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Full Length Research Paper

Contribution of tree ants towards the low production of fruits in *Phragmanthera capitata* (Sprengel) S. Balle (Loranthaceae)

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The follow up of the development of flowers of *Phragmanthera capitata* during four cycles of flowering plants had an objective to explain the low number of bays produced by this species observed in the agroecosystems of Douala. Collection of ants during the mornings were carried out in April, May and June 2009 on three floral knots belonging to a branch of *P. capitata* which parasites *Citrus maxima, Psidium guajava and Theobroma cacao.* The fructification in *P. capitata* was low and inversely proportional to the number of floral buds and full grown flowers. According to the ant species, labourers can cause lesions on underground and aerial parts of *Loranthaceae* (buds, leaves, flowers and fruits) so as to exploit extra floral nectarines, directly. Hence, most of the flowers do not reach maturity. Therefore fruit productions are limited. The magnitude of loss can vary from simple lesions to the cutting of soft part of the plant, leading to the death of the parasitized host plant.

Key words: *Phragmanthera capitata,* fructification, ant species, lesions.

INTRODUCTION

Contrary to other parasitic plants, namely Scrophulariaceae, Cuscutaceae and Lauraceae, the amount of seeds produced by Loranthaceae is reduced (Salle et al., 1995). This amount is high in Scrophulariaceae, 10000 to 50000 per formation of flowers and 2000 to 3000 seeds per plant in Cuscutaceae (Dembélé et al., 1994; Boussim, 2002). According to Sallé et al. (1998), each year, every cereal field is filled with several billions of seeds capped with a resistant tegument, important in the conservation of their germinative power for more than 20 years when underground. Furthermore, the minuscule and light seeds are easily disseminated by wind, running water, livestock, agricultural materials and men. However, several observations on Loranthaceae show that the number of seeds produced per plant is significantly low. In *Phragmanthera capitata*, it varies from 0 to 100. Also, those seeds are capped with a viscous pericarp, and are very vulnerable because they are quickly attacked by many yeast looking for a good source of sugar. When they fall on the ground, they get spoiled. So, the term "seed stock" exclusively used for *Scrophulariaceae* and *Orobanchaceae* (Sallé et al., 1998) is not applicable to *Loranthaceae*, namely to *P. capitata*. The *Loranthaceae* described by Balle (1982) are

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small trees, epiphytes, having chlorophyll and living as hemiparasites on the branches of wild or cultivated trees. These plants are fixed in the wood of their hosts through a sucking system used as functional linked with the host circulating system (Sallé et al., 1998). The parasite takes needed water and minerals as well as organic substances. *Loranthaceae* belong to the parasites angiosperms representing only 2% of all the plants bearing seeds (Parker and Riches, 1993; Raynal-Roques and Paré, 1998). But in some conditions, they can become true scourges. Their repartition and lost cost vary.

P. capitata (Sprengel) *S. Balle* is widely spread in Africa, particularly in Cameroon, Nigeria, Gabon and Ivory Coast (Engone et al., 2005 ; Engone and Sallé, 2006; Dibong et al., 2008; 2009a,b,c,d,e,f; Mony et al., 2009; Dibong et al., 2010; Mony et al., 2010). Cultures like rubber tree, pear tree, cocoa and coffee trees appear to be highly parasitized and big loss are sometimes unavoidable (Neumann and Sallé, 2003). Mechanical suppression of the host parasitized branches appears useless. Targeted fighting method can only be achieved if modalities regulating the adaptation of *Loranthaceae* to their cultivated or spontaneous hosts are identified and mastered (Neumann and Sallé, 2003).

The present study is aimed at understanding mechanisms leading to low production of fruits in *P. capitata*. The study site is the garden of the Ndogbong chieftaincy camp, isolated and well protected against any kind of men perturbations, except for the rigorous maintenance carried out there.

MATERIALS AND METHODS

Study site

The study site is the garden of the Ndogbong Chieftaincy Encampment, a neighbourhood situated North East of Douala Town. Douala (Latitude 03°40 - 04°11'N; Longitude 09°16' - 09°52'E ; Altitude 13 m) has an equatorial climate of a particular type called "Cameroonian", characterized by two seasons with a lengthy raining season (at least 9 months), high precipitations (around 4000 mm per year), and high and stable temperatures (26.7°C). Average minimal and maximal temperature in Douala for the past 30 years (1961 - 1990) has been 22.6°C in July and 32.3°C in February, respectively. Relative humidity of the atmosphere remains high the whole year and is around 100% (Din et al., 2008).

