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Scientific Research

Variation of the Consumption of Mushrooms by Pygmies and Bantus in the North of Gabon

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Abstract

A comparative study of the number of taxa and fungal biomass consumed by the Pygmies and the Bantus of Gabon has been realized in two Gabon north regions (Ogooue-Ivindo and the Woleu-Ntem). This study has allowed not only to establish the list of consumed fungal sorts by those populations, but also to estimate the daily consumed fungal biomasses by each ethnical group. The study has revealed a significant difference between a numbers of taxa and the quantity of mushrooms consumed by various ethnical groups: the Pygmies of the area who live especially by hunting and fishing consumed 96% of the recorded taxa with some high mushrooms quantities (around 3 kg/day/family); the Bantus who live nearby Pygmies also consumed some high mushrooms quantities (around 2 kg/day/family) but a low taxa number (56% of taxa counted by the Fang; 69% by the Kota; 39% by the Kwele); on the other hand, the Bantus living nearest the Pygmies consumed a high taxa number as much as Pygmies (around 90% of taxa counted) but eat a lower mushrooms quantities than theirs distant congeners Pygmies (around 800 g/day/family).

Keywords

Pygmies, Bantus, Mushrooms, Gabon

1. Introduction

The Gabonese territory is constituted more than 80% by dense rainforest. This forest belongs to those called

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"Guineo-Congolese rainforest" composed in two separate rain cycles and offer a rich biodiversity [1]. With Non-timber forest products (NTFPs), some people have good living conditions; indeed these forest resources (NTFPs) constitute a consequent source of income.

Among those ones, mushrooms are particularly searched because of their high nutritional value [2] [3].

They are so considered as substitution element to animals' proteins according mushrooms which substitute to meat and fish during the hard food period [4]. The Gabonese climate is tropical type, warm wet with rainfall composed in two rain cycles and separated by two dry seasons. The raining season (September-November) follows by a considerable real rainfall whereas the little raining seasons (February-May) is characterized by some more or less heavy rain falls [5]. During those two rainfall seasons, hunting and fishing become difficult in our area of study.

It has been shown that in some villages in the north of Gabon such as Doumassi (11˚28'59.43"E; 2˚15'32.52"N), existed competition towards this food resources between Pygmies (Baka), the hunters, the pickers, the farmers and Bantus (Fang) [6].

To better known taxa and fungal biomass consumed by these populations, a study on empirical knowledge of villagers and observation on the ground has been released in Ogooue-Ivindo and Woleu-Ntem regions, located in north of the country. The aim was to compare not only the number of species but also the fungal biomass consumed daily by different families (Pygmies and Bantus) and to detect, on statistic base analysis, the significant differences which may exist between this various ethnical groups.

2. Territory Studied and Methodology

2.1. Territory Studied

Ogooue-Ivindo and Woleu-Ntem regions are located in the north and northeast of Gabon. The rainfall and the temperature of the regions are close to 3500 mm/year and 25˚C. Their economy is mainly based around farming, miners and by trading activities. The few ethnological studies in these regions, allow us to pursue the studies that have already initiated to collect the new local knowledge about edibles mushrooms. Moreover these studies avoid losing knowledge about some local behavior, which trend to be forgotten nowadays with the aim to estimate the daily fungal biomass average consumed by every ethnical community, forty-five families have been studied in the ten selected villages (5 villages by province, 3 families per mono ethnic village and 6 families per mixed village) (**Table 1**, **Figure 1** and **Figure 2**).

2.2. Field Work

One part of the number of taxa consumption by Pygmies (Baka and Bakoya) their near neighbours (living in the same villages or less than three kilometers from Pygmies) and their away neighbours (living in more than 3 km) in study sites has been obtained during different inventories by means of ethnomycological survey [6] [7]. The complementary inventories achieved during the present study have allowed making out an updated list from species consumed by these populations.

Table 1. Villages investigated in the two regions with their geographic coordinates.

