Chimpanzee's (Pan Troglodytes Verus) Activity and Feeding Patterns in Taï National Park, Côte d'Ivoire

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Abstract

In Taï National Park (TNP), communities of wild chimpanzees (Pan troglodytes verus) have been studied since 1979. Studies have characterized the plant species diversity and the vegetation structural parameters of their habitats. However, the variability of the activities and feeding patterns of these chimpanzees have not yet clarified during a full year. The present study aimed to (1) identify the activities and feeding patterns of TNP chimpanzees and (2) determine the basic diet of their feeding during 15 consecutive months. Activity budgets (feeding, travelling, resting, etc.) was quantified from instantaneous focal animal samples on individual chimpanzees of three. Feeding is considered here as active consumption of plant parts as well as soil and animal prey. The diversity of the plant species component in chimpanzees' diet was calculated. Result showed that the chimpanzees of TNP spent more than half of their active time on feeding activities. The chimpanzees' diet in TNP consisted mainly in fruits supplemented by leaves mostly during wet season. A large range of plant species composing the diet and the availability of 30 of them during a full year can contribute to establish the scientific basis for their communities monitoring and their viability.

Keywords — *Chimpanzees, activity budget, feeding time, diet variation, Taï National Park..*

I. INTRODUCTION

The Chimpanzee (*Pan troglodytes*), is one of the most studied because of its genetic proximity with human. In the multitude of subjects covered, food ecology holds a special place. Indeed, the diet of chimpanzees has been studied across Africa in various habitat types ([1], [2]). These studies show that the diet of chimpanzees is varied, consisting predominantly of fruit, but supplemented by the frequent consumption of other plant material (such as leaves, pith, seeds, Bark) and insects (ants, termites, etc.). From time to time, meat is also consumed. Although it represents only 1 to 3% of the entire annual diet, it remains a highly valued element ([2], [4]).

Studies on the diet of chimpanzees have resulted in the publication of long lists of species consumed [5]. However, whenever the relative contributions of these species are given, it appears that, on a broad spectrum of plants consumed during the year, only very few constitute the basic diet. Field studies have shown that primates do not feed at random but have clear preferences for certain parts (fruits, flowers, leaves ...) or certain plant species [6]. Thus, over a broad spectrum of potentially available food resources, they spend a considerable amount of time consuming a limited number of fruit species ([7], [8], [9]). This varied food repertoire would doubtless be only the response to changes in fruit production. Thus, they were described as "opportunistic frugivorous" by [10].

Since 1979, three distinct neighboring communities of chimpanzees of the Taï National Park, habituated to human observers [11] have been studied. The territory of each community was characterized based on species diversity and structural parameters of their habitats [12]. These habitats were reached of 264 plant species, with dbh (Diameter at breast height) greater than 10 cm, dominated by *Diospyros mannii, Calpocalyx brevibracteatus,* and *Coula edulis* which are food species for chimpanzees [13] in Taï area. Also, [14] have demonstrated that the Taï National Park chimpanzees crack the nuts of some plant species such as *Coula edulis* and *Parinari excelsa* using stones as hammers to open the nuts. However, these studies did not give the general activity and feeding patterns of these chimpanzees. Also, the diversity and the importance of the variability of the food types in the diet at Taï level are not well documented. The current study tries to answer the following question: how chimpanzees in the Taï National Park allocate their time to the activities and the various food resources available in their territory and how the consumption of the food varies through time during a year. The main objective was to characterize the TNP chimpanzees' activities and their feeding patterns. For this, we have identified the activity and feeding patterns and estimate the

diversity of plant species composing their diet. By contributing to a best knowledge of chimpanzees' food types and variability, this study establishes a scientific basis for their communities monitoring and its viability in the Tai National Park.

II. METHODS

A. *Study site*

We collected data in the Taï National Park, on chimpanzee communities (Figure 1), over a period of 15 consecutive months from October 1999 to December 2000. The Taï National Park, comprises evergreen lowland rain forest and remains the largest protected forest fragment in West Africa. The Tai Chimpanzee Project was established in 1979 in the west of Tai National Park, Côte d'Ivoire. Habituation of North community was completed by 1984 and of South and Middle communities by 1995. Almost daily observations of all communities have been ongoing since. For more information about this field site see [11].

The studied communities have never been provisioned and are fully habituated to researchers [15]. There are twelve species of diurnal primates including chimpanzees, black and white colobus monkeys. The climate is characterized by two rainy seasons (Mar–June and September–October) and two dry seasons (July–August and November–February) with approximately 1,800 mm rainfall per year [11]. The mean monthly temperature varies between 24–28°C.

