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THE MANAGEMENT OF WILD YAM TUBERS BY THE BAKA PYGMIES IN SOUTHERN CAMEROON

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1 Location

The present paper deals with the exploitation of wild yam tubers by the Baka hunters and gatherers living in the southeastern part of Cameroon. This paper is the continuity of initial papers we have published on wild yam availability, and on the perception and use of these wild resources among several Pygmy populations of Central Africa (Hladik et al., 1984; Hladik and DOUNIAS, 1993; DOUNIAS, 1993, 1996, 1997; McKey et al., 1998.)

Firstly I am going to recall and sum up the basic data on yam perception and use by the Baka which have led us to elaborate the concept of “paracultivation.” I will explain what I mean by such neologism and I will present some of the results I obtained from a study, the main purpose of which was to test the concept of paracultivation and to see to what extent paracultivation may constitute a form of sustainable management of so-called “wild resources.”

On the Map (Figure 1), I have located the distribution area of the Baka Pygmies among whom the present study was carried out.

Fig. 1. Map of Location

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2 Yam Species

On Figure 2, (from Hladik and Dounias, 1993), I have listed the wild yam species (all belonging to the genus *Dioscorea*, among the monocotyledonous Dioscoreaceae family) which are up until now censused throughout the forests of Central African Congo basin. It is important to retain two major points from Figure 2:

1. *Dioscorea* genus is still under revision since all species have not yet been correctly described. I thus use Pygmy terms to name probable new yam species that are not definitively described;

2. some species grow only in forest edges and gaps, some others in the dense rainforest, and there exist a close relationship between the type of forest, the edibility, and—to some extent—the growth and development cycle of yam species.

3 Triptyc

In previous papers (Dounias, 1993, 1996, 1997) I have demonstrated that the Baka have an achieved knowledge of the ecology and the biology of these vines which produce starch-rich tubers, although the plant is extremely difficult to observe from forest undergrowth: tubers are generally deeply buried underground, and the sexual parts hang high within the canopy. Moreover ethnolinguistic observations have revealed the particular status of yams among plant nomenclature, since the Baka terminology for yam morphology exclusively refers to human anatomy.

Fig. 2

Wild yam species of the Central African forests

Classification according to tuber edibility, plant development cycle and forest type.

Some yam species are still not yet described (systematic revised). To refer to these species, we use the local names (B: Baka language; K: Kola language).

from Hladik et Dounias, 1996
Consumers of
*Dioscorea mangenotiana* Miège:
a Baka-Elephant-Spirit trypsic

"jengi" spirit
derived in the form
of a mask
(raffia fibres)

Baka yam gatherer

Elephant

*Dioscorea mangenotiana* Miège
Furthermore, I have underlined the fact that the relationships between the Baka and these starch-producing plants go far beyond the simple use as food. As Lévi-Strauss would say, yams are “not only good to eat, they are also good to think upon.” On Figure 3, I synthesise the fact that wild yams (and especially Dioscorea mangenotiana which produces the biggest tuber) play a key role in the close relations which exist between Man, the most important mammal of the forest (elephant), and jengi tutelary spirit, these 3 main inhabitants of forest sharing yam tuber as symbolic food (Joiris, 1996; Dounias, 1997.)

4 Cultural Complex

In Figure 4, I have grouped the main components which encourage us to consider wild yam harvesting as a complete cultural complex, in the sense that Sapir gives to this concept to characterize the whole set of terms and practices specifically refering to a given activity (Sapir, 1916). Wild yam harvesting is one of the 3 cultural complexes which characterize pygmy societies (with elephant hunting and honey gathering, refer to Babuchet, 1993). From then, the question was to wonder if such a set of knowledge and plant uses may—with recourse to a particular form of tuber harvesting—leads to a management of the resource, in a way that would respect the nomadic life of the Baka forest dwellers.

