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Full Length Research Paper

Ants and *Phragmanthera capitata* (Sprengel), Balle (*Loranthaceae*) impacts on considerable damages caused on fruit trees of the Ndogbong (Douala, Cameroon) chieftaincy's orchard

Mony Ruth[1], Dibong Siegfried Didier[2]*, Ondoua Joseph Marie[2], Boussim Issaka Joseph[3], Amougou Akoa[4] and Bilong Bilong[4]

[1]Department of Biology of Animal Organisms, Faculty of Science, P. O. Box 24157, University of Douala, Cameroon.
[2]Department of Biology of Plant Organisms, Faculty of Science, P. O. Box 24157, University of Douala, Cameroon.
[3]Laboratory of Plant Biology and Ecology, University of Ouagadougou 03, P. O. Box 848, Ouagadougou 03, Burkina Faso.
[4]Department of Plant Biology and Physiology, P. O. Box 812, University of Yaoundé I, Cameroon.

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Among the *Loranthaceae*, *Phragmanthera capitata* is better adapted to the conditions of the environment modified by man and to spontaneous or cultivated trees of Central Africa. The aim of this study is to inventory damages caused by *Loranthaceae* and ant trees on parasitized host trees (C*itrus maxima, Psidium guajava* and *Theobroma cacao*). Five main ant species are identified on three host trees: *Camponotus sp, Camponotus senex, Odontomachus longicornis, Pheidole megacephala* and *Tetramorium bellicosum. P. capitata* parasitism affects the repartition of ant species of which some can become dominant and harmful to the host plants. The results of *P. capitata* combined actions and ant species are notably the branches drying and the fruit wood heart rottenness. Often considerable yields loss are very perceptible on old host individuals which make up "real green graveyards" in agroecosystems. It is essential to promote the agroecology which permits to master host species/*Loranthaceae*/ant interactions.

Key words: *Phragmanthera capitata*, ant trees, parasitism, yields loss.

INTRODUCTION

Loranthaceae (Balle, 1982) are epiphyte chlorophyllian shrubs, which live as hemiparasites on trees and shrub branches, wild or cultivated. These plants which present themselves in the form of tufts are anchored in the host wood though a sucker which permits to establish functional links with the conductor apparatus of the host (Salle et al., 1998). The parasite takes water, mineral salts and the complement organic material it needs. *Loranthaceae* belong to angiosperm parasites which represent only 2% of all the seed plants (Raynal Roques and Paré, 1998). *Phragmanthera capitata* (Sprengel) S. Balle is widely spread in Africa notably in Cameroon, Nigeria, Gabon and Ivory Coast (Engone et al., 2005; Engone and Sallé, 2006). To show the importance of *Loranthaceae* and ant damages on these trees on economic aspects, we have added this before the aim of the study. In the region of Douala, agroecosystems represent a large part of the agricultural landscape throughout settled zones. Exotic species are the most wide spread agroecosystem species as in the whole forest zone of Cameroon. Unfortunately, during the past decades, agroecosystems have continually been undergoing severe damages due, besides the drought of the 1970's, to pests like mistletoes, birds, insects, fungi (Boussim, 2002). Specially, the large proliferation of mistletoes from *Loranthaceae*, probably arising from

*Corresponding author. E-mail: didierdibong@yahoo.fr.

Table 1. Number of individuals per ant species carried by healthy or parasitized individuals of host species detained.

Ants species	*Citrus maxima*		*Psidium guajava*		*Theobroma cacao*		Total
	Healthy individuals	Parasitized individuals	Healthy individuals	Parasitized individuals	Healthy individuals	Parasitized individuals	
Camponotus sp.	8	8	8	6	0	4	34
C. senex	0	7	5	6	6	8	32
C. auberti	0	7	0	0	6	8	21
C. scutellaris	0	3	0	3	6	8	20
Ondontomachus sp.	8	8	0	3	3	8	30
P. longicornis	4	5	0	0	0	0	9
P. megacephala	8	8	6	7	5	6	40
S. geminata	4	2	0	0	0	0	6
T. aculeatum	8	8	0	0	5	0	21
T bellicosum	8	8	6	5	1	8	36
Total	48	64	25	30	32	50	249

various ecologic factors and changes in land uses, is becoming worrying. So to improve agroecosystem management in Cameroon and to slow down the spread of *P. capitata* populations, a first approach concerning the inventory the damages caused by *Loranthaceae* and ant trees has been carried out. Three host trees are concerned: *Citrus maxima, Psidium guajava* and *Theobroma cacao*.