Region	Villages and their geographic coordinate	Ethnic groups studied
Ogooue-Ivindo	Ngounangou (14˚6'2.80"E; 1˚7'42.82"N)	Bakoya*
	Zamba-kangake (13˚48'0.40"E; 0˚57'44.30"N)	Kota**
	Mazingo (14˚5'15.80"E; 1˚22'34.91"N)	Kwélé**
	Zoula (mixte) (14˚3'44.53"E; 1˚5'53.66"N)	Bakoya*, Kota**
	Grand Etoumbi (mixte) (14˚6'46.46"E;1˚8'48.31"N)	Bakoya*, Kwele**
Woleu-Ntem	Bitouga (12˚2'46.04"E; 2˚8'3.11"N)	Baka*
	Akok (11˚36'28.84"E; 1˚38'39.36"N)	Fang**
	Doumassi (mixte) (11˚28'59.43"E; 2˚15'32.52"N)	Baka* and Fang**
	Saint-Benoit (mixte) (12˚9'16.09"E; 2˚10'18.78"N)	Baka* and Fang**
	Biti-bi-Okang (mixte) (12˚9'24.57"E; 2˚8'53.99"N)	Baka* and Fang**

Footnotes: Each village is associated with his origin region and the associated ethnic groups are specified. *represents Pygmies ethnic communities, whereas **represents Bantus ethnic community.

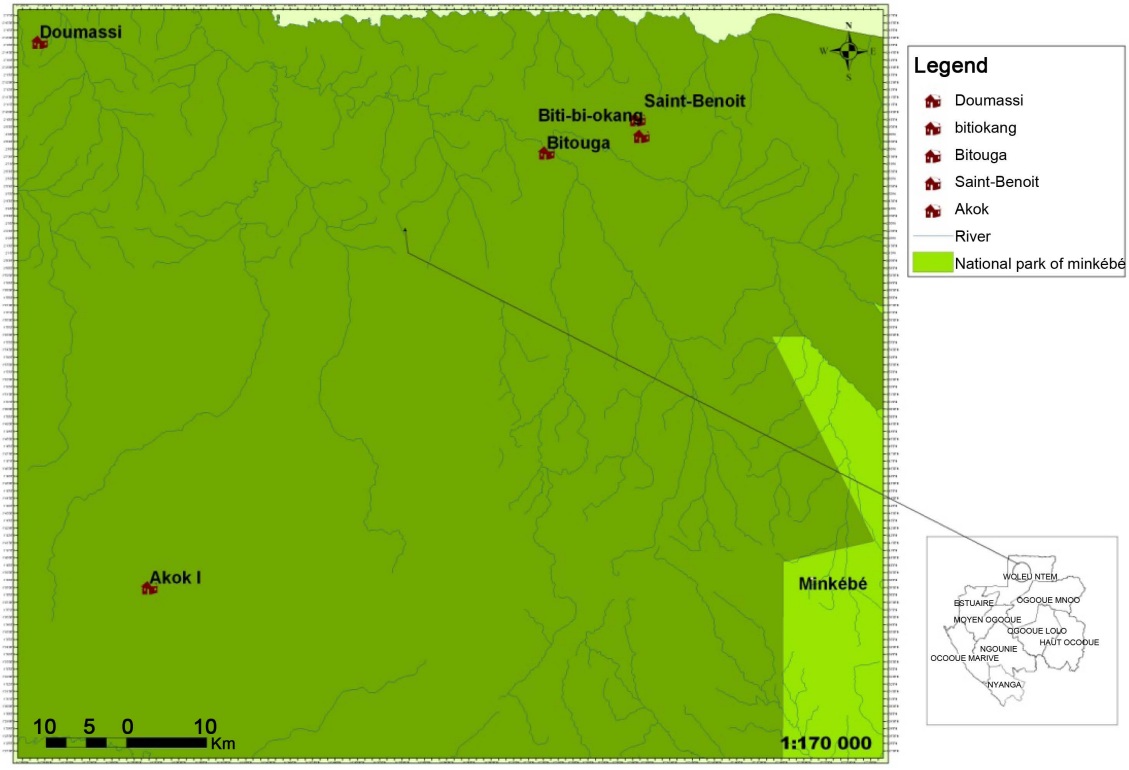

Figure 1. Location of villages investigated in the Woleu-Ntem. Different villages investigated (red), river (blue) and national park of Minkébé (green).

