

**PARASITISM EVOLUTION OF LORANTHACEAE IN THE NDOGBONG
CHIEFDOM'S ORCHARD (DOUALA, CAMEROON)**

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ABSTRACT : Loranthaceae are shrubs that form clumps more or less important on branches of trees and on other wild or cultivated shrubs. These parasites of woody plants can cause extensive damages in agroecosystems. The present investigation carried in the Ndogbong Chiefdom's orchard found three Loranthaceae species: *Phragmanthera batangae* (Engler) S. Balle, *P. capitata* (Sprengel) S. Balle and *Tapinanthus preussii* (Engler) Van Teghem. These parasites were found on 10 woody species over 11: *Citrus* spp., *Dacryodes edulis* (G. Don) H. J. Lam., *Garcinia kola* Heckel., *Manniophyton fulvum* Müll.-Arg. *Persea americana* Mill., *Psidium guajava* Linn., *Theobroma cacao* L. and *Spondias mangifera* Willd. *Mangifera indica* L. was the only species which was resistant. The rate of parasitism in the orchard was 59.18% and *P. capitata* was the most represented parasite with (97.38%). A research program on sensitive and resistant plants to parasitism would be essential to fighting effectively against Loranthaceae.

Keywords: Loranthaceae, Parasitism, Host species, Ndogbong, Douala

INTRODUCTION

Parasitic plants represent more than 3000 species in over 18 families [1]. Loranthaceae occupy the largest group with about 65 genera and 850 species [2]. Loranthaceae and Viscaceae are real pests in natural forests, plantations, orchards and ornamental plants throughout the world as they significantly reduce the yield or affect crop quality [3]. For many decades, parasitism by Loranthaceae is a highly prevalent environmental problem worldwide [4]. These parasitic plants bound the branches of their hosts *via* a sucker called haustorium, physiological and structural real bridge between the parasite and its host. They are responsible for economic and morphogenetic damages varying by infected tree species [5]. Loranthaceae are represented in Cameroon by 26 species in seven genera: *Agelanthus*, *Englerina*, *Globimetula*, *Helixanthera*, *Phragmanthera*, *Viscum* and *Tapinanthus* [4]. They are found in most plant communities described in Cameroon including mangroves [6]. They are mostly arboreal xylem parasites that depend on their hosts for water and nutrients. This trophic dependence is in addition to biological and chorological factors which depended on birds for their pollination and dispersal [7]. Orchards and homegardens even plantations represent an important source of cash income for local people and contribute to self food sufficiency [8].

This study was undertaken to assess the parasitism of Loranthaceae after 4 years (2008 to 2011) in Ndogbong chiefdom's orchard. The specific objectives were (1) conduct an inventory of all trees infected or not by Loranthaceae, (2) identify and count all Loranthaceae tufts on all infected host trees and (3) compare the parasitism within 2008 to 2011.

MATERIALS AND METHODS

Study site

The study was conducted in an orchard of 140 m x 200 m (28.000 m²) located in Ndogbong chiefdom, located in the northeast of Douala (Fig. 1). Douala is a city belonging to the equatorial climate variant called Cameroonian characterized by two seasons with a long rainy season (at least 9 months), heavy rainfall (about 4000 mm per year), high temperatures (annual average, 26.7 °C) and constant. The minimal average temperature in Douala over 30 years (1961-1990) is 22.6 °C in July and the maximal average is 32.3 °C in February. The relative humidity throughout the year is almost 100% [9]. The orchard is an old abandoned cocoa plantation with a high number of fruit trees..