MATERIALS AND METHODS

The study site

The study site is the orchard of the Ndogbong chieftancy camp. Neighbourhood situated in the North East of the town of Douala. Douala (Latitude 03°40' - 04°11'N; Longitude, 09°16'-09°52'E; altitude, 13 m) has a climate which belongs to the equatorial domain of a particular type called "Cameroonian" which is characterised by 2 seasons with a long rainy season (at least 9 months), abundant precipitations (about 4000 mm a year), high (26.7°C) and stable temperatures. The minimum average of temperature in Douala for 30 years (1961-1990) is of 22.6°C on July and the maximum average of temperature of 32.3°C on February. The main of temperature is near 26.7°C. The relative humidity of the air remains high all the year and similar to 100% (Din et al., 2008).

Harvesting and identification of myrmecofauna

The prospected orchard has a surface of about 2 ha and made up essentially of fruit trees intended to the landlord consumptions. It is established in an abandoned cocoa plantation and cleared afterwards to plant in the trees useful to nutrition.

The work has been realised on the land from January to July 2009. Eight collections of ants during morning have been made on three *P. capitata* host couples, parasitized and three healthy individuals belonging to three different hosts' species. The hosts' species concerned by this work are: *C. maxima* (*Rutaceae*), *P. guajava* (*Myrtaceae*) and *T. cacao* (*Sterculeaceae*). Ant labourers present on plants are harvested after using machete to lift fixation parts. Those ants are colleted with a mouth aspirator (for labourers of medium size) or with set of collecting devices for big size labourers and kept in labelled black boxes containing 70°C alcohol in the laboratory of the Biology of Animal Organisms of the Faculty of Science of the University of Douala.

Ant species identification is done using identification keys of the database of African ants (www.antbase.org) and their nomenclature approved by African ant specialists Drs Kenne Martin and Ruth Mony.

Statistic analysis of results

ANOVA LSD tests of comparison of the number of collected workers has been made by the Stat Software, Inc. (2001) STATISTICA (data analysis software system) version 6.0.

RESULTS

Variations of the initial mosaic structure in healthy individuals of host species. The obtained results (Table 1) show that the *P. capitata* parasitism affects the ant mosaic specificity which some can become dominant and harmful to the plant (Figures 1A, B and D). The scale of the parasitic attack depends on the host species. It is in this way that the rottenness of the trunk heart is more frequent in *P. guajava* (Figure 1C). In *C. maxima* and *T. cacao*, so are all the co-dominant ants of healthy individuals for parasitized individuals of the same host species. The ants concerned in *C. maxima* are: *Camponotus sp., Odontomachus spsanchia*, *Pheidole megacephala*, *Tetramorium aculeatum*, and *Tetramorium bellicosum*. In the case of *T. cacao*, three species are noted: *Camponotus senex*, *Crematogaster auberti* and *Crematogaster scutellaris*. Moreover, each of these categories of ants is specific to *C. maxima* or to *T. cacao* and the dominance is more marked in *T. cacao.*

A variation of the initial mosaic structure in healthy individuals of the implied host species concerns absent ants in healthy individuals but which appear at the favour of

P. capitata parasitrism in parasitized individuals to become co-dominant afterwards (*C. senex* and *C. auberti*) in *C. maxima* or non-dominant (*C. scutellaris*) in *C. maxima* and in the case of *P. guajava*, these are *C. scutellaris*, *O. sanchia* and *T. aculeatum*. In *T. cacao*, only one species of absent ant Camponotus sp.) in the healthy individual can become non-dominant in the parasitized individual of the same host species.

Another variation of the observed mosaic structure results from some non dominant ants in healthy individuals which can become co-dominant in parasitized individuals of the same host species. It is the case in *P. guajava* with *C. senex* and in *P. megacephala* on one hand and on the other hand in *O. sanchia* and *T. aculeatum* in *T. cacao*. Likewise, some ants can appear as non-dominant in healthy individuals and remain so in parasitized individuals of the same host species. Such is the case of *Paratrechina longicornis* and *Solenopsis geminata* in *C. maxima* and of *P. megacephala* in *T. cacao*.

Another type of variation which affects the initial mosaic structure of ants concerns a dominant ant in healthy individuals and which become co-dominant in parasitized individuals of the same host species. The only case pointed out is the one of *Camponotus* sp in *P. guajava*.