The Taï National Park is of high importance for global biodiversity, and contains about 1300 species of trees and shrubs ([16], [12]). The TNP chimpanzee communities live in a territory containing at least 264 plant species (with dbh ≥ 10 cm) belonging to 180 genera and 52 botanical families [17], The dominant plant species are *Diospyros mannii*, *Calpocalyx brevibracteatus*, and *Coula edulis* [12]. The studied territories present a density (486.5 individuals/ha) and a basal area (30.88 m2/ha) similar to those of most tropical forests [16]. Vegetation structure reveals that those habitats are stable with high regeneration capacity.

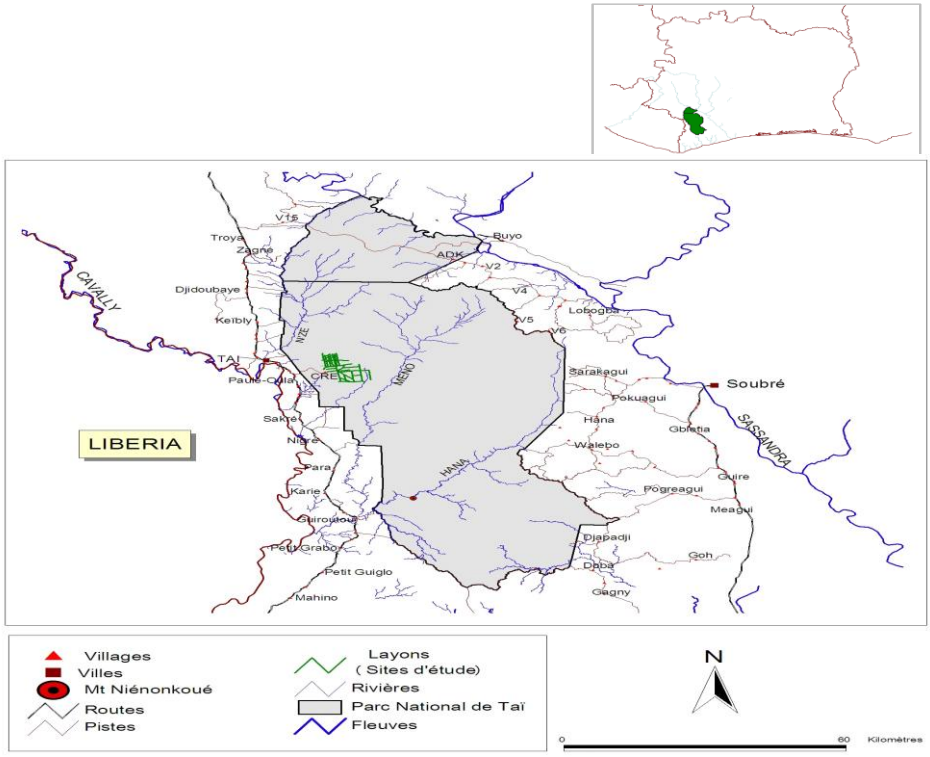

Figure 1: location of the Study site in Taï National Park, South west of Côte d'Ivoire

B. *Data collection*

To quantify activity budgets, we collected instantaneous focal animal samples [18] on individual chimpanzees. We followed an individual animal for approximately eight hours each day. We changed focal animals daily (when possible) and all adult chimpanzees from the communities were followed as focal subjects. We recorded all activities of the target individuals. Focal animal behaviors were classified as: feeding (foraging), travelling, or resting. Feeding was defined as active consumption of plant parts (e.g. fruits, leaves) as well as soil and prey, while travelling was time spent moving from a point to another and resting as time devoted to inactivity. We noted as "Other interactions", activities where the target animal

was involved in social interactions such as grooming, playing, mating, or hunting.

About feeding behavior, in order to quantify the diet, we noted the time spent on the type of food eaten when the focal animal was foraging. The food item was classified as "Animal food" (insects and animal preys), "Plant food" (fruits, seeds, leaves, pith, flowers) or "Other" (soil, rotten wood). For "Plant food", the plant species was noted and the part eaten specified. We distinguished fruits, leaves, piths and other parts. Under the term fruit, we grouped all types of fruits and seeds. There was no distinction made between mature and unripe fruit in this classification. All plant species entering the diet of chimpanzees were noted.

C. Data analysis

We compiled the monthly data in two ways. First, we simply calculated the mean percent of monthly feeding time devoted to each food across all months in the sample (N=15). Then, the overall diet was defined as all food species consumed by the chimpanzees during the study period. Secondly, we examined foods in terms of their importance in the chimpanzee diet. We defined important food as those consumed for more than 5% of the total feeding time. For each consumed plant part, the seasonality variability was compared considering rainy seasons (March, June, September and October) and relatively dry seasons (July, August, November and February) by using t-test or Man-Whitney U test when the parametric test could not be applied. .