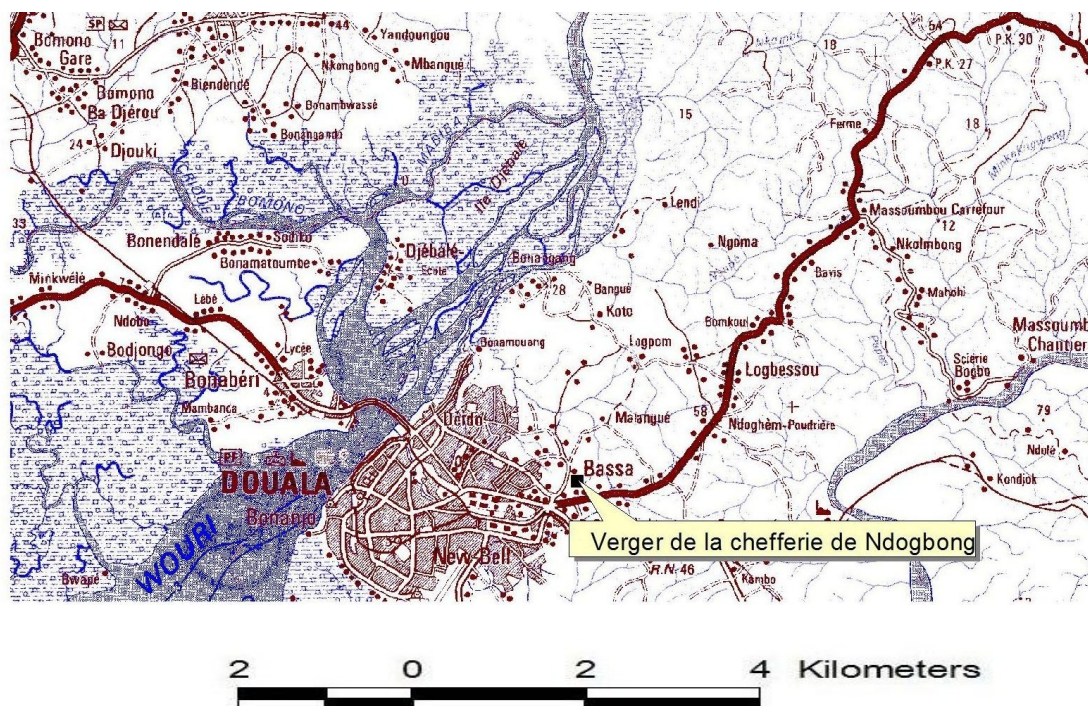


Fig. 1. Location of Ndogbong chiefdom's orchard (Software Arcview GIS 3.2a).

Procedure

The study was carried from November 2010 to February 2011. ; and consisted of a census and a survey of the geographical coordinates of all woody species of the site using a Global Positional System (GARMIN GPSmap 62) with an accuracy of less than 2 m, which helped to carry out location plan of trees in the orchard. The tufts of Loranthaceae were counted by climbing in the trees with a wooden ladder.

The percentage of parasitism (Pp) in the orchard was giving by the following expression

$$Pp = \text{number of trees infected} / \text{total number of trees} \times 100$$

RESULTS

Inventory of host trees

A total of 49 host trees belonging to 11 species including 9 genera and 8 families identified (Table 1). Anacardiaceae and Sterculiaceae were two genera best represented with 29 individuals (59.18%) of the flora recorded. All these species were exotic except *Spondias mangifera* Willd., which was indigenous and native to of the coastal evergreen rain forest. The most abundant species were *Theobroma cacao* L., *Mangifera indica* L., and *Citrus* spp. with 16, 13 and 10 plants individuals respectively (79.59% of the flora in the orchard). The remnant, 20.41% represented the least abundant species with 3 plants each (*Persea americana* Mill. and *Psidium guajava* Linn.) or rare with only one plant (*Dacryodes edulis* (G. Don) H. J. Lam., *Garcinia kola* Heckel., *Manniophyton fulvum* Mull.-Arg. and *Spondias mangifera* Willd.).

Table 1. Host species recorded in the orchard.