Two last variations can take place. An ant species can become dominant in healthy individuals individual and become dominant in parasitized individuals of the same host species. It is the case of *P. megacephala* in *P. guajava* and of *Camponotus* sp, *O. sanchia* and *T. aculeatum* in *T. cacao*. Finally the non dominant in healthy individuals can be absent in parasitized individuals of the same host species. It is the case of *T. bellicosum* in *P. guajava* and *T. cacao*.

Significative variations of the ants' mosaic are given in (Table 2) to show the most probable interactions of the combined parasitism of *P. capitata* and ants on host plants.

Interactions between *Loranthaceae* and ants

P. capitata like other hemiparasites look like clumps anchored in the wood of the host through a specialized organ, the haustorium or sucker (Figure 1D), which establishes functional connections with the host vascular tissues. Through the haustorium, the parasite pumps in water, mineral salts and the organic matter required for its development from the host (Dibong et al., 2008). The consequence that arise is the withering of the infected bough (Figure 1D) and a drop on the host plant's yield.

Ants like *Crematogaster* associated to *Loranthaceae* are drillers and take up the withered part of the plant while others build pasteboard nests from leave particles sample on the host plant (Figure 1B). Suckers of *Loranthaceae* can constitute nests that are formed of galleries dug in a living wood (Figure 1A). The interpretation of the host vascular material and the *Loranthaceae* associated to the combined action of driller ants from *Camponotus* brings about the formation of nests. These latter are made up of galleries dug in a living wood of plants (Figure 1C) where they live in association with Homoptera.

DISCUSSION

Generally, ants are considered to be predators (secondary consumers). However, sweet liquids (extrafloral nectaries and honeydew of Homoptera) represent an important part of the diet in tree living species and in some ground living species (Völkl et al., 1999). Tree living species are not nearly specialised in predation which is a secondary activity for workers. This predation permits the supplying of the colony in protein material (Hölldobler and Wilson, 1990).

Following the ant species, labourers can occasion lesions on underground and air parts of cultivated plants (buds, leaves, flowers and fruits) belonging to many families to exploit directly the sap or to eat into the internal tissues of the vegetable. The stage of occasioned damages can vary from simple lesions to the cutting up into pieces of the soft parts of the vegetable so provoking the death of the plant (Kenne et al., 1999).

Species of harvested ants belong to Ponerinae, Myrmicinae and Formicinae sub families (Hölldobler and Wilson, 1990). They are ants which harvest seeds and pile them up in their nests as food reserves (Hölldobler, 1976). In this environment, seeds harvested in great number are those of the most abundant vegetable species which can lose up to 90% of their seeds (Beattie, 1989). The majority of harvested ants' species known are the Myrmicinae of *Pheidole* genus (Kenne et al., 1999). These last mentioned are characterised by crowded colonies (Erickson, 1972) and a strong aggressiveness towards inter and intraspecific competitors (Hölldobler, 1976).

In the subfamily of Myrmicinae, *S. geminata* and *Tetramorium* feed on petals, ovarian tissue of flowers and on fruits of perennial plants such as lemon trees and cocoa trees (Veeresh and Gubbaiah, 1984).

P. capitata provokes a weakening of the host species, a reduction of his increase and an alteration of the wood quality (Peter-Contesse, 1937; Pourtet, 1961). The parts of barked tree trunk that it makes unusable at an unfolding or in wood-piece represent an important loss which can be easily worked out during forest exploitations. Losses on increase, though less perceptible, are also important: in the fir plantations of the val of Aran (Spanish Pyrenees), the reduction of the increase on the diameter is estimated to 42% when *Viscum album* L. (*Viscacae*) is well developed (Cervera and Villaescusa, 1977).

The generalised installation of *P. capitata* on the top

Table 2. Probabilities of variations of the ants species in association with *P. capitata* and host individuals at the Ndogbong chieftain's compound orchard.