In order to determine the most consumed plant species, we classified them according to several criteria, namely their consumption time during the 15 months of the study and the number of months during which they were consumed.

Dietary variability was described in terms of diversity (number of plant foods species eaten each month). We calculated dietary diversity in two ways. First, we calculated a diversity value for each month and for the composite diet using the Shannon Diversity Index (H') according to the following formula:

$$H' = \sum_{i=1}^{n} Pi\ln(Pi)$$

In this formula, p is the percentage of feeding time accounted for by the ith species and ln(p) is the natural logarithm of this value.

Following [19], we also calculated a normalized diversity value, [20] equitability index, or J' for each month and for the composite diet to control for variation in the number of foods; this is given by:

$$J' = H'/\ln(N)$$

Where N is total number of plant foods species eaten during the study period

III. RESULTS

D. Activity and feeding patterns

During the 15 month-period of the study, the chimpanzees of Taï National Park spent most of their time feeding (54.07%), followed by resting (24.66%), travelling (16.32%), and other interactions (4.94%) as shown by **Figure 2**

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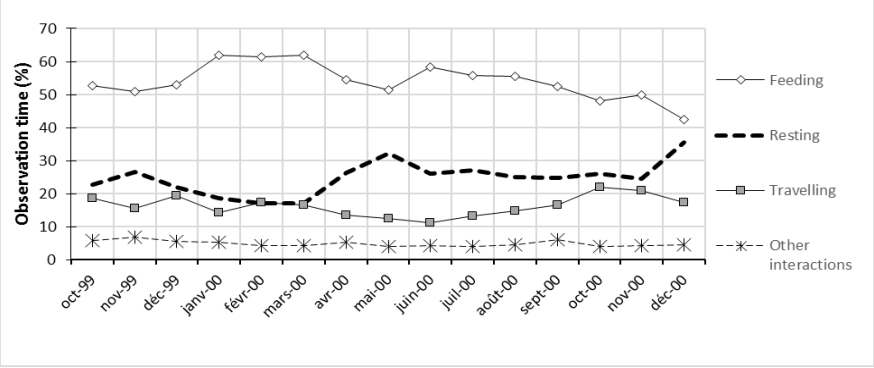

Figure 2: Chimpanzees' activity pattern during the study period

During the 15 months, feeding concerned more plant resources (97.78%) than others food type: animal food (1.59%) and the other resources (0.63%) (**Figure 3**).

Concerning animal resources, the studied chimpanzees have consumed meat from monkeys caught during hunting parties that they organize regularly. They also consume many species of insects, termites and ants. These different animal resources represent an average of 1.77% of the time devoted to food. Other food resources consist mainly of mushrooms, mineral and organic matter (soil and rotted wood) and water. They represent on average 0.75% of the time devoted to food.

Concerning the plant food (**Figure 4**), the chimpanzees were observed to feed on all plant parts, the preferred parts being fruits (84.91%), followed by

leaves (10.52%), pith (3.41%) and other parts (1.16%). During the dry season, fruit were consumed with 92% of the time. This duration decreases at 79 % in wet season. In contrast, the leaves consumption time increased from dry season (4%) to wet season (17 %). There was a significant difference in fruit ($p = 0.0091$) and leave ($p = 0.0066$) consumption between dry and wet months. Piths are the soft central part of non-woody herbaceous plants or monocotyledons commonly encountered in flooded environments. They represent on average 4% of the time devoted to plants. The other parts are flowers, barks, gums and resins. They represent less than 1% of the time devoted to plants. Pith and other parts consumption showed not significant difference between seasons (Figure 5).

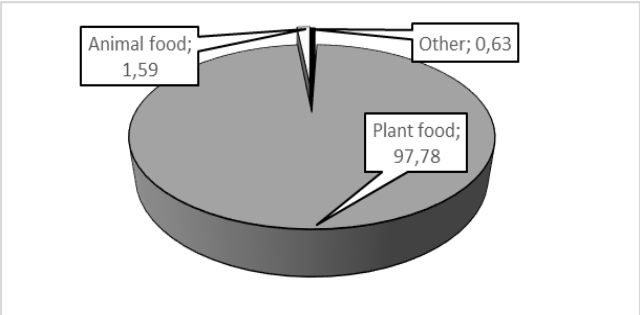

Figure 3: Different food kind consumed during the study period

E. Diversity of the plant species consumed

Composition of Chimpanzees' diet in Taï National Park during the study period (15 months) is given in **Table 1**.

During the 15 month-period of the study, the chimpanzees in the Taï National Park were found to eat at least 157 different types of food from 118 species of plants belonging to 42 taxonomic families. The Fabaceae contributed 16 species followed by Malvaceae with 11 species.