Families	Genera	Species	Total
Anacardiaceae	<i>Mangifera</i>	<i>M. indica</i> L.	14
	<i>Spondias</i>	<i>S. mangifera</i> Willd.	
Bursaceae	<i>Dacryodes</i>	<i>D. edulis</i> (G. Don) H. J. Lam	1
Clusiaceae	<i>Garcinia</i>	<i>G. cola</i> Heckel	1
Euphorbiaceae	<i>Manniophyton</i>	<i>M. fulvum</i> Müll. –Arg.	1
Lauraceae	<i>Persea</i>	<i>P. americana</i> Mill.	3
Myrtaceae	<i>Psidium</i>	<i>P. guajava</i> Linn.	3
Rutaceae	<i>Citrus</i>	<i>C maxima</i> Osbeck	10
		<i>C. sinensis</i> Arancio	
		<i>C. reticulata</i> Blanco	
Sterculiaceae	<i>Theobroma</i>	<i>T. cacao</i> L.	16
Total			49

Parasitism of Loranthaceae in the orchard

Three Loranthaceae species identified in the orchard: *Phragmanthera batangae* (Engler) S. Balle (Fig. 2), *Phragmanthera capitata* (Sprengel) S. Balle (Fig. 3) and *Tapinanthus preussii* (Engler) Van Teghem (Fig. 4). *P. batangae* and *T. preussii* were often in association with *P. capitata* on the same host.

Table 2 shows the distribution of the 11 host species recorded in, not infected and infected. Only one species, *Mangifera indica* L., represented by 13 individuals (26.53%) was not infected, and was considered as resistant. Ten species: *Citrus* spp., *Dacryodes edulis* (G. Don) H. J. Lam., *Garcinia kola* Heckel., *Manniophyton fulvum* Müll.-Arg., *Persea americana* Mill., *Psidium guajava* Linn., *Theobroma cacao* L. and *Spondias mangifera* Willd were infected. The rate of parasitism in the orchard was 59.18% and was compared to the investigation of 2008 (Table 3). A total of 267 Loranthaceae tufts recorded on 10 infected host species with 260 (97.38%) for *P. capitata*, 6 (2.25%) for *T. preussii* and 1 (0.37%) for *P. batangae*. Only *T. cocoa* infected by three Loranthaceae identified (Table 4). These data on Loranthaceae parasitism were compared to those of 2008 (Fig. 5) to assessing the parasitism evolution (Fig. 6).

Table 2. Level of Loranthaceae parasitism in the orchard, 2011.

Host species	Healthy plants	Infected plants	Total
<i>Mangifera indica</i> L.	13	0	14
<i>Spondias mangifera</i> Willd.	0	1	
<i>Dacryodes edulis</i> (G. Don) H. J. Lam	0	1	1
<i>Garcinia cola</i> Heckel	0	1	1
<i>Manniophyton fulvum</i> Müll.-Arg.	0	1	1
<i>Persea americana</i> Mill.	0	3	3
<i>Psidium guajava</i> Linn.	0	3	3
<i>Citrus maxima</i> Osbeck	0	1	10
<i>Citrus sinensis</i> Arancio	0	8	
<i>Citrus reticulata</i> Blanco	0	1	
<i>Theobroma cacao</i> L.	7	9	16
Total	20	29	49

Table 3. Level of Loranthaceae parasitism in the orchard, 2008 [10].

Families	Host species	Healthy plants	Infected plants	Total
Anacardiaceae	<i>Mangifera indica</i> L.	13	0	14
	<i>Spondias mangifera</i> Willd.	0	1	
Burseraceae	<i>Dacryodes edulis</i> (G. Don) H. J. Lam	1	0	1
Cluslaceae	<i>Garcinia cola</i> Heckel	0	1	1
Euphorbiaceae	<i>Manniophyton fulvum</i> Müll.-Arg.	1	0	1
Lauraceae	<i>Persea americana</i> Mill.	0	3	3
Myrtaceae	<i>Psidium guajava</i> Linn.	0	3	3
Rutaceae	<i>Citrus maxima</i> Osbeck	0	1	10
	<i>Citrus sinensis</i> Arancio	2	6	
	<i>Citrus reticulata</i> Blanco	0	1	
Sterculiaceae	<i>Theobroma cacao</i> L.	11	5	16
Total		28	21	49

Table 4. Number of Loranthaceae tufts on infected species. *Pc*: *Phragmanthera capitata*, *Pb*: *Phragmanthera batangae*, *Tp*: *Tapinanthus preussii*.

