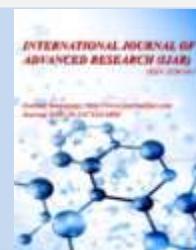




Journal Homepage: [-www.journalijar.com](http://www.journalijar.com)

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/21977
DOI URL: <http://dx.doi.org/10.21474/IJAR01/21977>



RESEARCH ARTICLE

SELECTION OF PLANTS CONSUMED BY CHIMPANZEES AND HUMANS IN AN AGROFORESTRY SYSTEM ON THE EASTERN PERIPHERY OF TAÏ NATIONAL PARK, SOUTHWESTERN COTE D'IVOIRE

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Manuscript Info

Manuscript History

Received: 13 August 2025

Final Accepted: 15 September 2025

Published: October 2025

Key words:-

Chimpanzee, Human, Food Plants,
Human-Wildlife Conflicts

Abstract

The main objective of this study, which took place in the eastern peripheral zone of the Taï National Park (TNP), was to identify the food plants consumed by chimpanzees and humans. The methodology consisted first of all in conducting a bibliographic research, then in conducting surveys among local populations and in carrying out pedestrian surveys in the plantations in the eastern peripheral zone of the TNP. At the end of the surveys, 13 plant species were listed as being consumed by both chimpanzees and humans. The main organs of these consumed plants are : fruits, leaves, stem pith. Of the 13 plant species, five (5) are domesticated in the plantations. While some of these plants are either left in the plantations by farmers for their food use, others have been introduced into the plantations at the instigation of the park manager in order to limit human-wildlife conflicts.

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Introduction:-

The whole world is facing a worrying degradation and loss of biodiversity due to human activities (Norro, 2017; IUCN, 2019). One of the strategies adopted globally in recent decades to mitigate biodiversity degradation is agroforestry (Torquebiau et al., 2002; FAO, 2008). Agroforestry is a land use system in which woody species are deliberately used on the same unit as agricultural plants, animals in a form of spatial arrangement or temporal sequence (Lundgren & Raintree, 1982; Alexandre, 2002). In Cote d'Ivoire, the natural spaces where animals still live are a few "green islands" in the middle of farms, thus causing discomfort on both sides. Indeed, completely cleared areas containing only agricultural plants still do not have the desired yield and when they are close to natural habitats, animals come to help themselves. In the southwest of the country, the main remaining natural area is the Taï National Park (PNT). It still contains great wealth of both flora and fauna. However, it is subject to a lot of pressure from populations, especially on its eastern periphery where there are large farms. The chimpanzee, a species classified as "Critically Endangered", still present in large numbers in this park, often comes into conflict with humans, both inside the park and in the plantations. Indeed, the chimpanzee is a species that has many food

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resources in common with humans (IUCN, 2020). This spatial and food proximity requires cohabitation that should be analyzed in the interest of both species. Indeed, to understand our feeding behavior, we must go back well beyond the period during which *Australopithecus* and the first species of the genus *Homo* differentiated. The search for food, for a chimpanzee, necessarily depends on the ecosystem, where one can freely use the available products distributed both in space and time according to the periodicity of seasonal climatic phenomena (IUCN, 2020). Even if entering the park without authorization is illegal, people continue to go there to gather food plants for their needs, undermining the integrity of this world heritage. Also, chimpanzees make devastating incursions into the fields on the periphery of the park. To mitigate these conflicts and find solutions that benefit humans and animals, an agroforestry project with food plants has been initiated on the eastern periphery of the park. To contribute to this initiative, it would be useful to focus on food plants consumed by both humans and chimpanzees. The overall objective of this study is to contribute to sustainable wildlife management by mitigating human-wildlife conflict. Specifically, it involves: (i) identifying food plants consumed by chimpanzees; (ii) identifying food plants consumed by both chimpanzees and humans.

Methodology:-

Study site:-

Tai National Park is located in the southwest of Cote d'Ivoire, between $5^{\circ}10'$ and $6^{\circ}20'$ north latitude and between $4^{\circ}20'$ and $6^{\circ}20'$ west longitude. It is located in the Cavally and Nawa region, near the border with Liberia. It is approximately 20 km east of the town of Tai (Esser, 1994). The park covers a total area of approximately 536,000 ha (IUCN, 2008) (Figure 1).