Fig. 4

CULTURAL COMPLEX

Baka perception of plant biology
Baka perception of plant ecology
Competition with other wild yam predators
Harvesting pattern

Wild yams

Baka classification
Food uses
Non food uses
Ritual and symbolic functions
Social rules of gathering activities

PARACULTIVATION

?? RESOURCE MANAGEMENT ??
5 What is Paracultivation?

What do I mean by PARACULTIVATION? I have proposed this neologism to define a combination of technical and social patterns of wild plant exploitation. Paracultivation characterizes a particular process of wild plant harvesting which aims at encouraging plant reproduction, so that the plant can be repeatedly harvested. Furthermore, the plant is voluntary kept within its original environment, in order to better respond to the mobility of forest dwellers. This maintainace of plant in the forest is the key difference with protocultivation. As a step leading to full domestication, protocultivation generally consists of a transplantation of the manipulated wild plant into domestic space. In addition, paracultivation has necessitated the technical design of a specific digging tool. Eventually, several social rules codify the access to the resource. Such rights of ownership, protection and possible inheritance focusing on a “wild” resource are fairly rare in the litterature dealing with “egalitarian” societies. (Figure 5)

6 Classification of Yams

In Figure 6, I confronte both scientific and Baka classifications of wild yams. Please just retain 3 points from this table

1. Close correspondence between the two classifications. Most of our recent discoveries on wild yam biology were suggested by Baka empirical knowledge of these plants;

2. Only 3 among 14 yam species are concerned by paracultivation: D. semperflorens, D. praehensilis and D. mangenotiana. These paracultivated species share several ecological, morphological and taxonomic characteristics: they are found in closed forests, produce annual or bi-annual stems, as well as annual or bi-annual tubers (refer to Figure 2);

3. Baka classification focuses on tuber morphology, which determines digging up processes.

Fig. 5

<table>
<thead>
<tr>
<th>what is PARACULTIVATION ??</th>
</tr>
</thead>
<tbody>
<tr>
<td>➔ Voluntary reburing of wild yam head after tuber harvesting</td>
</tr>
<tr>
<td>➔ Plant maintained in its original environment</td>
</tr>
<tr>
<td>(≠ from “Protocultivation” leading to plant domestication)</td>
</tr>
<tr>
<td>➔ Technical expertise</td>
</tr>
<tr>
<td># specific harvesting patterns</td>
</tr>
<tr>
<td># conception of an adapted tool (the auger)</td>
</tr>
<tr>
<td>➔ Social rules of access to plant</td>
</tr>
<tr>
<td># individual ownership of a wild plant</td>
</tr>
<tr>
<td># transmission - inherittance</td>
</tr>
<tr>
<td># resource protection</td>
</tr>
<tr>
<td># punishment in case of theft</td>
</tr>
<tr>
<td># sharing - redistribution of harvested tubers</td>
</tr>
<tr>
<td># prestige food</td>
</tr>
<tr>
<td># bridewealth</td>
</tr>
</tbody>
</table>
Fig. 6 Wild yam major characteristics, confronted with Baka classification

<table>
<thead>
<tr>
<th>Ecological characteristics</th>
<th>Morphological characteristics</th>
<th>Systematic botany</th>
<th>Baka names</th>
<th>Edibility</th>
<th>Generic terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>open areas</td>
<td>annual tuber</td>
<td>left turning stems</td>
<td>Helmia</td>
<td>ndiα mbokè</td>
<td>inedible</td>
</tr>
<tr>
<td></td>
<td>perennial tuber</td>
<td>elongated capsules</td>
<td>Lasiophytos</td>
<td>ndiα bëgô</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>both vegetative propagation by bulblets and generative propagation</td>
<td>Macrocarpae</td>
<td>ndiα pëmi</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>scarcely fleshy tuber (small or tiny or branched or fibrous or verticillate)</td>
<td>Macroura</td>
<td>pf ndiα</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asterotricha</td>
<td>D. buñgora</td>
<td>?ësëngô</td>
<td></td>
</tr>
<tr>
<td></td>
<td>annual tuber</td>
<td>right turning stem</td>
<td>D. semperflorens</td>
<td>?ësëmô</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bi-annual</td>
<td>compacted capsules</td>
<td>D. prothunnilis</td>
<td>sëpå</td>
<td></td>
</tr>
<tr>
<td>closed forest</td>
<td>perennial tuber</td>
<td>priority to generative propagation</td>
<td>D. mangenotiana</td>
<td>bë</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>unical oblong or numerous fleshy parts</td>
<td>Eudiosorea</td>
<td>D. sp. 1</td>
<td>bë</td>
</tr>
<tr>
<td></td>
<td></td>
<td>long and fibrous swellings with small and fleshy extremities</td>
<td>Enanthiophyllum</td>
<td>D. buñkô</td>
<td>ndëndë</td>
</tr>
</tbody>
</table>

