflora* and *D.smilacifolia* although I managed to dig up many of the latter sample stems.

IV. The Biomass of Wild Edible Tubers

The biomass of edible tubers of wild yams and yam-like plants can be estimated from the density of their standing stems (Table 3) and the mean weight of their edible tubers per stem (Table 6). The largest biomass was calculated for *D.burkilliana*, followed by *Dp.cumminsii*, *D.minutiflora*, *D.praehensilis* and *D.smilacifolia* (Table 7). Although the estimated biomass of each species varied from site to site surveyed, the total biomass of wild edible tubers tended to be larger in the three mosaic zone sites (S1, S2 and S3) than in the three remote forest sites (S4, S5 and S6). The biomass for the mosaic sites varied from 15.3 to 17.0 kg/ha, and that for the remote forest sites varied from 5.3 to 8.7 kg/ha. The estimated biomass of any species except for *D.praehensilis* and *D.mangenotiana* was larger in "bi" than in "manja" (Table 8). The total estimated biomass of wild edible tubers in "bi" was three times as large as that in "manja." The biomass of wild edible tubers in "manja" was estimated at 5.8 kg /ha.

Table 7. Estimated biomass of wild edible tubers by species by site.

Site Species	S1 g/ha	S2 g/ha	S3 g/ha	S4 g/ha	S5 g/ha	S6 g/ha
Dp.cumminsii	2,793	6,584	6,052	1,197	1,696	150
D.praehensilis			1,110			278
D.mangenotiana	12	12	6		12	3
D.minutiflora	370	398	974	500	412	19
D.burkilliana	13,575	8,824	6,788	6,788	3,054	7,466
D.smilacifolia	206	213	353	248	107	131
"njakaka"					?	
Total kg/ha	17.0	16.0	15.3	8.7	5.3*	8.0

*: The biomass of "njakaka" is excluded.

Table 8. Estimated biomass of wild edible tubers by the type of micro-vegetation.

Micro-vegetation Species	"manja" g/ha	"bi" g/ha
Dp.cumminsii	678	6,963
D.praehensilis	444	111
D.mangenotiana	8	8
D.minutiflora	300	747
D.burkilliana	4,235	9,883
D.smilacifolia	176	239
"njakaka"	?	?
Total kg/ha	5.8*	18*

*: The biomass of "njakaka" is excluded.

DISCUSSION

I. Productivity of Wild Edible Tubers

1. *The density of wild yams and yam-like plants and its environmental factors*

My investigation clearly showed that the density of wild yams and yam-like plants varied with the sites surveyed and the vegetation of sites. Some species, especially *Dp.cumminsii*, grew more densely in the mosaic zone sites near sedentary villages than in the remote forest sites. Several authors pointed out that wild yams and yam-like plants could have high productivity in the secondary vegetation in tropical rain forests (Hladik et al., 1984; Bailey et al., 1989; Hart & Hart, 1986). My survey confirmed their observations. However, it also showed that a considerable number of wild tuberous plants, especially wild yams with perennial stems and tubers: i.e. *D.burkilliana*, *D.minutiflora*, and *D.smilacifolia* were distributed even in remote forests beyond mosaic zones. "Manja," where many large and small trees construct multiple canopies which obstruct the from reaching the floor, is not a suitable environment for the light-demanding plants, especially the climbing plants such as *Dp.cumminsii*, whose stems and tubers are annually renewed. This is the reason why *Dp.cumminsii* had much higher density in “bi” than “manja.”

The bush-like vegetation, “bi,” can appear frequently in the forests where people frequently clear land for farming or logging. This probably brought about the high density of wild yams and yam-like plants in the mosaic zone sites. However, my impression from the investigation is that the natural gaps from trees felled by storms or aging as well as human-induced gaps produced a considerable number of “bi.” It has been pointed out that natural gaps occurred much more frequently in the tropical rain forests than in temperate forests (Yamamoto, 1981). The “bi” as successive vegetation to natural gaps made by fallen trees is likely to contribute to the growth of wild tuberous plants even in remote forests beyond mosaic zones.

My survey also found that *D.minutiflora* and *D.smilacifolia* had relatively high densities in “manja.” These two species, besides *D.burkilliana*, “njakaka”, “booli” and “efange,” perennially renew their stems and tubers (Hladik & Dounias, 1993). According to Hladik and Dounias (1993), the resting tuberous phase is an adaptation permitting rapid growth as soon as a fallen tree allows light to penetrate the closed forest. And the perennial aerial stems and tubers may be more advantageous in an environment where the “waiting phase” for such a natural gap is of unpredictable duration rather than occurring annually (Bahuchet et al., 1991). This may allow the above two yam species to have their relatively high density in “manja.” Thus, in the semi-deciduous forest occupying the large part of the western Congo Basin, “manja” may also yield considerable productivity of wild yams.