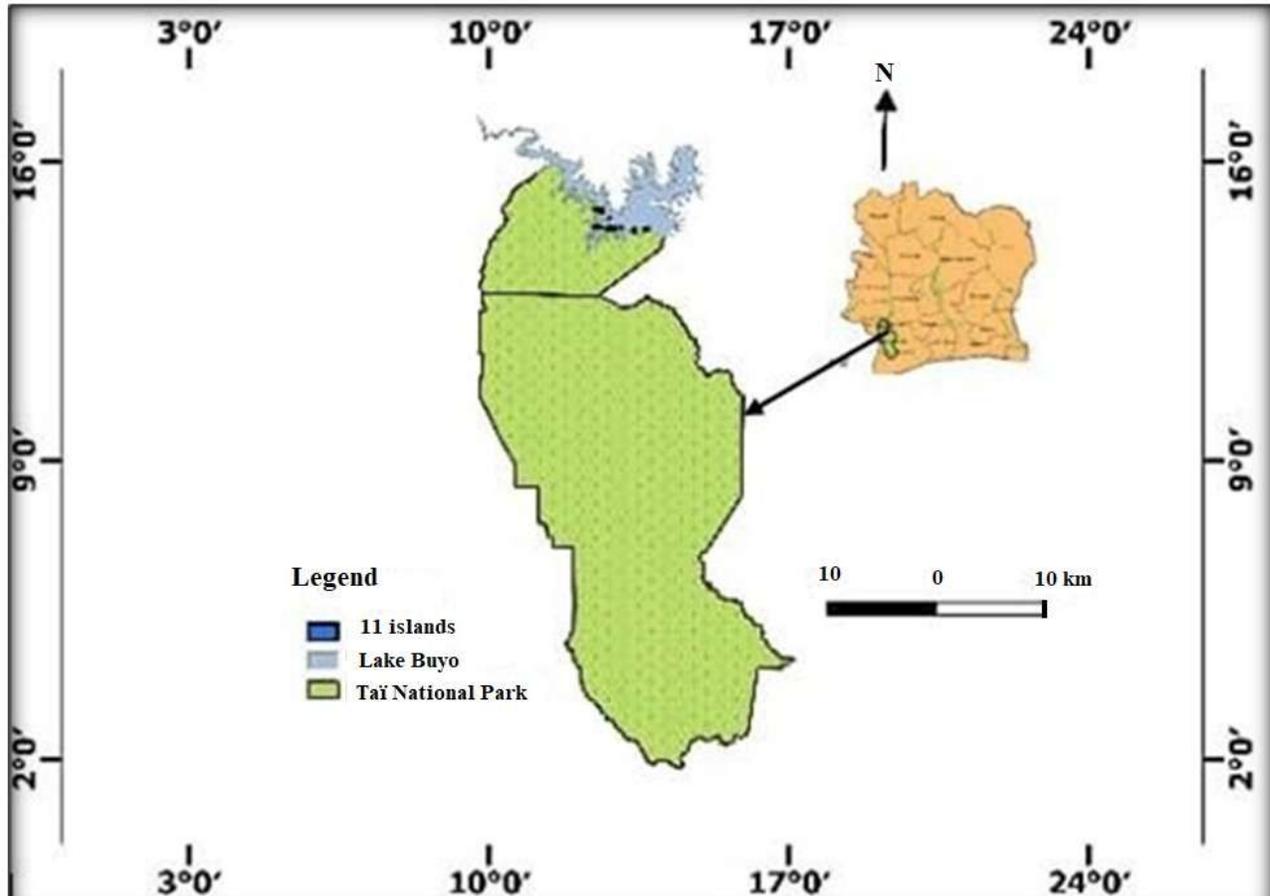


Figure 1 :Location of Tai National Park

Data collection methods:-

Three methods were combined to carry out this work in order to maximize the reliability of the results, (i) bibliographic research (ii) surveys of local populations (iii) pedestrian prospecting. The criteria for selecting villages

for data collection were based on their proximity to the park. Thus, the data were collected in the villages of Tietaly located in the Buyosub-prefecture and Sarakagui in the Soubre sub-prefecture (Figure 2).