Pancultivated yam species
7 Tuber Morphology

I propose in Figure 7 a description of the different forms of yam tubers, following Baka classification. This classification reveals that paracultivation concerns only species which have the larger proportion of fleshy and unotoxic parts. Meanwhile, it is worth to underline that yam species which were dug out and weighted by Sato during August–September period in Northern Congo (Sato, 1998), all belong to “ndondo” sub-group: a ligneous and perennial head is prolonged by fibrous and radial swellings terminated by round and fleshy reserves (ndóondó sensu stricto).

8 Tuber Harvesting

On Figure 8 I describe the technical process implemented by the Baka for harvesting the tubers of two paracultivated yam species: *D. praehensilis* and *D. semperflorens*. As shown on Figure 7, these species both produce vertical and oblong annual tubers. The hole is so far made that the head of the tuber is not removed. The starchy parts of the tuber (Figure 8) are dug up with the earth, using a special tool. The gatherer takes care to leave the terminal part of the tuber, and rebury the pit with backfill and humus. The earth will be less condensed than originally, so that the new tuber will encounter less mechanic resistance during further growth and development. Furthermore, a second stem is going to resprout from the terminal portion, and a second tuber will develop from this part. Consequently, paracultivation duplicates within each yam pit (Dounias, 1993, 1996).
Fig. 8. Harvesting of annual tubers

Fig. 9. Augers

Aka auger with inserted wooden paddles (from Bahuchet 1975)

Baka auger empty with extracted earth (from Dounias 1996)
9 The Auger

Both Baka and Aka Pygmies use a particular digging tool, an auger, which is specifically designed for the harvesting of paracultivated yam species. The differences of shape between the two augers reveal two parallel evolutions: the Baka’s auger is mainly suitable for *D. praehensilis* tubers, whereas the Aka’s auger is adjusted for *D. semperflorens* tubers (Dounias, in preparation). Both tools are perfectly adapted to nomadic life since they are at the same time easy to manufacture, effective in use and ephemeral (Babuchet, 1989).

10 Map of Yam Study Sites

In order to further understand the effect of paracultivation on plant demography, I have implemented an experimental plot in an area which is extremely rich in one of the annual tuber producing species: *Dioscorea praehensilis* (Dounias, 1994). In this map (Figure 10) I have located the different sites where I have conducted field work on wild yams (Hladik et Dounias, 1995). Yam plot area (9 ha) is characterized by an average 1,650 mm annual rainfall. Dry season intervenes from November to February. The forest is semi-deciduous ecotype, and dominant tree species belong to Ulmaceae and Sterculiaceae families. In this region, the Baka have close relationships with Mezime villagers who are Bantu agriculturalists.