Seven plant species were consumed for more than 5% of total feeding time. They accounted for 55.73 % of total feeding time. The most widely consumed species are Parinari excelsa, Sacoglottis gabonensis, Coula edulis, Ficus spp, Klainedoxa gabonensis, Scotellia klaineana, Chrysophyllum taiense. Among these species, *Parinari excelsa* with 15.42 % of feeding time has been eaten during all the 15 months. Eighty-six (86) species were eaten for their fruit, fifty-one (51) for their leave, ten (10) for their pith and two (2) for their flower. Fifty (50) plant species accounted for less than 1% of the feeding time and chimpanzees spent 50.2% of the feeding time on only six species (**Table 1**).

The plant species consumed by Taï chimpanzees, were diversified every month. Overall diversity was moderate ($H = 3.136$). Monthly diversity values varied from 1.493 to 4.033 (mean 3.129 ± 0.711). Monthly Evenness J' values varied from 0.320 to 0.865 (mean 0.671 ± 0.152). The chimpanzees' diet was the most diversified during the month of November ($H' = 4,033$) and the least diversified during the month of August ($H' = 1,493$ respectively)

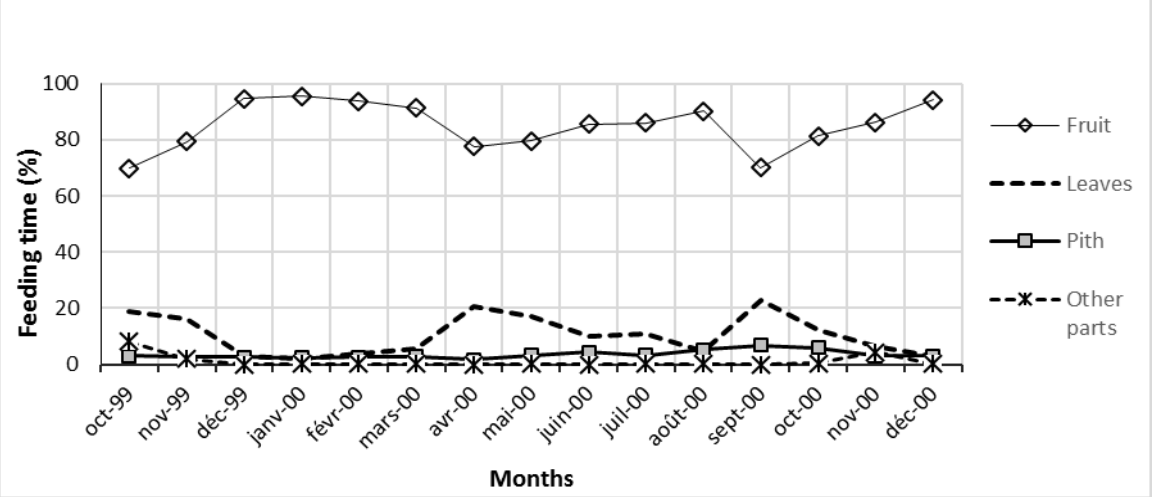

Figure 4: Consumption of plant parts during the study period

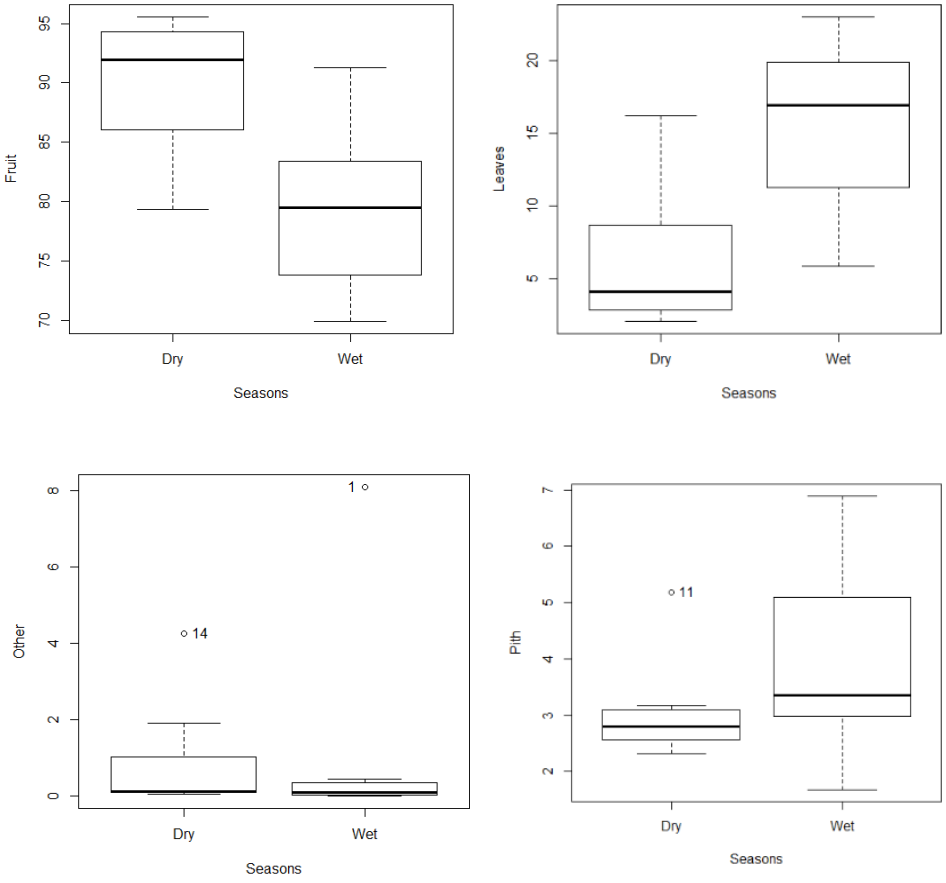

Figure 5: Comparison of the consumption of different food types between wet and dry seasons