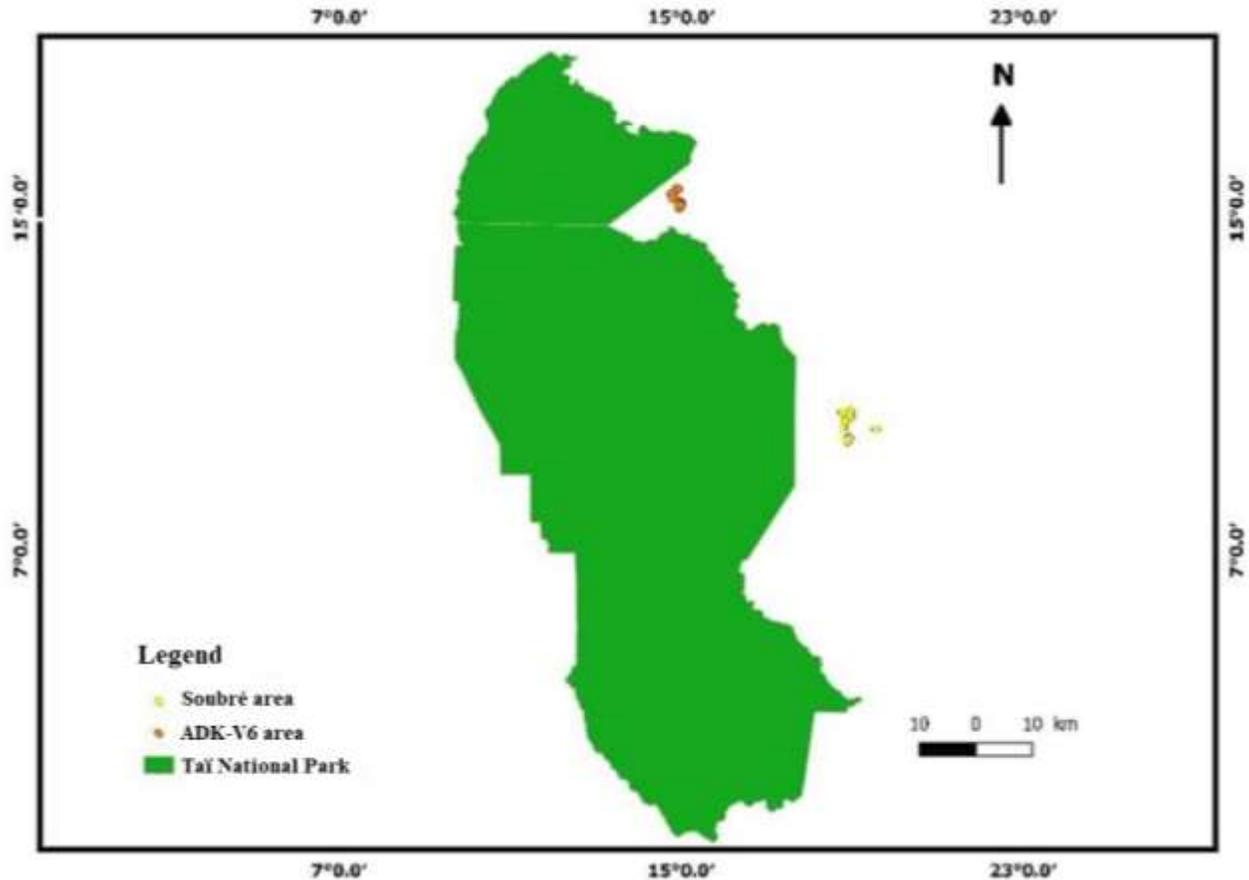


Figure 2 :Soubre (Sarakagui) and ADK-V6 (Tietaly) data collection areas

Bibliographic research:-

Research on the diet of chimpanzees in Taï National Park (PNT) was consulted in order to produce a list of plants regularly consumed by them (Gone Bi, 2007; N'guessan, 2012).

Survey of local populations:-

The objective of this survey was to obtain from the population the names of plants consumed by chimpanzees and humans. To achieve this, people from two villages located on the periphery of the PNT were interviewed. During this survey, individuals who had stayed in the area for a long time, people who had their plantation on the periphery of the park, and OIPR guides involved in ecological monitoring programs were interviewed. A total of 20 people were individually interviewed. The surveys were conducted with the prior agreement of the village chiefs.

Foot prospecting:-

The objective of the pedestrian surveys on the periphery of the PNT was to confirm the presence in the plantations of the plants reported during the surveys and present on the referencelist while marking their geographical coordinates. The pedestrian surveys were carried out using the reconnaissance walking technique. This technique consists of making observations while moving slowly and silently at a speed of approximately 0.5 to 1 km/h, using areas of least resistance in the plantations (animal tracks, human tracks, clear undergrowth, ridgelines). Whenever an obstacle is encountered, a deviation not exceeding 40° may be authorized (Tutin, 1991). When a plant present on the list is identified, the name and geographical coordinates are marked and a photograph is taken.