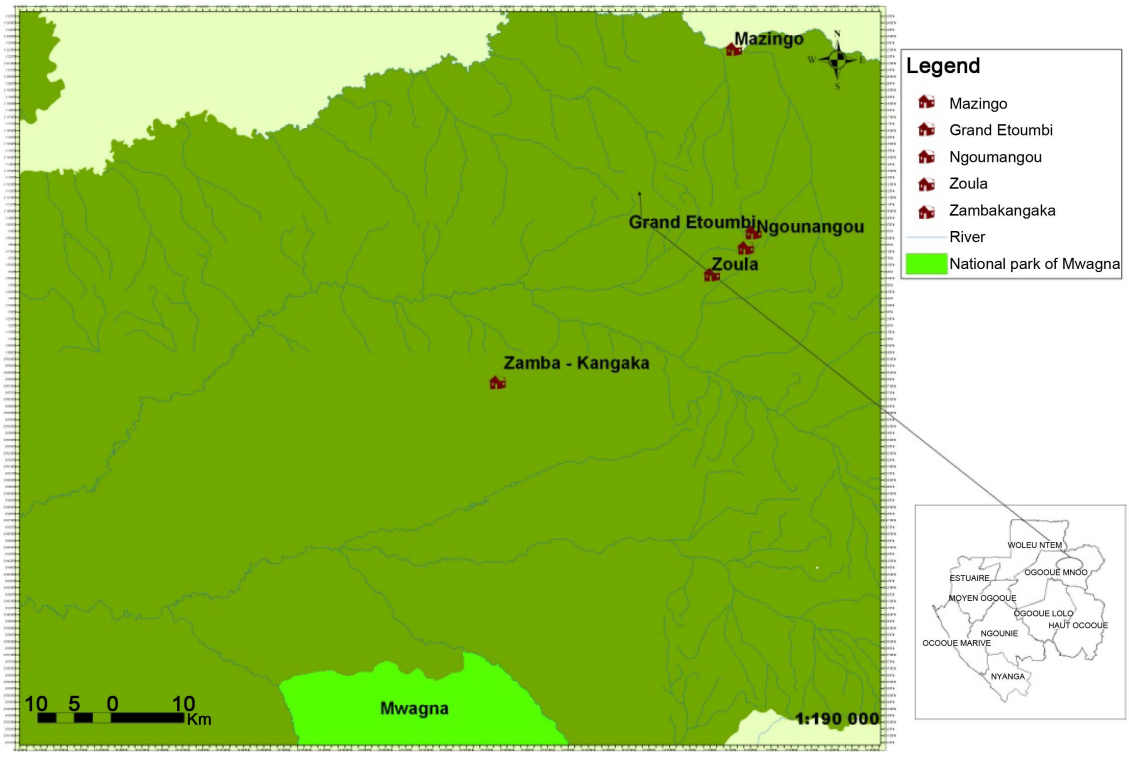

Figure 2. Location of villages investigated in the Ogooue-Ivindo. Different villages investigated (red), river (blue) and national park of Mwagna (green).

Three families of five persons have been chosen by village and by ethnical communities on the base of their established motivation and mycological knowledge. For Bantus populations there were Fang, Kota and Kwele communities (**Table 1**). Two big families groups have been the subject of this study. The first group is composed of three families of each ethnical communities living in the same villages like the Pygmies or in the Pygmies' village area. These families who are likely to be subject to the Pygmies influence have been designated by Fang (iP) (Fang influence Pygmies in the Woleu-Ntem), Kota (iP) and Kwele (iP) (Kota and Kwele influence Pygmies in the Ogooue-Ivindo). The second group is composed of three others families from the same communities, but living out of the Pygmies, they are designated by Fang, Kota and Kwele. The quantities of mushrooms consumed by these families have been weighted (dynamometric scales 5 kg accuracy 5 kg) every day for two weeks during the short raining's season (February-May) and two weeks during the long raining's season (September-November). An average of daily biomass has been calculated.

Identification of mushrooms consumed by these populations has been done by microscopic observation (Olympus microscope Cx30 equipped from a drawing tube). These microscopic observations have been carried out in the Congo red to the ammoniacal solution or the Melzer test. In practice, the examined structure has been drawn, their dimensions have been measured and compared with description appearing in the reference books (essentially "Flora illustrated from Central Africa mushrooms", "Flora Iconographical from Congo mushrooms", "Fungus Flora of Tropical Africa"), in particular for the types *Volvariella* [8], *Cantharellus* [9], *Lentinus* [10], *Lactarius* [11] and *Marasmius* [12]. Others books like "Fungus Edibles of Dense Forest to Central Africa, Taxonomy and Identification", "The Fungus Edibles of West Burundi" and "Guide of Edibles Fungus to Benin" have also been used.