	Citrus maxima		***Psidium guajava***		***Theobroma cacao***	
	HI	**PI**	**HI**	**PI**	**HI**	**PI**
Camponotus sp.	8 48 0.654	8 64	8 25 0.59	6 30	0 32 0.108*	4 50
Camponotus senex	0 48 0.108*	7 64	0 25 0.108*	6 30	6 32 0.593	8 50
Crematogaster auberti	0 48 0.108*	7 64	0 25	0 30	6 32 0.593	8 50
Crematogaster scutellaris	0 48 0.108*	3 64	0 25 0.108*	3 30	6 32 0.593	8 50
Ondontomachus sp.	8 48 0.654	8 64	0 25 0.108*	3 30	3 32 0.108*	8 50
Paratrichina sanchia	4 48 0.285	5 64	0 25	0 30	0 32	0 50
Pheidole megacephala	8 48 0.654	8 64	6 25 0.285	7 30	5 32 0.593	6 50
Solenopsis geminata	4 48 > 0.999	2 64	0 25	0 30	5 32	6 50
Tetramorium aculeatum	8 48 0.654	8 64	0 25	0 30	5 32 > 0.999	0 50
Tetramorium bellicosum	8 48 0.654	8 64	6 25 0.593	5 30	1 32 0.108*	8 50

*: Significant probability; HI : Healthy individuals; PI : Parasitized individuals. For *Camponotus* sp*;* concerning HI of *Citrus maxima*: 8 is number ants; 48 is total of ants collected on HI of *C. maxima* and 0.654 is the probability of the variation of number of ants.

doubled to the combined action of boring tree living ants of the wood of *Camponotus* genus (Lévieux, 1976) of the canopy provokes damages leading to the trunk heart rottenness. Moreover, ants of *Pheidole* genus attack too much abundant vegetable species (Kenne et al., 1999). Therefore a parasitic competition settles in the disturbed environment. The ecological perturbations of the environment linked to the parasitic associations can have positive or negative harmful impacts which modify an ecosystem working on account of specific interactions which settle between the implied actors. Host wood species that are found in it can constitute harmful or harmless *Loranthaceae*/ant associations.

Associations are harmful in the case of cultivated or spontaneous host species of the Ndogbong chieftaincy's orchard. Boring ants of *Camponotus* genus form nests into galleries dug in the living wood. These galleries form an impressive network in the *Loranthaceae* haustoriums. In Savoie, in such cases, Firs are practically not growing neither in size, nor in diameter (Peter-Contesse, 1937). It is the deplorable situation lived in most of the agroecosystems where *P. capitata* pre-dominated and is