11 Yam Study Plot

The study plot consists of a 12000 m² square, divided into 10 meter by 10 meter subsquares (120 subsquares) (Figure 11). The plot is located in a 25 year old secondary regrowth, which I defended from any attempt of cultivation during the study period (1993–1998). Within the plot, all yam and yam like (*Dioscoreophyllum cuminsii*, Menispermaceae) individual plants were inventoried, from seedling to adult stages. Among several observations, I have noticed whether they had been already harvested before and by whom (meaning Baka foragers or Mezime villagers). The Mezime villagers of this area also occasionally dig up *D. praehensilis* tubers, but they use no auger. Harvesting by the villagers is thus superficial and tuber is never reburied, inducing sometimes the death of the plant. Experiment was undertaken specifically on *D. praehensilis* which was by far dominant (57 % of censused yam and yam like individuals). I divided the general plot into seven sub-plots. Six of them were successively harvested during contrasted seasons, and the last one (white sub-squares on figure, totaling 520 m²) were preserved for further physiologic experiments.

12 Harvested Plots

In each sub-square, yam individuals were marked, mapped, identified, measured and described (height of stems, presence of leaves, flowers or fruits or traumasisms of any kind). For each harvested individual plant I also measured light exposure using a fish-eye lens (Rich, 1990). During the harvesting sessions, Baka harvesters were told to respect paracultivation processes. The age and gender of each harvester was noticed, and the time allocated to each plant harvesting was measured, including resting time. The time for manufacturing the auger was also estimated, and I noticed the kind of wood employed as well as the distance covered to find the small tree for making it. Finally, each harvested tuber was measured, weighted, and described.

Several harvesting sessions where organized 5 times every three months, from September 93 to September 94, and then again in April 1996 and lastly in April 1998. This represents over 560 harvested individuals.
Fig. 10. Map of yam study sites
**Fig. 11. Study squares**

<table>
<thead>
<tr>
<th></th>
<th>100</th>
<th>90</th>
<th>80</th>
<th>70</th>
<th>60</th>
<th>50</th>
<th>40</th>
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<th>20</th>
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<td>48</td>
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<td>VIII</td>
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<td>57</td>
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<td>27</td>
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<td>7</td>
<td>VII</td>
<td>VII</td>
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<td>96</td>
<td>86</td>
<td>76</td>
<td>66</td>
<td>56</td>
<td>46</td>
<td>36</td>
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<td>35</td>
<td>25</td>
<td>15</td>
<td>5</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>94</td>
<td>84</td>
<td>74</td>
<td>64</td>
<td>54</td>
<td>44</td>
<td>34</td>
<td>24</td>
<td>14</td>
<td>4</td>
<td>IV</td>
<td>IV</td>
</tr>
<tr>
<td>93</td>
<td>83</td>
<td>73</td>
<td>63</td>
<td>53</td>
<td>43</td>
<td>33</td>
<td>23</td>
<td>13</td>
<td>3</td>
<td>III</td>
<td>III</td>
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<tr>
<td>92</td>
<td>82</td>
<td>72</td>
<td>62</td>
<td>52</td>
<td>42</td>
<td>32</td>
<td>22</td>
<td>12</td>
<td>2</td>
<td>II</td>
<td>II</td>
</tr>
<tr>
<td>91</td>
<td>81</td>
<td>71</td>
<td>61</td>
<td>51</td>
<td>41</td>
<td>31</td>
<td>21</td>
<td>11</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Squares harvested**
- **Squares not harvested**

**Production plot 1**
- September 1993:
  - 710 kg/ha
  - 330 pits/ha
  - 2.15 kg/pit

**Production plot 2**
- December 1993:
  - 961 kg/ha
  - 240 pits/ha
  - 4.00 kg/pit

**Production plot 3**
- March 1994:
  - 897 kg/ha
  - 433 pits/ha
  - 2.05 kg/pit

**Production plot 4**
- June 1994:
  - 70 kg/ha
  - 200 pits/ha
  - 0.35 kg/pit

**Production plot 5**
- September 1994:
  - 1348 kg/ha
  - 427 pits/ha
  - 3.15 kg/pit

**100 x 120 m² inventoried squares**

**TOTAL = 472 pits**

- **D. praehensilis**: 264 pits
- **D. burkiliiana**: 63 pits
- **D. minutiflora**: 92 pits
- **D. similacifolia**: 35 pits
- **Dioscoreophyllum camminsii**: 18 pits