Follow up of the flowering and fructification in *P. capitata*

The follow up of the flowers and fruits development of *P. capitata* during four cycles of production was aimed at explaining the low number of bays of this species observed in the orchard. For that purpose, an experimental system permitting this follow up from the formation of floral buds to bays through full grown flowers was set in place. Several tufts of *P. capitata* holding many floral buds were seen on branches near the ground of three parasite plants of *Citrus maxima* where three floral buds of knots were marked with paints of different colors (white, green, red or blue) depending on the flower (1st, 2nd, 3rd or 4th) to avoid confusions in counting the flowers or fruits appearances. Under each branch choice, a plastic sheet of around 3 m² (Figure 1 D) was set to collect floral buds, full grown flowers and naturally fallen fruits. Regular observations carried out daily from January to July 2009 by the Masters' students of the Department of Botany, Faculty of Science, University of Douala helped in the follow up of this experimental system. These students were organized into three groups of six persons for nine floral knots of three individuals of *C. maxima* (Rutaceae).

Harvesting and identification of the myrmecofauna

The investigated orchard is in an area of around 2 ha and constitutes essentially of trees whose fruits are intended for landlord consumption. It is located in an abandoned cocoa farm that has been exploited for fruits trees. Collection of ants in the morning were carried out in April, May and June 2009 on three floral knots belonging to a branch of *P. capitata* which parasites *C. maxima, Psidium guajava and Theobroma cacao*. Ant labourers present in plants were harvested after using machete to lift fixation parts. These ants were collected with a mouth aspirator (for labourers of medium size) or with a 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, Faculty of Science, University of Douala.

Ant species identification was 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.

RESULTS

Four cycle of flowering plants were identified from January to August 2009 in *P. capitata* in the orchard (Figure 1 B). In total, 2972 floral buds, 1774 flowers in full bloom and 1126 fruits were produced by nine floral knots belonging to three parasitized individuals of *C. maxima*. The yield of fruit production was, thus, small that is 37.89%. The production of floral buds is important per branch and per floral knot (Figure 1A). The maximum production of the floral buds was observed in January – February, that is to say 1223 floral buds and the minimum production of floral buds were observed on July-August that is 540 floral buds. The maximum production of fruits (785) was equally observed on January - February and minimum production (59) on May - June (Table 1). The production of fruits (Figure 1 C) was thus very limited per floral branch and floral knot.

They were considerable losses of floral buds or flowers in full bloom during all cycles of production (Table 2).

In total, 433 labourers belonging to three species of ants were harvested on the floral buds during the months of April, May and June 2009 (Table 3). The three species identified were *Crematogaster auberti*, *C. Scutellaris* and *Pheidole megacephala*. These species can be dominant (*P. megacephala*), co-dominants (*C. auberti* and *P. megacephala*) or non dominant (*P. Megacephala*) on the floral buds. If the *Crematogaster* genus is tree ant, *Pheidole* genus is earthliness but rummages on *C. maxima* as a predator. The fodder activity of these ants was more marked in the months of April (219 labourers

Figure 1. A/ High production of flowers of *P. capitata* on a knot of the branch ; B/ sub wood of the orchard of the Chieftaincy of Ndogbong ; C/ Small production of fruits on the same knot ; D/ Experimental device of harvest of floral buds, flowers and fruits of *P. capitata*.

The smallest fodder activity was observed in May with 39 labourers of *P. megacephala*.

DISCUSSION

P. capitata has been observed to have at least four production cycles during which a big number of flowers were produced. However, bays production was very limited. Several hypothesis can explain this scarcity: the abortion of most of the bays before maturity; fruits are likely eaten by birds before their maturity; most of the flowers do not reach the maturity state; one or several factor(s) external to the *Loranthaceae* could be responsible for the falling of the floral buds.

For the first hypothesis, if the abortion problem was real, the dissemination of seeds will not take place and *Loranthaceae* will not be ubiquitous. The second hypothesis does not explain the large distribution of this specie either. If the seeds were disseminated before their maturity, germination would not have taken place. The follow up of the development of flowers from the floral buds to the bays via full grown flowers support the 3rd and 4th hypothesis. In fact, the fall of a big number of flowers before and after anthesis was observed, this could explain the low production of the bays.

To avoid this loss, *P. capitata* should have adopted a strategy consisting of the production of a big number of flowers several times annually. Several production cycles and a low production of the bays in *P. capitata* were also observed in others African countries. So, in Gabon, *P. capitata* produces flowers and fruits three times a year (Obiang, 2006).

Due to multiple flowerings and fructifications, the African

Table 1. Number of floral buds, of flowers and fruits on nine floral knots of *Phragmanthera capitata* divided in three lot of host individuals of *C. maxima* at the orchard of the Chieftaincy of Ndogbong (Period: January-August 2009).