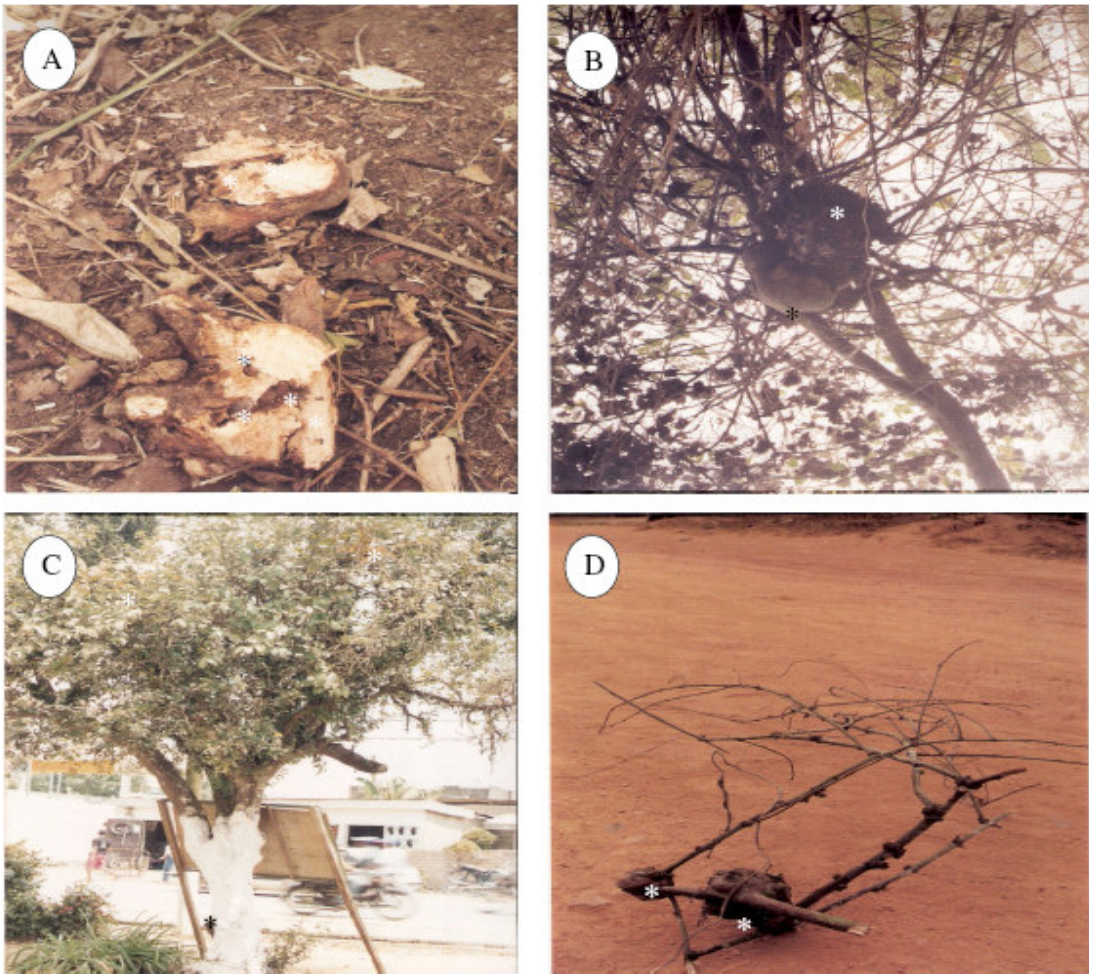

Figure 1. *Phragmanthera capitata* (Sprengel) S. Balle (*Loranthaceae*) at Ndogbong chieftaincy's orchard. A/ The bird of nest *Camponotus* genus build in seved sucker showing access holes (white stars); B/ The pasteboard nest of *Crematogaster* genus (white star) build on the sucker below (black star) fixed on the host individual of *P. guajava*; C/ The decay of the wood's heart (white star) formed in the *Citrus reticulata*'s trunck parasitized by *P. capitata* (white stars)*;* D/ *Loranthaceae*'s suckers (02) (white stars) carrying dried up branches of *P. guajava.*

dominated and is plentiful calling into question the food self-sufficiency brandished in days gone by as a political slogan. Agroecosystems has become "real green churchyards". Therefore, in all the visited agro-ecosystems, the disaster extremely worries the peasants with whom long punctual and spontaneous interviews to manifest their confusion compared with this disastrous situation. Food self-sufficiency has become an illusion in Cameroon. Harvests not only know the most drastic falls, but their quality is equally damaged. The case of avocado trees is more flagrant. All the fruits are stuffed with cracks and small rodents.

Negative consequences connected to the neglect of cocoa and coffee plantations in the agroecosystems after the prices fall occurred in the international market. Abandoning these income cultures for supply cultures, farmers have favoured without knowledge the *Loranthaceae* parasitism. Today, the government encourages the taking back of these abandoned plantations by providing peasants with improved plants called of high income without having taken this reality into consideration. What's the use of high income harvests which will be parasitized later by *Loranthaceae*?

It is urgent and essential to envisage a target and effective fight of *Loranthaceae*. It will be done with the financial support (putting into place of a tax of fight against green pollution) of agro-industrial companies which destroy vast areas of forest for monoculture (banana, hevea, palm tree). Hevea monoculture is more worrying because this woody species is very sensible to the *P. capitata* parasitism (Dibong et al., 2008). Now, in the coastal region (study area) three agro industial companies (Socapalm, Safacam, Hevecam) exploit *Hevea* and are situated at the periphery of secondary forests, potential reservoir of the *Loranthaceae* (Dibong et al., 2009a).

Moreover, these companies encourage the peasants to do heveaculture and to abandon supply cultures. “Green churchyards” are put into place at the favour of the pronounced deforestation by the putting into place of vast monogenic plantations of hevea and the excessive forest exploitation of woody essences of wood piece by forest concessionaries. The clearing leaved in the forests makes easier the scattering birds movements which perch to feed on tasty *Loranthaceae* fruits. These birds scatter step by step the parasitism on healthy host trees. There are also cases of repeated autoparasitism which pronounce the trauma of host woody species. It is the case of the Burkina Faso karite and nere agroeco-systems where the *Loranthaceae* parasitism provokes the premature withering of these essences of great economic value (Boffa, 2000).

Conclusion

The study of Loranthaceae/ants relations on host woody species in Cameroon, in particular of *P. capitata*, can be modified by two major interests: one economic and the other therapeutic (Dibong et al., 2009b). In order to respond to these two (à priori) antagonistic demands, it is essential to master the host species/ *Loranthaceae*/ant interactions.

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