Data analysis:-

Two software programs (PAST 3.10 and QGIS 3.10) were used for data analysis. PAST 3.10 was used to perform statistical tests on frequency differences and to calculate numerical abundance. QGIS 3.10 was used to create maps of the study area and the distribution of plants consumed by chimpanzees and humans around Taï National Park.

Plant identification was based on the illustrated guides to the flora of the TNP (Aubreville, 1959; TNP Management Unit, 2000) and the list of plants regularly consumed by chimpanzees in the TNP (N'guessan, 2012). The proportion of consumption of a given plant organ (P) is the ratio of the number of species whose organ is consumed to the total number of species consumed. It is determined according to the following equation: $P = (n_i / N) \times 100$, with P: Percentage of consumption of an organ, n_i : number of plant species whose organ i is consumed and N: the total number of species whose organs are consumed.

Results:-

Plants regularly consumed by chimpanzees in Taï National Park:-

The pedestrian surveys made it possible to identify 45 plant species belonging to 27 families. All these plant species are regularly consumed by chimpanzees in Taï National Park. The different parts consumed by chimpanzees at the level of these plants are the fruits (71.12%; N = 32), the leaves (15.55%; N = 7) and the pith of the stems (13.33%; N = 6). At the level of the Arecaceae and Marantaceae Families, it is the pith of the stems which are more consumed (Kruskall-Wallis test, p-value = 0.02 < 0.05; $X^2 = 11.58$) (Table I).

Table I: Plants regularly consumed by chimpanzees at TNP

FAMILY	SCIENTIFIC NAME	PART CONSUMED		
		Fruit	Leaf	Bone marrow
Apocynaceae	Landolphiahirsuta	X		
Arecaceae	Ancistrophyllumsecundiflorum			X
Arecaceae	Chrysophyllumtaiense	X		
Arecaceae	Elaiesguineensis			X
Arecaceae	Eremorpathamacrocarpa			X
Anacardiaceae	Tricoscyphaarborea	X		
Burseraceae	Dacryodesklaineana	X		
Caesalpinaceae	Afzeliabella		X	
Caesalpinaceae	Detariumsenegalense	X		
Caesalpinaceae	Dialiumaubrevillei	X		
Chailletiaceae	Dichapetalum pallidum		X	
Chrysobalanaceae	Magnistipulabutayi	X		
Dioscoreaceae	Dioscoreamultiflora		X	
Euphorbiaceae	Kaeyodendronbrideloides	X		
Euphorbiaceae	Manniophytonfulvum		X	
Flacourtiaceae	Scotelliaklaineana	X		
Fabaceae	Platysepalumhirsutum	X		
humiriaceae	Sacoglottisgabonensis	X		
Irvingiaceae	Klainedoxagabonensis	X		
Irvingiaceae	Irvingiagrandifolia	X		
Lauraceae	Beilschmiediamanni	X		
Marantaceae	Halopegiaazurea			X
Marantaceae	Hypselodelphysviolacea			X
Marantaceae	Sarcophrynium sp			X
Melastomataceae	Memecylon sp	X		
Melastomataceae	Tristemmacoronatum		X	
Mimosaceae	Calpocalyx sp	X		
Mimosaceae	Parkia bicolor	X		
Moraceae	Antiariswelwischii	X		
Moraceae	Ficus sp	X		
Moraceae	Musangacecropiodes		X	
Myristicaceae	Treculia africana	X		

Myristicaceae	Pseudospondiasmicrocarpa	X		
Myristicaceae	Pycnanthusangolensis	X		
Myristicaceae	Uapaca sp	X		
Octoknemataceae	Coula edulis	X		
Olacaceae	Strombosiapustulata	X		
pandaceae	Panda oleosa	X		
Rubiaceae	Naucleaxanthoxylon	X		
Rosaceae	Parinariexcelsa	X		
Sapotaceae	Pouteriaaningeri	X		
Sterculiaceae	Sterculiaoblonga	X		
Tiliaceae	Dubosciaviridiflora	X		
Tiliaceae	Glyphaeabrevis		X	
Tiliaceae	Grewia bicolor	X		
	Total	N=32	N= 7	N = 6

Plants consumed by both chimpanzees and humans according to surveys around the TNP:-

At the end of the surveys, it was noted that 13 of the 45 plants consumed by chimpanzees are also consumed by humans, or 28.8%. These are plants whose organs consumed are mainly fruits (92.3%), the palm tree whose fruits and pith (heart) are consumed and the yam whose tubers are consumed (Kruskall-Wallis test, p-value = 0.007 < 0.05; $X^2 = 11.47$) (Table II).