2. *The biomass of wild yams and yam-like plants*

The biomass of wild yams and yam-like plants in the undisturbed primary forests is one of the keys to assessing whether it is possible for foragers to lead a life independent of agriculture in the tropical rain forests. As Headland (1987) pointed out, because the quantity of available wild starch foods is a critical factor to enable pure foragers to live in deep tropical rain forests, such tuberous plants as wild yams and yam-like plants discussed here are the strong, likely candidates. I estimated the total biomass of wild edible tubers in the mosaic zone sites and the remote forest sites from 15.3 to 17.0 and from 5.3 to 8.7 kg/ha, respectively. My estimates support the hypothesis of high productivity of wild yams and yam-like plants in the secondary vegetation of the tropical rain forest zone.

One issue is the biomass value of edible tubers in the remote forest sites: 5.3 kg/ha to 8.7 kg/ha. This value is fairly high compared to other estimations: 2.39 kg/ha in the semi-deciduous forests of Central Africa (Bahuchet et al., 1991) and 3.0 kg/ha in the semi-deciduous forests of southeastern Cameroon (Hladik et al., 1984). Firstly, the forest where I surveyed the three sites (S4, S5 and S6) was not entirely undisturbed. But, as it was remote from villages and only S5 showed traces of a past logging road, I regarded it as an undisturbed forest. Secondly, it is possible that a conspicuously large tuber sample of *D.burkilliana* dug up for weighing biased my estimation upward. However, *D.praehensilis*, *D.mangenotiana*, and *D.burkilliana* occasionally produce very large edible tubers. These yam species are the major targets of Baka woman gatherers and usually fill their baskets.

Based on the Aka example, Bahuchet et al. (1991) estimated the biomass of wild yams and yam-like plants that can maintain the present population level of pure hunter-gatherers in a tropical rain forest at 2 kg/ha. My estimated biomass value of 5.3 kg/ha to 8.7 kg/ha in the remote forest sites exceeds Bahuchet's estimate. Excluding the value of *D.burkilliana* from my estimation, the biomass is still high, at 0.5 kg/ha to 2.2 kg/ha. Although much more data about the biomass of wild yam species is needed, my research suggests that the undisturbed semi-deciduous forests in the southern part of Cameroon have considerable potential for producing starch food resources.

II. Potential of Various Wild Yam and Yam-like Plants in Semi-deciduous Forests of Southern Cameroon

According to Headland (1987), wild yams in the tropical rain forest cannot be a reliable staple food for the forest foragers because of sparsity, small biomass and the hard labor involved in digging. In other words, there is little reward for the hard work. I have already examined the biomass. Here, I will discuss resource sparsity and labor.

The present research showed the ubiquitousness of *Dp.cumminsii*, *D.minutiflora* and *D.smilacifolia*. The standing stems of *Dp.cumminsii* grew in relatively high density in all sites except one and, moreover, grew edible tubers at a high proportion of more than seventy percent. This suggests that by merely wandering in the forest one will come across some edible tubers. But at the end of the rainy season, the ratio of stems with edible tubers may decrease because of germination (Dounias, personal communication).

D.minutiflora and *D.smilacifolia* have similar characteristics: the relatively high density in any forest and the low proportion of stems growing edible tubers. In other words, these two species were found in any forest, however small their amount. In contrast, *D.praehensilis*, *D.mangenotiana* and *D.burkilliana* had low densities. However, their gathering cost was also low. Firstly because of their peculiar, strong and long, twisting stems with prickles, it is easy for the Baka to spot *D.mangenotiana* and *D.burkilliana* even in closed forests. Secondly, according to the Baka, *D.praehensilis* often are found in clusters although I could not confirm it in this survey. Thirdly, in the case of *D.praehensilis*, the particular gathering techniques, described in detail and named paracultivation by Dounias (1993), is likely to contribute to decreasing the cost. That is, when the Baka gatherers dig up a tuber, they leave the small upper portion in the soil for the next germination. Therefore, it is possible that collecting wild yams is a rather predictable activity for the Baka women, the main gatherers who know well about such roots. Another factor decreasing the gathering cost is the size of edible tubers. It is not rare for the Baka women to fill a basket with tubers by digging up only one or two roots of *D.praehensilis*, *D.mangenotiana* or *D.burkillianathem*. In other words a collector needs to spot one good stem for a huge reward.