2.3. Data Analysis

In order to detect significant differences from consumption of Fungus under the influence of accurate factors, the averages comparison of consumption has been realized from variance analysis (ANOVA) to a classification of criteria. Factors studied are:

-The season: let's remind that area studied present a short and long raining season;

-The ethnic or social group: it's a matter here to look for the influence of ethnic or social belonging on fungus consumption.

The eight groups studied (Baka, Bakoya, Fang, Fang iP, Kota, Kota iP, Kwele, Kwele iP) have been subjected to this test. At the time of making one of these tests, the conditions of applications have been verified beforehand. A particular accent has been put on the homogeneity of variances (Levene Test), and in the less measure about the normality on the distribution of data which is judged less restrictive than the homogeneity of variance [13]. When these conditions aren't satisfied a transformation of variable, "consumption" has been carried out one into logarithm, the other into square root, the conditions were double checked.

In the case where these transformations didn't make one changing in respect of conditions for application from the parametrical ANOVA, a variance analysis from Kruskal-Wallis (not parametrical) or the test of Mann-Whitney (for two groups) has been made.

3. Results and Discussion

3.1. Number of Species Consumed by Ethnic Group in the North of Gabon

Table 3 which specifies the number of fungal taxa consumed by the ethnical group of the north of Gabon shows that those ones consumed a high number of fungal species, except Malawi population which consumed more than 60 mushrooms taxa [14]; West of Burundi, 28 taxa [15] [16]; of Zambia, 20 taxa identified [17] [18]; from Zambezian region, 42 taxa [3] and of Pygmies Aka de la lobaye with 27 taxa of mushrooms consumed [19].

Moreover the majority of species consumed in Gabon are also in others geographic areas of Africa, particularly in Benin [20]; in Cameroun [21] [22]; in Ivory coast [23]-[25]; in Ethiopia [26]; in Ghana [25]; in Kenya [27]; At Madagascar [28]; in Malawi [29]-[33]; in Mozambique [34] [35]; in Nigeria [36]; in Ouganda [37]; in Democratic Republic of Congo [38] [39]; in Republic of centre Africa [40]; in Senegal [25] [41]; in Sierra Leone [27]; in Tanzania [18]; in Zambia [17] and in Zimbabwe [42] [43]. The important forest mulch, environmental temperature (25˚C to 35˚C) and humidity (85%) make environments favorable to the development of mushrooms of these areas studies.

This one witnesses the importance and reliability of mycological knowledge of the population of the north of Gabon in general and of Pygmies Baka in Particular. Among mushrooms consumed by this population, the most appreciate species belong to *Termitomyces* Kind, and the most wide spread among them are *Cantharellus* (edible mushrooms) (**Figure 3**). Pygmies Baka and Bakoya know and consumed the most species inventoried in the north of Gabon (37/39 for Baka and 38/39 for Bakoya). Except Kwele leaving in immediate Pygmies environment, Kwele iP but who know and consume few taxa, the others bantus populations (Kota iP and Fang iP) know and consume almost as much species than Pygmies. Three groups have been bring out; Fang iP, Kota iP, Baka and Bakoya community consume almost the same taxa numbers (more than 30 taxa); then fang, community Kwele iP, and Kota (more than 20 taxa consume); and at last Kwele community which consume very little (less than 20 taxa). The influence of Pygmies on bantu populations shows itself by the difference between the taxa numbers consumed by fang iP (35), Kota iP (35) and Kwele iP (25) leaving nearest Pygmies is the one consumed by their congeners fang (22), Kota (27) and Kwele (15) living distant to Pygmies.

Indeed Pygmies who live mainly from hunt and picking test the taste and adopt the news food species during scarcity period; then they consume more mushrooms species than bantus. However leaving together with Pygmies push bantus populations to eat the same food than this latter. Consequently to test the news mushrooms species [44]; where from the high number of taxa consumed by the Pygmies neighbors (Fang iP, Kota iP and, to a lesser extent, Kwele iP). On the other hand, the distrust towards mushrooms allows populations distant to Pygmies for more than 3 km, to consume only the known taxa such as *Canthrellus*, *Termitomyces*, *Lentinus Pleurotus*, as well as some others rare taxa *Lactarius*, *kind Marasmus*, *Volvariella*, and *Auricularia*.