Host species	Number of Tufts	<i>Pc</i>	<i>Pb</i>	<i>Tp</i>
<i>Mangifera indica</i>	0	-	-	-
<i>Spondias mangifera</i>	26	26	-	-
<i>Dacryodes edulis</i>	3	-	-	3
<i>Garcinia cola</i>	17	17	-	-
<i>Manniophyton fulvum</i>	2	2	-	-
<i>Persea americana</i>	33	33	-	-
<i>Psidium guajava</i>	100	100	-	-
<i>Citrus maxima</i>	6	6	-	-
<i>Citrus sinensis</i>	38	38	-	-
<i>Citrus reticulata</i>	8	8	-	-
<i>Theobroma cacao</i>	34	30	1	6
Total	267	260	1	6



Fig. 2. *Phragmanthera batangae* inflorescences.



Fig. 3. *Tapinanthus preussii* inflorescences.



Fig. 4. *Phragmanthera capitata* (a) inflorescences; (b) fruits.

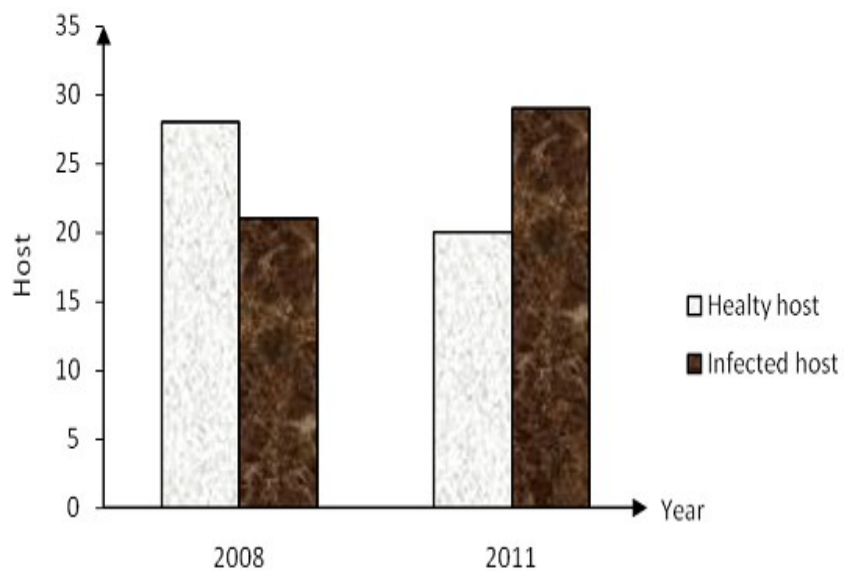


Fig. 5. Parasitism evolution in the Ndogbong chiefdom's orchard from 2008 to 2011.