**Street of Wild Yam Tubers**

- **7%**: 57%
- **4%**: 13%
- **19%**: 19%
- **57%**: 7%
Fig. 12 Koudjina study site: Harvesting of production plot no. 3 (March 1994)

- 74-1 D. minutiflora
- 74-2 D. burkilliana
- 74-3 D. burkilliana
- 74-4 D. burkilliana
- 74-5 D. minutiflora
- 74-6 D. praehensilis
- 74-7 D. minutiflora
- 74-8 D. praehensilis
- 74-9 D. minutiflora

Legend:
- 0 = 10 m
- 40°
- 310°
- 220°

<table>
<thead>
<tr>
<th>Species</th>
<th>Pits</th>
<th>Heads</th>
<th>Total Weight of Edible Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. praehensilis</td>
<td>39</td>
<td>48</td>
<td>104.95 kg</td>
</tr>
<tr>
<td>D. smithii</td>
<td>5</td>
<td>5</td>
<td>0.05 kg</td>
</tr>
<tr>
<td>D. burkilliana</td>
<td>7</td>
<td>7</td>
<td>1.4 kg</td>
</tr>
<tr>
<td>Pilocereiphyllum cunningii</td>
<td>1</td>
<td>1</td>
<td>0 kg</td>
</tr>
<tr>
<td>D. minutiflora</td>
<td>21</td>
<td>not measured</td>
<td></td>
</tr>
<tr>
<td>Total of gathered yams</td>
<td>52</td>
<td>61</td>
<td>106.4 kg</td>
</tr>
</tbody>
</table>
13 Yam Biological Cycle

In order to clarify the interest of seasonality in harvesting, I have synthetized the biological cycle of *Dioscorea praeagens*, as revealed to us during this study.

I consider the beginning of the rainy season as a starting point, when the plant which has stored its maximum of reserve underground, has to renew its aerial stem.

The problem raised at this stage of plant maturity is mostly physiologic: as monocotyledonous vines, yams are not able to take benefit of the secondary growth (which characterizes dicotyledonous plants). It is vital for the plant that the apical meristem reach the canopy without being damaged by potential herbivorous insects. This forms the critical step of the plant cycle. If it fails, the plant will not be able to reproduce, since there will be no photosynthesis enabling the renewal of tuber reserves, and no sexual reproduction ensuring further plant generation. Doyle McKey and I have here discovered that annual tuber yam have elaborated a biotic defense against herbivorous insects. From glands located near the apical meristem, they produce a rich nectar which attracts ants. In return, ants protect the stem from its potential herbivorous predators (beetles, grasshoppers). Such sophisticated mutualism is being analyzed by Di Giusto (Pascal et al., submitted) on the individual plants which are kept in unharvested squares (white squares on Figure 12). Another consequence of this growth phase is that the plant must store not only energetic reserves (under the form of starch) but also nutrients which are necessary for the building of the stem during its growth. This storage thus justifies that starch rich yams are also rich in minerals and proteins (more than 10 % of dry weight for some species, Hladik and Hladik 1984, McKey et al. 1998). Nutrient and starch reserves which are stored in the tuber decrease until the photosynthetic material located in the canopy becomes efficient. Then, a new tuber is produced, and during the next dry season, once the reserves have been restored, the stem and leaves are progressively going to dry and disappear. As mentioned on this figure, the best period for harvesting annual tubers, intervenes during the dry season.