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Table1: Composition of the diet of the chimpanzees of Taï National Park during the study period.
% FT = percentage of feeding time

N°	Species	Families	Number of eaten months	% FT	Part eaten
1	Parinari excelsa Sabine	Chrysobalanaceae	15	15.4196	Fruit, seeds
2	Sacoglottis gabonensis (Baill.) Urbain	Humiriaceae	15	9.7964	fruit
3	Coula edulis Baill.	Olacaceae	11	6.5064	seeds
4	Ficus spp.	Moraceae	15	6.4351	leaves, fruit
5	Klainedoxa gabonensis Pierre	Irvingiaceae	8	6.0916	fruit
6	Scottellia klaineana var.klaineana Pierre.	Achariaceae	4	5.9648	fruit
7	Chrysophyllum taiense Aubrév.et Pellegr.	Sapotaceae	7	5.5195	fruit
8	Cola spp. (C. nitida, C. attiensis)	Malvaceae	15	3.8665	leaves, fruit
10	Calpocalyx spp. (C. aubrevillei, C. brevibracteathus)	Fabaceae	10	3.2445	leaves, seeds
12	Dacryodes klaineana (Pierre) Lam.	Burseraceae	6	3.1538	fruit
13	Nauclea spp. (N. diderrichii, N. xanthoxylon, Sarcocephalus pobeguinii)	Rubiaceae	10	2.9506	fruit
16	Xylia evansii Hutch.	Fabaceae	6	2.4302	leaves, seeds
17	Dialium aubrevillei Pellegr.	Fabaceae	12	2.2902	leaves, fruit, seeds
18	Afzelia bella Var. gracilor Harms	Fabaceae	12	2.2407	leaves, fruit
19	Treculia Africana Decne.	Moraceae	13	2.0749	fruit, seeds
20	Irvingia spp. (I. gabonensis, I. grandifolia)	Irvingiaceae	14	1.776	fruit, seeds