3.2. Fungal Biomass Daily and Number of Taxa Consumed by Ethnical Group

The data from **Figure 4** reveal that a pygmy family consumes between 2 and 3 kg of mushrooms on average by day in raining season compared to 1kg of mushrooms from their near neighbors (Kota iP, Kwele iP and Fang iP). On the other hand, quantity of mushrooms consumed by a Bantu family away from Pygmies' village (Fang and Kota) is high enough, on average 2 to 2.5 kg by day in raining season. Moreover, **Table 2** presenting matrix results from "p-values" many comparisons carried out with Mann-Whitney test, reveal undeniably one influence from Pygmies on Bantu communities living in the same village. This chart also shows that among Bantu ethnics groups living outside Pygmies, only Kwele consumed quantities of mushrooms significantly different from the ones consumed by Pygmies (Baka and Bakoya).

In fact, the closeness of Pygmies leads not only to the significant diminution of consumed fungal biomass but also an increase of the number of consumed taxa. The Bantus unlike to Pygmies draw the essential of their food from farms which they put in practice and eat mushrooms occasionally.

On the other hand, Pygmies spend their time by seeking Non-timber forest products such as mushrooms. This is one reason why they consumed higher mushrooms quantities than their neighbors. The search for mushrooms always put Bantu and Pygmies in challenge; it's the case in Doumassi village between Pygmies Baka and Bantu Fang [6]. Pygmies familiar with their forest ecosystem often arrive first on the scene of harvest, while their neighboring Bantu give priority to work in the fields and harvest the mushrooms in returning from the fields at night, after the essential collection of the daily production by the Pygmies. This daily activity organization gives explanation why Bantus living near Pygmies consumed the low mushrooms quantities while theirs congeners-

(a) (b) (c)

Figure 3. General survey of some edibles species more appreciated (a) *Termitomyces filuginisus and* (b) *Termitomyces microcarpus* and more propagated (c) *Cantharellus luteopunctatus* throughout the north of Gabon.

Table 2. The "p-values" multiple comparisons using the Mann-Whitney test.

	Baka	Bakoya	Fang	Fang iP	Kota	Kota iP	Kwele	Kwele iP
Baka		0.332 ns	0.091 ns	0.003**	0.054 ns	0.003**	0.003**	0.003**
Bakoya	0.332 ns		0.054 ns	0.003**	0.057 ns	0.003**	0.006**	0.003**
Fang	0.091 ns	0.054 ns		0.003**	0.629 ns	0.003**	0.078 ns	0.003**
Fang iP	0.003**	0.003**	0.003**		0.003**	0.420 ns	0.006**	0.809 ns
Kota	0.054 ns	0.037**	0.629 ns	0.003**		0.003**	0.092 ns	0.003**
Kota iP	0.003**	0.003**	0.003**	0.420	0.003**		0.003**	0.293 ns
Kwele	0.003**	0.006**	0.078 ns	0.006**	0.092 ns	0.003**		0.003**
Kwele iP	0.003**	0.003**	0.003**	0.809	0.003**	0.293 ns	0.003**	

Footnotes: not significant difference = ns; significant difference = *; highly significant difference = **. Kota iP, Kwele iP and Fang iP: ethnical Bantu groups leaving in the same village or less than 3 km from Pygmies. Kota, Kwele and Fang: Bantu ethnical groups leaving distant of 3 km from Pygmies. Baka and Bakoya: ethnical group Pygmies.