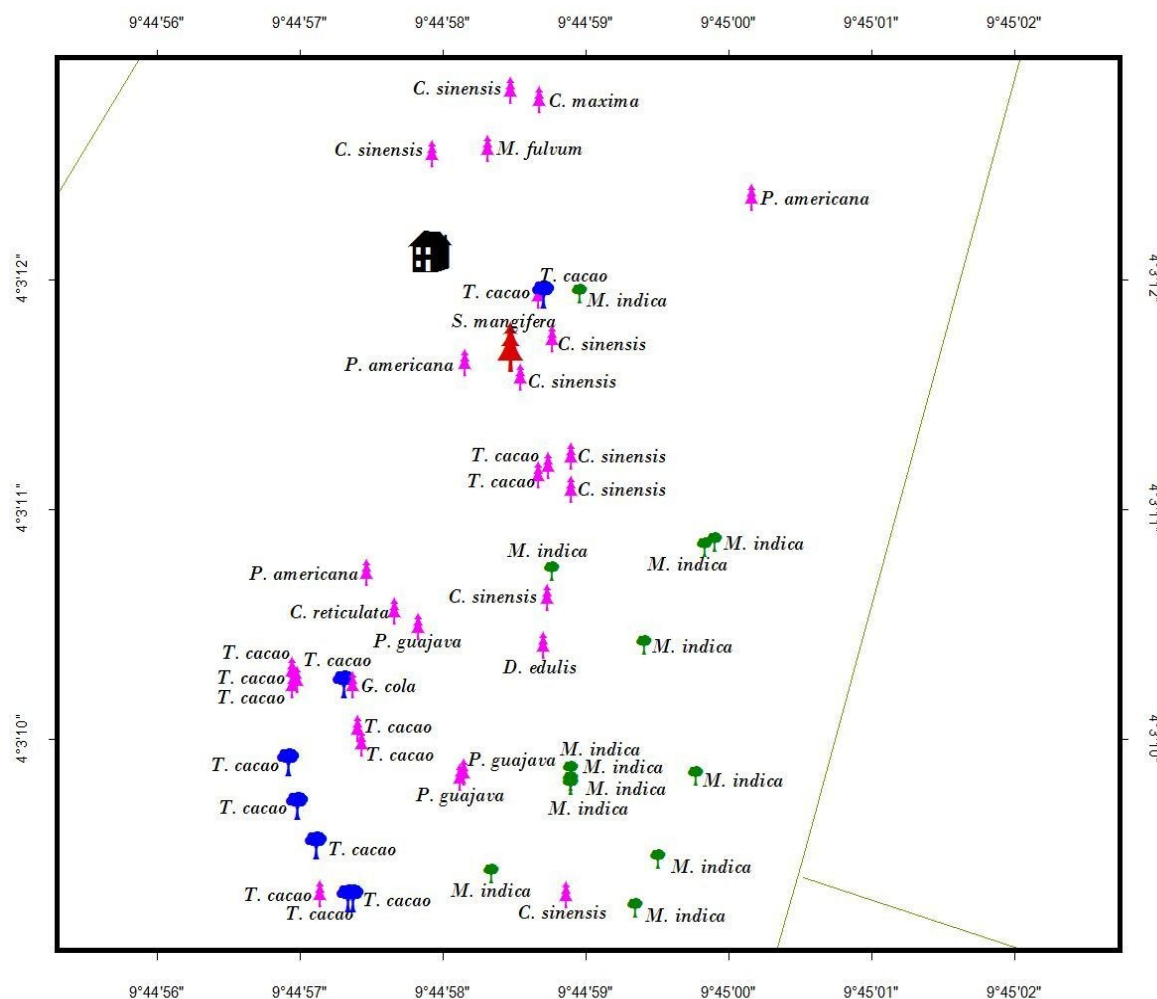


Fig. 6. Detailed distribution of infected and not infected plants in the orchard, 2011 (Software Arcview GIS 3.2a).

DISCUSSION

Parasitism of woody plants by Loranthaceae in the orchard

Three Loranthaceae identified in the orchard: *Phragmanthera batangae*, *Phragmanthera capitata* and *Tapinanthus preussii*. Among these, *P. capitata* was ubiquitous and the other two endemic in Cameroon [11]. *P. capitata* was very devastating [12, 13, 14, 15, 16, 17] and its remarkable ubiquity was suitable to all the ecological variations in Cameroon [5]. So Dibong et al. [14] reported the presence of *P. capitata* on the monogenous plantations of *Hevea brasiliensis* in Nyétté via Kribi. The same species encountered in Limbe, Penja, Sangmelima and Mintom (personal communication from Dibong). Sonké [6] reported this Loranthaceae in Yaoundé and its surroundings on *Persea americana*. In addition, this species was the most abundant in southern Cameroon in agrosystems [13].

Very invasive on infected hosts, this Loranthaceae had a wide host range compared to the others. But in the orchard, mango trees were not infected (Fig. 6) as reported by Dibong [8]. The resistance of *Mangifera indica* (Anarcadiaceae) was interspecific and can be attributed to the chemical composition or structural tissues of the host. According to Hariri [18], the development of Loranthaceae was largely conditioning by the nature of the host. From artificial infestations, Hariri [18] found differences in sensitivity of Gui (Loranthaceae) to some poplar cultivars. Hariri [19] identified the tannins, flavonoids and lignins as part of the factors involved in Gui resistance. Four anatomical features identified as having a higher discriminatory power of resistance in the oak. were: bark thickness, cell density in polyphenols, the thickness of the first fiber and the thickness of collenchyma.