22	Memecylon spp.	Melastomataceae	7	1.7735	fruit
23	Halopegia azurea (K.Schum.) K.Schum.	Marantaceae	15	1.4803	pith
24	Sterculia oblonga Mast.	Malvaceae	10	1.3933	leaves, fruit
25	Uapaca spp. (U. escuenta, U. guineensis, U. paludosa)	Phyllanthaceae	13	1.2198	fruit
28	Pycnanthus angolensis (Welw.) Warb.	Myristicaceae	7	1.2188	fruit
29	Strombosia pustulata Oliv.	Olacaceae	3	0.996	fruit
30	Panda oleosa Pierre	Pandaceae	15	0.9804	seeds
31	Pouteria aningeri Baehni.	Sapotaceae	2	0.9698	fruit
32	Hypselodelphys violacea (Ridl.) Milne-Redh.	Marantaceae	15	0.9337	fruit, pith
33	Landolphia spp.	Apocynaceae	15	0.8592	leaves, fruit
34	Trichoscypha spp. (T. arborea, T. beguei)	Anacardiaceae	3	0.8336	fruit
36	Glyphaea brevis (Spreng.) Monach.	Malvaceae	15	0.5279	leaves, fruit
37	Eremospatha macrocarpa H.Wendl.	Arecaceae	15	0.4855	pith
38	Parkia bicolorA.Chev.	Fabaceae	3	0.4606	fruit, seeds
39	Scytopetalum tieghemiiA.Chev.ex Hutch.	Lecythidaceae	5	0.4581	fruit
40	Zanha golungensisHiern	Sapindaceae	2	0.4453	fruit
41	Gilbertiodendron splendidum (A.Chev.ex Hutch.et Dalz.) Léonard	Fabaceae	2	0.373	seeds, flower
42	Elaeisguineensis Jacq.	Arecaceae	15	0.3409	leaves, pith
43	Pseudospondias microcarpa (A.rich.) Engl.	Anacardiaceae	5	0.277	fruit
44	Manniophyton fulvum Müll. Arg.	Euphorbiaceae	15	0.2749	leaves
45	Triplochiton scleroxylon K.Schum.	Malvaceae	6	0.2272	leaves
46	Magnistipula butayei De Wild.	Chrysobalanaceae	9	0.2206	fruit
47	Dichapetalum spp.	Dichapetalaceae	15	0.2035	leaves
48	Duboscia viridiflora (K.Schum.) Mildbr.	Malvaceae	5	0.1935	leaves, fruit
49	Pachypodanthium staudtii Engl. Et Diels	Annonaceae	5	0.1876	fruit
50	Manilkara obovata (Sabine et G.Don) J.H.	Sapotaceae	2	0.186	fruit
51	Syzygium spp.	Myrtaceae	2	0.1839	fruit
52	Erythroxylum mannii Oliv.	Erythroxylaceae	5	0.1798	fruit
53	Urera obovata Benth.	Urticaceae	9	0.1792	leaves
54	Cordia platythyrsa Bak.	Boraginaceae	3	0.1714	leaves, fruit
55	Detarium senegalense J. F. Gmel.	Fabaceae	7	0.1608	seeds
56	Leptoderris sp.	Fabaceae	12	0.1543	leaves
57	Vitex spp.	Lamiaceae	2	0.1231	fruit
58	Laccosperma secundiflorum (P. Beauv.) Kuntze.	Arecaceae	15	0.1206	pith
59	Bombax buonopozense P. Beauv.	Malvaceae	4	0.1019	seeds
60	Keayodendron bridelioides (Mildbr.ex Hutch.)	Phyllanthaceae	4	0.1003	fruit
61	Palisota hirsuta (Thunb.) K.Schum.	Commelinaceae	14	0.0857	pith
62	Dioscorea spp.	Dioscoreaceae	15	0.081	leaves
63	Zanthoxylum gilletii (De Wild) Waterman.	Rutaceae	15	0.077	leaves
64	Myrianthus spp.	Moraceae	11	0.0739	leaves, fruit
65	Musanga cecropioides R.Br. ex Tedlie	Urticaceae	10	0.0729	leaves, fruit
66	Desplatsia spp.	Malvaceae	15	0.0711	leaves, fruit
67	Aframomum spp.	Zingiberaceae	15	0.0679	leaves, fruit, pith
68	Pentaclethra macrophylla Benth.	Fabaceae	2	0.0664	seeds