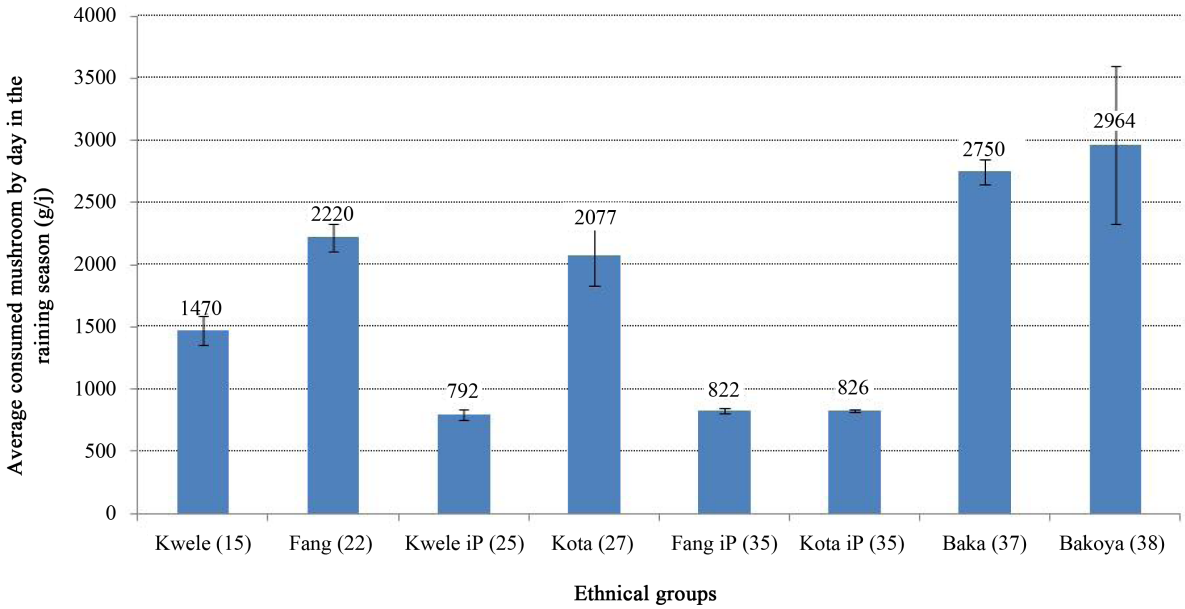

Figure 4. Daily average consumption ± standard deviation (g/j) according to ethnics groups from north of Gabon. Kota iP, Kwele iP and Fang iP are bantu ethnics groups living in the same village or less than 3 km from Pygmies, while Fang, Kota and Kwele are the same ethnics groups living outside (more than 3 km) Pygmies (Baka and Bakoya).The values in parentheses indicate the number of fungal taxons consumed by each ethnic group.

living in 3 km far from Pygmies consumed more quantities. However mushrooms quantities consumed by investigated populations is higher than other tropical Africa's countries; notably in Zimbabwe, where families consume until 20 kg dry matter by year, approximately 60 g/j/family [43], in Democratic Republic of Congo around Lubumbashi, Kolwezi and Likasi, or Degreef [2] estimated the weight dry mass of mushrooms consume yearly by local family at around 30 kg (80 g/j/family) for villagers and around 15 kg (40 g/j/family) for city-dwellers, and Mozambique where mushrooms quantities consumed yearly by houses are estimated from 7 to 16 kg for dry mushrooms by year, (16 to 44 g/j/family) [42].

The different results may be explained not only by the Pygmies influence who are the biggest mushrooms consumers and by Bantus of the country which influence the mushrooms consumption rate; but also by our data that were expressed as fresh matters different from other Africa's countries where mushrooms consumed quantities are indicated in dry matter.

According to De Kesel *et al*. [4], the time you spend in a village affects knowledge about mushrooms. Never-

theless, our observations show that Pygmies who arrived latest in the Bantu village have a better knowledge of edible mushrooms than their neighbors. Mushrooms knowledge for Pygmies doesn't depend on the time spent in the locality, but is rather cultural. This observation is illustrated by the taxa number consumed by Baka and Bakoya compared to Bantus (Fang, Kota and Kwele). The low rate of mushrooms consumed by the Kwele shows their little traditional mycological knowledge. It's a traditionally fisher people which mycological knowledge is very limited [6]. A study of mycological variation knowledge of north Gabon populations according to mycological activities practiced has indeed shows that traditional mycological knowledge of hunters was more diversified than those of fishers and farmers [44]. The people from neighboring villages may have sometime different mycological knowledge. It's the case of Kota and Kwele in Ogooué-Ivindo in the same village but who don't always consume the same type of mushrooms. Some species still well spread and usually consumed by Kota such as *Cantharellus luteopunctatus* and *Cantharellus rufopunctatus* are rejected by Kwele (**Table 3**). The same observation has been returned by De Kesel *et al.* [4] and Yorou & De Kesel [20] in Benin in the classified forest area of Wari Maro where ethnics like Lopka and Yom reject all yellow *Lacteous* while all are consumed by Nago. Conversely, *Xilaria polymorpha* and *X. papyrifera* wich are consumed by Lokpa and Yom for medicine purpose are rejected by Nagot.