Table II: Plants consumed by chimpanzees and humans according to the survey

SCIENTIFIC NAME	ORGAN CONSUMED BY MEN			
	Leaf	Fruit	Bone marrow	Stem
Bechimediamanni		X		
Calpocalyxaubrevillei		X		
Coula edulis		X		
Dialiumaubrevillei		X		
Discorea sp		X		X
Elaeis guineensis	X	X	X	
Glypheabrevis	X			
Irvingiagaboneinsis		X		
Klainedoxagabonensis		X		
Landolphiahirusta		X		
Nucleadiderrichi		X		
Nucleaxanthoxylon		X		
Parkia bicolor		X		
Treculia africana		X		
Total	N=2	N=13	N=1	N=1

Plants consumed by chimpanzees and humans according to pedestrian surveys in plantations:-

Walking surveys in the plantations located in the peripheral zone of the Taï National Park made it possible to identify five (5) species of plants consumed by both chimpanzees and humans. These are: *Elaeisguineensis*, *Irvingiagaboneinsis*, *Dialium aubrevillei*, *Coula edulis* and *Parkia bicolor*. Among these plants, two (02) are natural plants of the environment which were left in the plantations by the farmers. These are *Elaeisguineensis* and *Parkia bicolor*. On the other hand, the other three (3) were planted by the farmers in an agroforestry program initiated by the OIPR to contribute to the mitigation of human-wildlife conflicts. These plants are represented by *Irvingiagaboneinsis*, *Dialium aubrevillei*, and *Coula edulis* (Figure 3).