According to Dibong [10], parasitism in the orchard had as origin, infected *Spondias mangifera*, left standing in the concession, after the forest decline; because originally, all Loranthaceae had a forest habitat and adapted to environments altered by man on host species cultivated or spontaneous [14]. This passage from the forest to human environments was the fact of disseminators. Carlo [20] observed that fruit-eater birds fed better with fruits of one or many specific host plants and visited them more often than others. This assertion confirmed in the chiefdom orchard by *Psidium guajava* plants which had an average density of tufts (33.33/foot) higher than the other host trees.

The fruit-eater birds by feeding on Loranthaceae berries disseminated the seeds of fruit trees in the orchard step by step [10], though, some individuals of *Theobroma cacao* were not infected and were therefore considered as resistant to parasitism. This type of resistance have been highlighted by Boussim [21], following an artificial infestation of the same individuals species. The hypothesis that led to this experiment derived from the fact that most often, in within the same closed plant species, some were infected and others not. It therefore appeared that some individuals are endowed with a resistance which is attributed to intrinsic factors of each plant.

State of parasitism in the orchard from 2008 to 2011

The average rate of parasitism, 59,18% obtained in this study was higher than the one of Dibong et al. [8] (36%) in a previous study in heterogeneous plant communities of sites in the city of Douala. However, the same authors obtained a higher rate (63.64%) in homogeneous groups of *Hevea brasiliensis* at Nyetté . Among the three identified Loranthaceae (*Phragmanthera batangae*, *P. capitata* and *Tapinanthus preussii*), Dibong et al. [10] reported the presence of Loranthaceae, *P. capitata* only. It appeared that parasitism was no more monospecific but extended to three Loranthaceae. The scattering was not only vertical [10] but also horizontal. Avian disseminators after feeding the berries elsewhere (probably nearby forest), arrived in the orchard and laid the seeds ingested by defecation.

Healthy new host species in 2008 [10] were nowadays infected: *Dacryodes edulis* and *Manniophyton fulvum*. The first was the host species of *T. preussii* and the second of *P. capitata* with respectively three and two tufts. Other species were already more infected today, *Citrus sinensis* which all the eight plants were infected against six in 2008 and *Theobroma cacao* of which nine infected against five in 2008. For all host species, there is also a significant increase in the number of tufts per individual compared to 2008.

CONCLUSION

All woody species with the exception of *Mangifera indica* were infected. *Theobroma cacao* was the only species of the orchard not infected by the three Loranthaceae. Given the rate of parasitism in the orchard, higher than in 2008 and the socio-economic importance of infected species, a further research on parasitism should be undertaken to understand the mechanisms behind, which will enable to create resistant varieties to Loranthaceae parasitism.