Is digging work hard? Of all ten species of wild yams and yam-like plants, *D.semperflorens* has the longest tubers, occasionally buried 3 to 4 m according to the Baka. *D.praehensilis* also has tubers sometimes over 1 m long, but digging may not be so hard. As mentioned above, most of the collectors target the reburied tubers. A hole often remains from the previous digging, and the collector need not remove much soil. Even if the collectors have to dig for deeply buried tubers, as reported in detail by Dounias (1993), the Baka can surmount the hardships with several digging tools. Since most tubers of the other yams and yam-like plants are not buried deep, the collectors can easily dig them up. For example, in the present reseach, it took 22 seconds (n=5), 69 seconds (n=4), and 109 seconds (n=13) on the average to dig up a root of *D.minutiflora*, *D.smilacifolia*, and *Dp.cumminsii*, respectively. These tuberous plants are not the major targets of Baka woman gatherers. However, the ubiquitousness, the high density in any forest and the light digging work guarantee their potential as an important complementary starch food resource. Above all, *Dp.cumminsii* is of importance. Hladik et al. (1984) neglected *Dp.cumminsii* in their estimation of the productivity of wild edible tuberous plants, because the Baka children mainly collect the plant for pleasure. I often watched adult men or women dig up its tubers. According to Kitanishi (1995), when the Aka live in a remote forest away from their settlements, *Dp.cumminsii* significantly contributed to their diet.

I am in favor of the interdependent model asserted by Headland and Reid (1989): modern hunter-gatherers have had close relationships with their neighbors, farmers or pastralists for 2 millenia. However, I cannot agree with another of Headland's assertion (1987) that it is impossible for hunter-gatherers in the tropical rain forests to lead a life independent of agriculture. The findings from the present research did not negate the potential of wild yams and yam-like plants as a staple food resource. To examine the potentiality of tropical rain forests as a human habitat I intend to gather more ecological data.

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REFERENCES

Bahuchet, S, D. Mckey & I. de Garine 1991. Wild yams revisited: Is independence from agriculture possible for rainforest hunter-gatherers? *Human Ecology*, 19(2): 213-243.

Bailey, R. C., G. Head, M. Jenike, B. Owen, R. Rechtman & E. Zechenter 1989. Hunting and gathering in tropical rainforest: is it possible? *American Anthropologist*, 91: 59-82.

Dounias, E. 1993. Perception and use of wild yams by the Baka hunter-gatherers in south Cameroon. In (C. M. Hladik, A. Hladik, O. F. Linares, H. Pagezy, A. Semple & M. Hadley, eds.) *Tropical Forests, People and Food*, pp.621-632. The Man and the Biosphere Series (Volume 13), UNESCO.

Endicott, K. & P. Bellwood 1991. The possibility of independent foraging in the rain forest of Peninsular Malaysia. *Human Ecology*, 19(2): 151-185.

Hart, T. B. & J. A. Hart 1986. The ecological basis of hunter-gatherer subsistence in African rainforest: The Mbuti of eastern Zaire. *Human Ecology*, 14(1): 29-55.

Headland, T. N. 1987. The wild yam questions: How well could independent hunter-gatherers live in a tropical rainforests environment? *Human Ecology*, 15(4): 463-491.

Headland, T. N. & L. A. Reid 1989. Hunter-gatherers and their neighbors from prehistory to the present. *Current Anthropology*, 30(1): 43-66.

Hladik, A. & E. Dounias 1993. Wild yams of the African forest as potential food resources. In (C. M. Hladik, A. Hladik, O. F. Linares, H. Pagezy, A. Semple & M. Hadley, eds.) *Tropical Forests, People and Food*, pp.163-176. The Man and the Biosphere Series (Volume 13), UNESCO.

Hladik, A. S., S. Bahuchet, C. Ducatillon & C. M. Hladik 1984. Les plantes a tubercules de la foret dense d'Afrique centrale. *Revue d'Ecologie (Terre et Vie)*, 39: 249-290.

Kitanishi, K. 1995. Seasonal changes in the subsistence activities and food intake of the Aka hunter-gatherers in northeastern Congo. *African Study Monographs*, 16(2): 73-118.

Sato, H. 1991. The Baka in northwestern Congo: A group of hunter-gatherers living in sedentary villages (in Japanese). In (J. Tanaka & M. Kakeya, eds.) *Natural History of Mankind*, pp.543-566. Heibonsha, Tokyo.

Yamamoto, S. 1981. The maintenance systems of climax forests (in Japanese). *Biological Science (Seibutsu Kagaku)*, 33(1): 8-16.

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