The result of T test (seasonally and independently of ethnics groups) has shown that there is no effect of seasons on mushrooms consumption for the whole ethnical group studied ($t = 0.455$; $dl = 46$; $p = 0.651$). The **Figure 5** also illustrates similarity consumption, all group mixed according to the season.

4. Conclusions

In this study, we have demonstrated that Pygmies consumed all of the inventoried species. The knowledge and the consumption of mushrooms by the nearby Bantu people of Pygmies are influenced by the latter. The closeness of Pygmies allowed to these Bantus not only a significant decrease of the consumed fungal biomass, but also an increase of the number of consumed taxa.

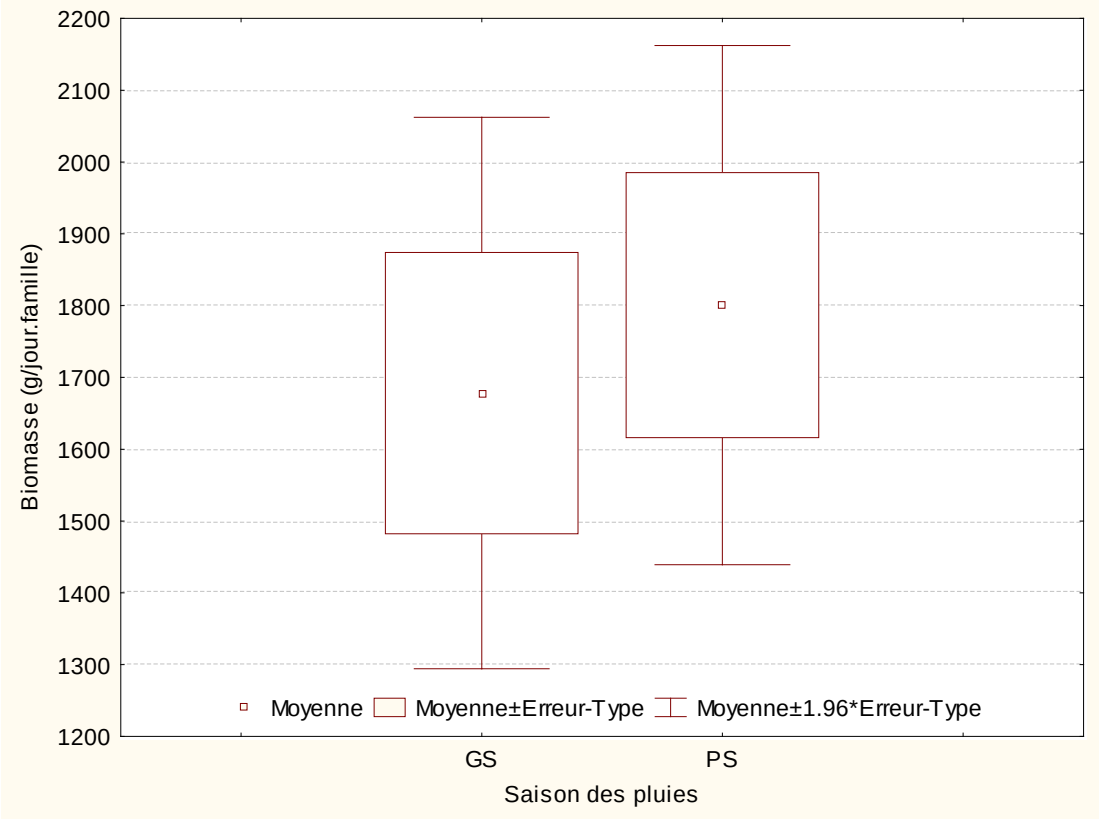

Figure 5. Box whiskers consumption by season (GS = long rainy season; PS = short rainy season).

Table 3. Fungal taxa consumed by the ethnic groups in the North of the Gabon.