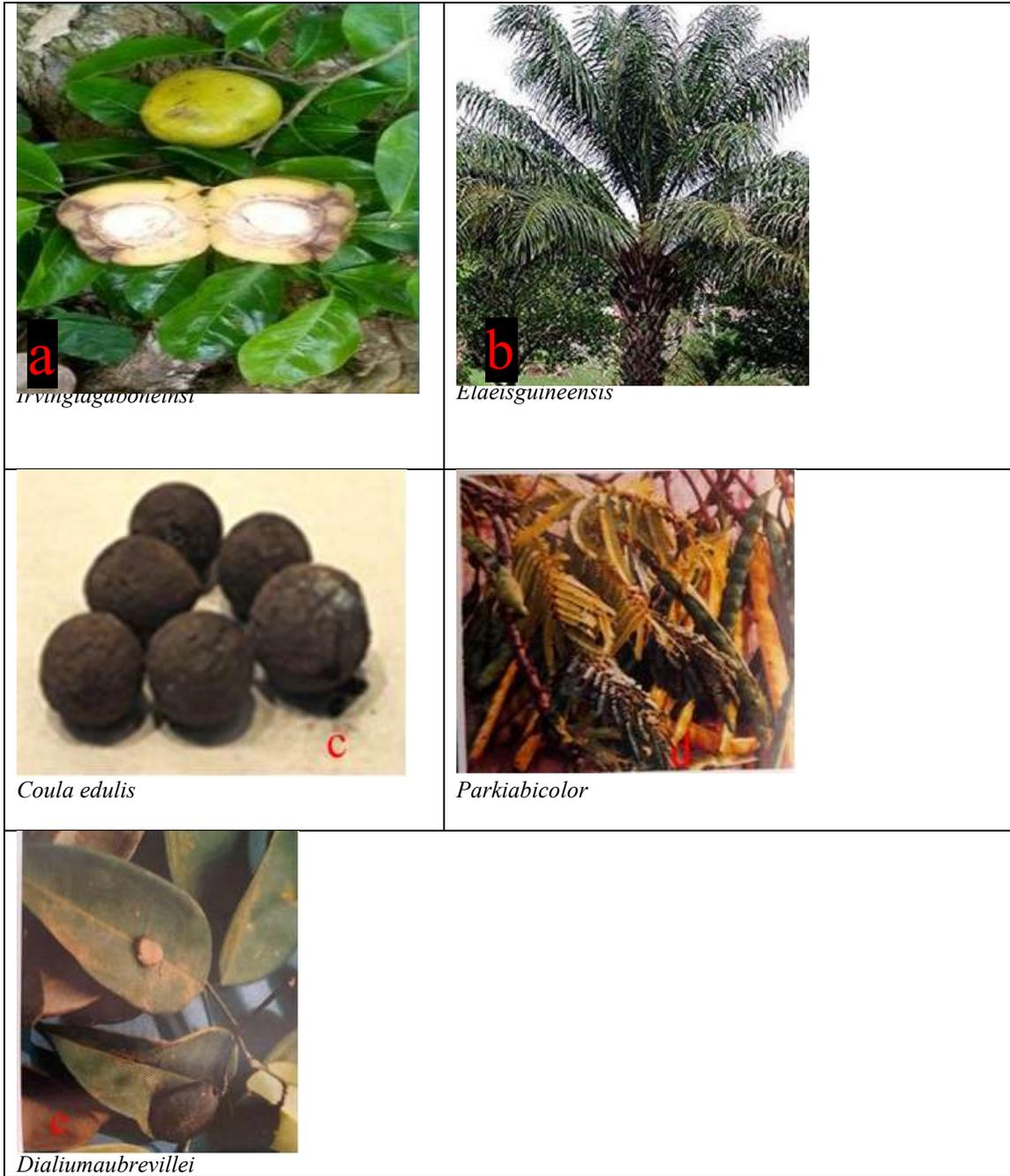


Figure 3 : Plants eaten by both chimpanzees and humans around the TNP

Discussion:-

The combination of the three methods made it possible to note that among the 45 plant species consumed by chimpanzees in Tai National Park, 13 are also consumed by humans in the eastern periphery of Tai National Park. Also, the plant organs consumed by chimpanzees and humans are almost identical. This area of dietary overlap between chimpanzees and humans could be justified by the genetic proximity between the two species (Boesch & Tomasellon, 1998; Edwards & Beerli, 2000). This proximity very often puts the two species in conflict in cohabitation areas such as the periphery of Tai National Park. Studies carried out on the typologies of human-wildlife conflicts have shown that one of the fundamental reasons why wildlife comes into conflict with humans is the search for food resources by humans, since their home areas have been replaced by agricultural plantations (Gone Bi, 2007). An equitable presence of plants consumed by the two neighboring species in their respective living

environments could mitigate these conflicts (Groves, 2001). In this sense, it was noted during the present study that among the 13 plants common to both species (Human and Chimpanzee), five (5) were identified as used in agroforestry. This relatively low number is certainly linked to the apprehensions that farmers have regarding the presence of certain plants in plantations (Mollet et al., 2000). Indeed, the choice of cultivation of a given wild plant is often based on its food, commercial, medical utility and its impact on the leaves and the soil. This criterion for choosing a tree in agroforestry has been confirmed by some previous studies (Isaac et al., 2007). According to these studies, following farmers' perceptions, certain species cultivated in agroforestry could be identified as being favorable to crops. This category exclusively includes forest species for food, medicine or timber (Mollet et al., 2000; Isaac et al., 2007; Dupraz & Liagre, 2008). However, some authors believe that the persistence of these large trees is linked to the fact that farmers are unable to cut them down during agricultural clearing (Zapfack et al., 2002; Adou Yao et al., 2006). In any case, several studies have shown the importance of agroforestry compared to traditional systems which consisted of complete clearing when planting (Adou et al., 2011).

Conclusion:-

Bibliographic research, surveys and walking surveys in the plantations used during this study made it possible to establish a list of plant species consumed by both chimpanzees and humans on the periphery of the Taï National Park and to determine those cultivated in agroforestry in this area. Thus, 13 plant species were listed as being consumed by both chimpanzees and humans on the periphery of this park. The main organs of these plants consumed by both these primate species are: fruits, leaves, stem pith. Of these 13 plant species, only five (5) are cultivated in agroforestry.

Conflicts of interest:-

The authors declare that there is no conflict of interest for this article.

Authors' contribution:-

KOUAME ANTOINE N'GUESSAN initiated this project. KRAMOKO BAMBA and MASSANDJE MAMY DIABATE performed the data processing, statistical analysis, and manuscript writing. The other co-authors contributed to proofreading and improving the article.

Acknowledgement:-

We would like to express our gratitude to the entire Southwest Zone Directorate of the Ivorian Office of Parks and Reserves (DZSO-OIPR) for their support and the smooth running of this study. We also thank all the ecologists of the Taï National Park for their technical support.

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