REFERENCES

- [1] Kuijt J. 1969. The biology of flowering parasitic plants. University of California. Press, Berkeley and Los Angeles.
- [2] Thorne RF. 1992. Classification and geography of flowering plants. *Bot. Rev.* 58.
- [3] Engone Obiang NL, Pare J, Duredon J., Sallé G. 2005. Germination et développement de la plantule d'*Helixanthera mannii* (Oliv.) Danser (*Loranthaceae*) sur le cacaoyer (*Theobroma cacao* L.) au Gabon. *Rev. Cytol. Biol. Veg.* 29 (1/2): 13–21.
- [4] Polhill R, Wiens DW. 1998. *Mistletoes of Africa*. Kew Ed. ISBN. p 370.
- [5] Sallé G, Tuquet C, Raynal-Roques A. 1998. Biologie des Phanérogames parasites. *C. R. Soc.*
- [6] Sonké B, Kenfack D, Tindo M. 2000. Parasitisme de l'avocatier (*Persea americana* Mill, *Lauraceae*) par les Loranthacées dans la région de Yaoundé (Cameroun). *Fruits*, 55: 325- 331.
- [7] Marshall JD, Ehleringer JR. 1990. Are xylem-tapping *Mistletoes* partially heterotrophic? *Oecologia*, 84: 244-248.
- [8] Dibong SD, Din N, Priso RJ, Taffouo VD, Sallé G, Amougou A. 2009. Germination et régénération naturelle de *Phragmanthera capitata* (*Loranthaceae*) sur les arbres fruitiers à Douala, Cameroun. In : Systématique et Conservation des Plantes Africaines, X. van der Burgt, J. van der Maesen & JM Onana (eds), Royal Botanic Gardens, Kew, pp. 839-846
- [9] Din N, Saenger P, Priso JR, Dibong SD, Amougou A. 2008. Logging activities in mangrove forests: A case study of Douala Cameroon. *African J. Environ. Sci. Technol.*, 2 (2): 22-30.
- [10] Dibong SD, Ndiang Zenabou, Mony R, Boussim Issaka Joseph, Amougou Akoa. 2010. A parasitic study of *Phragmanthera capitata* (Sprengel) S. Balle (*Loranthaceae*) in the anthropic environments: The case of the Ndogbong chieftain's compound orchard (Douala, Cameroon). *AJAR*, 5 (15): 2051 – 2055.
- [11] Balle S. 1982. Loranthacées, flore du Cameroun, vol. 23, Satabié B., Leroy J. F., Yaoundé, Cameroun 82 p.
- [12] HEVECAM, 1995. Rapport de la direction d'exploitation agricole : Bilan de l'essai *Loranthus* (12 - AGRO/DEA du 17/02/95) 9 p.
- [13] Engone ONL, Sallé G. 2006. Faut-il éradiquer *Phragmanthera capitata*, parasite des hévéas en Afrique ? *C. R. Biol.*, 329: 185-195.
- [14] Dibong SD, Din N, Priso RJ, Taffouo VD, Fankem H, Amougou A. 2008. Parasitism of host trees by the *Loranthaceae* in the region of Douala (Cameroon). *Afri. J. Environ. Sci. Technol.*, 2 (11): 371-378.
- [15] Amon ADE, Soro D, N'Guessan K, Traoré. 2010. Les *Loranthaceae* : Plantes vasculaires parasites des arbres et arbustes, au Sud-Est de la Côte d'Ivoire. *J. Appl. Biosci.*, 25: 1565-1572.
- [16] Mony R, Dibong SD, Ondoua JM, Engone Obiang NL, Boussim IJ, Amougou A, Bilong Bilong. 2010. Ants and *Phragmanthera capitata* (Sprengel) S. Balle (*Loranthaceae*): Impacts on considerable damages caused on fruit trees of the Ndogbong (Douala, Cameroon) chieftaincy's orchard. *J. Agri. Exten. Rural. Develop.*, 2 (3): 048-053.
- [17] Soro K, Soro D, N'Guessam K, Gnahoua GM., Traoré. 2010. Parasitisme des *Loranthaceae* sur les hévéas en zone forestière des sous-préfectures de Gagnoa et d'Ouragahio, en Côte d'Ivoire. *JAPS*, 6 (1): 597-604.

- [18] Hariri EB, Sallé G. & Andary C. 1990. Mécanisme de résistance de 4 cultivars de peuplier en réponse à l'attaque du gui (*Viscum album*), *C.R. Acad. Sci., Paris*, t. 311, série III, 439-444.
- [19] Hariri EB, Jeune B, Baudino S, Urech K, Sallé G. 1991. Elaboration d'un coefficient de résistance au gui chez le chêne, *Can. J. Bot.*, 70: 1239-1246.
- [20] Carlo T, Collazo J, Groom M. 2003. Avian fruit preferences across a Puerto Rican forested landscape: attern consistency and implications for seed removal. *Oecologia*, 134: 119-131.
- [21] Boussim IJ, Raynal A, Sallé G, Guinko S. 1995. Impact de 4 Loranthacées parasites sur leurs espèces ligneuses hôtes du Burkina Faso: *T. dodoneifolius* (DC) Danser, *T. globiferus* (Rich) Danser, *T. ophioides* (Sprague) Danser et *T. pentagonia* (DC) Van Tiegh, *Annales de l'université de Ouagadougou*, série B, vol III, pp. 203-216.