69	Beilschmiedia spp.	Lauraceae	7	0.0564	fruit
71	Dactyladenia spp.	Chrysobalanaceae	3	0.0552	fruit
73	Baphia spp.	Fabaceae	13	0.0483	leaves
75	Drypetes spp.	Putranjivaceae	1	0.0418	leaves, fruit
76	Antiaris toxicaria var.africana (Engl.) C. C.	Moraceae	1	0.0414	leaves, fruit
77	Diospyros spp.	Ebenaceae	5	0.0396	leaves, fruit
80	Strychnos aculeata Soler.	Loganiaceae	5	0.0393	leaves
81	Daniellia thurifera Benn.	Fabaceae	1	0.0362	leaves
82	Uvariastrum pierreanum Engl.	Annonaceae	2	0.0327	fruit
83	Dorstenia africana (Baill.) C.C.Berg	Moraceae	5	0.0284	leaves
84	Grewia malacocarpa Mast.	Malvaceae	2	0.0231	leaves, fruit
85	Sarcophrynium spp.	Marantaceae	4	0.0209	pith
86	Maesobotrya barteri var. sparsiflora (Baill.) Hutch.	Phyllanthaceae	4	0.0184	leaves, fruit
87	Raphia spp.	Arecaceae	8	0.0162	pith
88	Agelaea paradoxa Gilg	Connaraceae	4	0.0159	fruit
89	Tarrietia utilis (Sprague) Sprague	Malvaceae	7	0.0153	seeds
90	Piper guineense Schumach. &Thonn.	Piperaceae	1	0.0122	leaves, fruit
91	Uvariodendron occidentale Le Thomas	Annonaceae	2	0.0122	leaves
92	Pancovia sp.	Sapindaceae	1	0.0115	fruit
93	Berlinia grandiflora (Vahl) Hutch. et Dalz.	Fabaceae	1	0.0097	leaves
94	Mammea africana Sabine.	Calophyllaceae	2	0.0081	fruit
95	Milicia excelsa (Welw.) Berg.	Moraceae	2	0.0081	leaves, fruit
96	Millettia zechiana Harms	Fabaceae	1	0.0081	leaves
97	Rhaphidophora africana N. E. Br.	Araceae	5	0.0078	leaves
98	Rourea coccinea (Schumach. &Thonn.) Benth.	Connaraceae	6	0.0062	leaves
99	Tristemma sp.	Melastomataceae	1	0.0056	leaves
100	Ceibapentandra (Linn.) Gaertn.	Malvaceae	2	0.0041	leaves
101	Calamus deerratus G.Mann&H.Wendl.	Arecaceae	5	0.0034	leaves
102	Rothmannia sp.	Rubiaceae	1	0.0034	fruit
103	Anchomanes difformis (Blume) Engl.	Araceae	2	0.0028	leaves
104	Eugenia calophylloides DC.	Myrtaceae	1	0.0028	fruit
105	Psydrax arnoldiana (De Wild. & T. Durand) Bridson	Rubiaceae	1	0.0028	leaves
106	Placodiscus boya Aubrév. et Pellegr.	Sapindaceae	1	0.0025	leaves, fruit
107	Marantochloa sp.	Marantaceae	1	0.0016	fruit, pith
108	Anthonota sp.	Fabaceae	1	0.0009	leaves
109	Spondianthus preussii var. preussii Engl.	Phyllanthaceae	1	0.0006	leaves, fruit
110	Piptostigma fasciculatum (De Wild.) Boutique	Annonaceae	1	0.0006	fruit
111	Coffea liberica Bull ex Hiern	Rubiaceae	1	0.0006	fruit
112	Cuviera nigrescens (Oliv.) Werhnam	Rubiaceae	1	0.0006	leaves
113	Mussaenda sp.	Rubiaceae	1	0.0006	leaves
114	Annona sp.	Annonaceae	1	0.0003	fruit
115	Aporrhiza urophylla Gilg.	Sapindaceae	1	0.0003	flower
116	Pentadesma butyracea Sabine	Clusiaceae	1	0.0003	fruit
117	Friesodielsia enghiana (Diels) Verdc.	Annonaceae	1	0.0003	fruit
118	Uvaria sp.	Annonaceae	1	0.0003	fruit

IV. DISCUSSION

The chimpanzees from Taï National Park spent more of the half of their time feeding. They rest more than they travel. As shown by ([21] [22]), Primates display wide interspecific and intraspecific variations in activity patterns. Some species spend much of their time foraging while travelling over long distances each day and surviving on patchy, high quality food sources. Other species adopt a strategy of energy conservation, feeding on relatively abundant food items and spending most of the day resting, and travelling short distances, that is the case of Taï chimpanzees. The relative low amount of time spent on travelling by the chimpanzees in Taï National Park may indicate an adaptation to their environment. Indeed, the stability of these chimpanzee habitat was demonstrated by [12]. This fact is also confirmed by the regular time spent on social activities (grooming, playing, mating,). Indeed, according to [23], once the chimpanzees' home range was defined and food patches identified, travelling time for food searching decreases.

Our results showed that the diet of chimpanzees in the Taï National Park (TNP) is variable, consisting mainly of fruits supplemented by the frequent consumption of other vegetal materials (leaves, seeds, pith, and bark) and insects (ants, termites, etc.). However, the plant resources are the main food resource for Taï chimpanzees (97.49% of the time spent on food). This diet of chimpanzees is dominated in TNP by fruits (84.91 %). In Budongo, Uganda, [24] showed that chimpanzees are 90% frugivorous. [25] described them as "mostly frugivorous" in Rio Muni, Equatorial Guinea. In Tanzania, [26] reported that out of the 60% of the 80 food types of chimpanzees are fruits. In the same country, [27] reported 78% of time devoted to fruit and seed consumption by Kibale chimpanzees. [28] reported that fruits made up 35.7% of chimpanzee food types in the woodland savanna of the Kasakati Basin (Tanzania). By compiling chimpanzee diet data from 24 studies at 11 different study sites, [4] found an average value of 64% fruit. This value is similar to results from drier regions ([29]: on average 62%). However, it is lower than the values usually obtained from chimpanzee populations in tropical moist forests such as Kibale (on average 78%) according to [30]. The chimpanzees of the Taï forest, with an average of 85% of time devoted to fruit consumption, position themselves as one of the most frugivorous populations. To balance their diet, from time to time, meat, a highly valued element [11], whose importance varies according to the seasons, is also consumed by these primates in TNP. They also consume many species of insects, termites and ants during hunting parties that they organize regularly.