Taxa	Woleu-Ntem			Ogooue-Ivindo				
	Baka	Fang iP	Fang	Bakoya	Kota iP	Kota	Kwele iP	Kwele
Armillaria heimii Pegler	+	+	−	+	+	−	−	−
Auricularia cornea Ehrenb.	+	+	+	+	+	−	+	+
C. congolensis Beeli	+	+	−	+	+	−	+	−
C. croceifolius Heinem.	+	+	+	+	+	+	+	+
Cantharellus defibulatus (Heinem.) Eyssart. & Buyck	+	+	+	+	+	+	+	+
C. densifolius Heinem.	+	+	+	+	+	+	+	+
C. floridulus Heinem.	+	+	+	+	+	+	+	−
C. goossensiae (Beeli) Heinem.	+	+	−	+	+	−	+	−
C. isabellinus Heinem.	+	+	+	+	+	+	+	+
C. luteopunctatus (Beeli) Heinem.	+	+	+	+	+	+	+	−
C. microcibarius Heinem.	+	+	+	+	+	−	+	+
C. platyphyllus Heinem.	+	+	−	+	+	+	−	−
C. ruber Heinem.	+	+	−	+	+	+	−	−
C.rufopunctatus var. *ochraceus* Heinem.	+	+	+	+	+	+	−	−
C.rufopunctatus var. *rufopunctatus* (Beeli) Heinem.	+	+	+	+	+	+	−	−
C. subincarnatus Eyssart. & Buyck	+	+	−	+	+	+	+	+
Favolus tenuiculus Beauv.	+	+	+	+	+	−	−	−
Gerronema hungo (Henn.) Degreef & Eyi	+	+	+	+	+	−	−	−
Gymnopilus zenkeri (Henn.) Singer	+	−	−	+	+	−	−	−
Laccaria amethystina Cooke	+	+	−	−	−	−	−	−
Lactarius gymnocarpus Heim	+	+	−	+	+	+	−	−
Lentinus brunneofloccosus Pegler	−	+	−	+	+	+	+	−
L. squarrosulus Mont.	+	+	+	+	+	+	+	+
L. tuber-regium (*Fr.*) *Fr.*	+	+	+	+	+	+	+	+
Marasmius bekolacongoli Beeli	+	+	−	+	+	+	−	−
M. buzungulo Singer	+	+	−	+	+	+	−	−
Nothopanus hygrophanus (*Mont.*) *Singer*	+	−	−	+	−	+	−	−
Pleurotus flabellatus (*Berk.* & *Br.*) *Sacc.*	+	+	+	+	+	+	+	−
Russula pseudocarmesina Buyck	−	−	−	+	−	−	+	−
Schizophyllum commune Fr.	+	+	−	+	+	−	−	−
Termitomyces fuliginosus Heim	+	+	+	+	+	+	+	+
T. globulus Heim & Gooss.-Font.	+	+	+	+	+	+	+	+
T. mammiformis Heim	+	+	+	+	+	+	+	+
T. microcarpus (*Berk.* & *Br.*) *Heim*	+	+	+	+	+	+	+	+
T. robustus (*Beeli*) *Heim*	+	+	+	+	+	+	+	+
T. striatus (*Beeli*) *Heim*	+	+	+	+	+	+	+	+
T. striatus f. bibasidiatus Mossébo	+	+	+	+	+	+	+	+
Trogia infundibuliformis Berk. & Broome	+	+	−	+	+	+	+	−
Volvariella volvacea (*Bull.*) *Sing.*	+	−	−	+	−	−	+	−
Total: 39	37	35	22	38	35	27	25	15

Footnotes: compartment +: consumed taxa; compartment −: non consumed taxa; Kota iP, Kwele iP, and Fang iP: ethnic groups living in the same villages or less than 3 km of Pygmies; Kota, Kwele and Fang: ethnic groups of Bantus living in more than 3 km of Pygmies; Baka and Bakoya: Pygmies ethnic groups.

Pygmies ethnic groups (Baka and Bakoya) consumed almost the same number of taxa, whereas at the Bantus, the number of taxa consumed varies mainly according to the ethnic group and the closeness with Pygmies. Fang and Kota consumed more taxa than Kwele. However, within group ethnics Fang, Kota and Kwele, the families living near Pygmies consumed more taxa than the distant families of the latter.

It is possible to estimate the total fungal biomass consumption per day, however, it is almost impossible to estimate this biomass by sorts because some collected sorts not only offered little of sporophores but also quite small which are then mixed in other sorts in the same basket, which makes the very difficult sorting.

Finally, the ethnomycological knowledges of the investigated populations are similar to those of the other peoples of sub-Saharan Africa in particular Gbaya and Aka (Central African Republic), Yorouba (Nigeria), Lopka, Yom and Nagot (Benin), which testified the reliability of inquiries led on the ground.

Acknowledgements

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