Fig. 13. Biological cycle of wild yam species producing annual tubers
14 Seasonal Production of Tubers

The quantitative data presented by Sato concerning biomass availability are consistent with those we have published earlier: 1 to 3 kg of fleshy tuber per hectare (Hladik and Dounias, 1993, 1996, 1997). Sato’s quantification, where undertaken during the rainy season and they mainly concern perennial species which belong to the *ndondo* sub-group (refer to Fig 7). During this period corresponding to sexual reproduction stage in the canopy, *D. praehensilis* tubers are almost indelible. But this period of low starch reserves in *D. praehensilis* tuber appears to be the best period for harvesting *ndondo* species. There exists a seasonal complementarity of tuber production between perennial tuber producing species and annual tuber producing ones, thus enabling continuous procurement of wild starch-rich food for forest dwellers throughout the year.

Seasonal complementarity between species is shown on Figure 14. Highest yield for *D. praehensilis* appears in December, while it intervenes in March for *D. smilacifolia*, and in September for *D. burkiliiana*. The tuber biomass given by Sato for *D. minutiflora* and the yam like *Dioscoreophyllum cumminsii* concern August period.

However the production of starch is proportionately 6 to 33 times higher for paracultivated species than for *ndondo* ones (exception made of *D. mangenotiana*—the King of yams—which associates paracultivation and *ndondo* morphology and which produces the larger quantity of starch reserves).

Fig. 14. Seasonal rates of tuber harvesting (g/hour)
15 Effect of Paracultivation

The positive effect of paracultivation on tuber production is visualized on Figure 15. I compare the average quantities of *D. praehensilis* tubers harvested in one hour by one gatherer, according to the number of stems emerging from each yam pit. For any period of harvesting that we may consider, the yield is significantly higher in paracultivated pits (with 2 stems per pit, called ndiá by the Baka), than the yield of individuals which are harvested for the first time, thus being characterized by only one stem per pit (such yam individuals are called mòpimá by the Baka). The situation is more complex for pits which contains 3 stems or more, since the yield decreases when there exceeds 4 stems per pit. These kinds of yam pits are called mòyákí by the Baka, and they generally correspond to yam individuals which have been harvested by the Mezime villagers. Even though the production of such pits is relevant, the Baka feel reluctant to dig them up because the use of the auger is no longer efficient.

Furthermore, this figure takes into account only harvestable individuals, but I must emphasize the fact that morbidity is very high among the mòyákí category. By contrast, in December 94, I checked out all the individuals which had been harvested and reburied for the first time during December 93 harvesting session, with respect of paracultivation process. None of them died. But a check up harvesting on 5 of them revealed that the average biomass of starchy parts was 20% lower than one year before. Such observation suggests that, in order to be sustainable, a paracultivated plant should not be harvested two years successively.

Fig. 15. Yield of *Dioscorea praehensilis* according to the number of heads

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I mòpimá: yam harvested for the first time
II ndiá: paracultivated yam
III mòyákí: yam already dug out before harvest session, but not paracultivated (exploited by villagers)
16 Conclusion

My presentation does not exactly respect what was initially announced in the title given for this paper: these are not final results. We are working with Doyle McKey and Martine Hossaert in elaborating a matrix model that would integrate the whole set of data we have been gathering during 4 years in our study plot. This model would include data on seedling survivorships which appear to be conditioned by light environment (Elias, 1996). In turn, the model should enable check the hypothesis that—in accordance with Baka's point of view—paracultivation has a profitable effect on wild yam demography, without affecting tuber production The model would also help us to test the last assumption that paracultivation should not be repeated every year and to determine the frequency of harvesting which would be convenient for paracultivated resource sustainability.

By then, Paracultivation encourages us to reconsider some preconceived stereotypes about foraging societies, who are generally seen as opportunists, and as parasites of their environment. Certainly, paracultivation as mentioned here for wild yams, might exist or have existed for other forest wild food resources. I can only encourage anthropologists to collaborate more closely with ecologists. Further understanding of such kind of indigenous resource management is necessary for estimating the impact of man on the dynamics of the tropical rain forests through the ages. Such understanding should be a preliminary step for any attempt to implicate foraging peoples to the sustainable management of the rain forests.

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