study shows also that the chimpanzees of Taï National Park exploit a large range of plant species (118 species). This number is lower than the what can be expected by long term data. A comparison of the diets of this population of chimpanzees from Bossou in Guinea, Gombe and Mahale in Tanzania with that of the chimpanzees in the Taï National Park shows that they have a very rich diet in number of species as well. Although the composition of the diet reflects a preference and availability effect, these data suggest that a tropical forest habitat can provide a richer, more stable source of fruit than open habitats [31]. Generally, wild populations of chimpanzees are reported to consume variable numbers of plants, from only 45 plant species being recorded in Semliki, Uganda [32] to 200 plant species recorded in Bossou population (Guinea, [33]). Thus, it appears that the diversity of diet in the released chimpanzees of TNP (118 plant species) is within the range found in wild animals.

The most widely consumed species are *Parinari excelsa, Sacoglottis gabonensis, Coula edulis, Scotellia klaineana, Chrysophyllum taiense, Klainedoxa gabonensis, Ficus spp.* These species have been also reported by [34] as food resource entering in the diet of many other primates. Among these species, [14] have demonstrated that the Taï National Park chimpanzees crack the nuts of *Coula edulis, Parinari excelsa, Sacoglottis gabonensis* using wood or stones as hammers to open the nuts to access the nutritious kernel. These chimpanzees spend 21.43 % of the year cracking one type of nut *Sacoglottis gabonensis* as reported by [35]. Coula edulis nuts are very abundant and the softest of all; Parinari excelsa is very large trees with irregular fruit production. For [36] one of the keystone resources entering in chimpanzees' feeding, is the fig, which is available throughout the year. Since figs are eaten almost every month in Tai, they should be considered as staple food rather than as reserves [19].

Result from seasonal feeding comparison show that, fruit consumption time decreases during rainy months and increases during dry months. Generally, in African tropical humid forest area, fruit availability is maximal during dry months ([37], [38]). The decreasing of fruit consumption during wet season was offset in PNT area by increased leaf consumption. Thus, the consumption of leaves increases during the rainy months and decreases during the dry months. In other words, based to the time allocation to leaves and fruits of the plants consumed, we demonstrated that these parts are not consumed in the same way within one year. However, the consumption of the other parts remains fairly constant throughout the year. "Optimal food search theory" predicts that an animal broadens its diet during periods of low food abundance, decreasing its specialization when the cost of food search increases [39]. It is shown that when the most popular fruits are not available, chimpanzees expand their diets to more widely available and often poor-quality foods [40]. However, other studies have shown that increases in diet diversity during periods of low

food abundance are not significant ([41], [42]). This suggests that the increase in consumption of poor quality plants remains more selective than the predictions of "optimal food search models", which do not incorporate concepts of absolute nutritional value, essential nutrient balance, and avoiding secondary toxic plant compounds [43].

In the case of this study, we think that, the most obvious seasonal change in the diet of chimpanzees would be the variation in the number of plant species consumed according to the seasons. [44] suggested that leaf or seed consumption would be the last resort for mostly frugivorous primates. Thus, changes in the types of food items appear to be a common strategy for primates faced with fluctuations in fruit availability [45]. During periods of fruit shortages, chimpanzees in Kibale (Uganda) and Lopé (Gabon) increase their intake of a range of plant foods including leaves and marrow from terrestrial herbaceous plants ([10], [46]). In Bossou (Guinea) and elsewhere, chimpanzees are increasingly exploiting oil palm nuts during periods of low food availability [41]. On some sites, figs (Ficus spp.), which are available throughout the year, are important alternatives during periods of shortage of other fruits [41]. In mountain forests where fruit diversity is low, figs are the preferred food throughout the year [47]. In Taï, we did not observe during this study of period of food restriction because on average, 30 species of plants entered monthly in the diet. However, a relatively small number of species (11 species) represented more than 75% of the total time devoted to feeding.

V. CONCLUSIONS

This study reveals interesting changes in feeding ecology and activity patterns in released Taï National Park (TNP) chimpanzees over the investigated time period of 15 months. The chimpanzees from Taï National Park spent more of the half of their time feeding and spent least time on travelling. Many plant species have been identified as entering in the feeding composition of these chimpanzees. Due to the availability of at least 30 plant species entering each month in their feeding, social and ecological sustainability of these chimpanzees' communities in the TNP could be ensured. Fruits, the most attractive food type, are more available in the dry than the wet season. However, chimpanzees in TNP are ecologically flexible omnivores with broad diets comprising many plant and animal foods. The changes in activity pattern as well as the changes in feeding ecology of these chimpanzees seem to reflect important behavioral and ecological adaptations to their environment.

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