Type of flowering	Mois	Phenological parameters	Cycles of production	Floral branches (03)			Total
				Distal knots (03)	Intercaled knots (03)	Proximal knots (03)	
1st Flowering	January	BF	I	378	401	444	1223
		F		219	280	286	785
		Ft		0	0	0	0
	February	BF		0	0	0	0
		F		0	0	0	0
		Ft		221	250	250	721
2nd Flowering	March	BF	II	154	226	183	563
		F		101	120	128	349
		Ft		0	0	0	0
	April	BF		0	0	0	0
		F		0	0	0	0
		Ft		62	59	76	197
3rd Flowering	May	BF	III	194	250	202	646
		F		78	167	127	372
		Ft		0	0	0	0
4th Flowering	June	BF	IV	179	195	98	472
		F		109	151	45	305
		Ft		11	34	14	59
	July	BF		183	151	206	540
		F		102	71	95	268
		Ft		0	0	0	0
5th Flowering	August	BF		44	42	34	120
		F		42	3	0	45
		Ft		61	45	43	149
Total							7186

BF, floral buds; F, flowers; Ft, fruits.

Loranthaceae in general have a different behaviour from the *Arceuthobium*, *Phoradendron* and *Viscum* genera which produces flowers and fructify once a year (Sallé et al., 1993). This level of flower bearing could be linked to African weather conditions (high temperatures).

The principal factor responsible for this fall, most of the time, are tree ants, even though those that are earthly (*Pheidole* genus) can also be found on the *Loranthaceae*. Ants in general are considered as predators (secondary consumers). However, sweet liquids (extrafloral nectaries) represent an important part of the alimentation of tree ants and some ground ants (Dejean and Suzzoni, 1997; Völkl et al., 1999; Orivel, 1999). Tree ants are pretty and do not specialize in predation which is a secondary activity for the labourers. This predation provides proteins for the colony (Hölldobler and Wilson, 1990).

According to the ant species, labourers can cause lesions for direct exploitation of plant nutritive liquids or internal tissues on underground and aerial parts of cultivated plants (buds, leaves, flowers and fruits) belonging to several families. The magnitude of loss caused can vary from simple lesions to the cutting of soft part of the plant, leading to the plant's death (Kenne et al., 1999).

Harvestibg ant's species belong to the subfamily of the Ponerinae, Myrmicinae and Formicinae (Hölldobler and Wilson, 1990). These are ants that harvest seeds and stock them as food reserve (Mony et al., 2009; 2010). In the field, seeds harvested in big number are those of most abundant plant species which are able to lose up to 90% of their seeds (Beattie, 1989). This is not the case for *Loranthaceae*, namely *P. capitata* whose fruits are bays.

Table 2. Estimations of losses of floral buds, flowers and fruits on nine floral knots of *Phragmanthera capitata* divided in three lots of host individuals of *Citrus maxima* at the orchard of the Chieftaincy of Ndogbong (Period : January-August 2009).

Period of production	Phenological parameters	Distal knots (03)	Intercaled knots (03)	Proximal knots (03)	Average knot
January - February	BF	378	401	444	444.67
	F	219	280	286	261.67
	BF-F	159	121	158	146
	(BF-F/BF×100)%	42.06	30.17	35.58	35.94
	F	219	280	286	261.67
	Ft	221	250	250	240.33
	F-Ft	2	30	36	22.67
	(F-Ft/F×100)%	0.91	10.71	12.59	8.07
March - April	BF	154	226	250	210
	F	101	120	183	134
	BF-F	53	106	67	75.34
	(BF-F/BF×100)%	34.4	46.90	26.80	36.04
	F	101	120	183	134.67
	Ft	62	59	76	65.67
	F-Ft	39	61	107	69
	(F-Ft/F×100)%	38.61	50.83	58.46	49.3
May - June	BF	194	250	202	215.33
	F	78	167	127	124
	BF-F	116	83	75	91.33
	(BF-F/BF×100)%	59.79	33.20	37.13	43.37
	F	78	167	127	124
	Ft	11	34	14	19.67
	F-Ft	67	33	113	71
	(F-Ft/F×100)%	85.90	19.76	88.98	64.88
July - August	BF	183	151	206	180
	F	102	71	95	89.33
	BF-F	87	80	111	92.67
	(BF-F/BF×100)%	47.54	52.98	53.88	51.47
	F	102	71	95	89.33
	Ft	61	45	43	49.67
	F-Ft	41	26	52	39.67
	(F-Ft/F×100)%	40.20	36.62	54.73	43.85

Table 3. Number of ants harvested on the floral buds of knots of *Phragmanthera capitata* at the orchard of the Chieftaincy of Ndogbong (Period: April - June 2009).

Host species	*Citrus maxima*			*Psidium guajava*			*Theobroma cacao*		
	April	April	June	April	April	June	April	April	June
Crematogaster auberti			105	16			43		
C. scutellaris	207				Non-flowering	36		Non-flowering	
Pheidole megacephala	12	39	70						
Camponotus senex						6			16

bays. These have normally a well developed pericarp where mesocarp is a major component. It consists of a tissue; the viscin. Hence, despite being rich in polysaccharides, (Gedalovich et al., 1988), its viscous consistency (Dibong et al., 2009a) constitute a fatal trap for the labourers' ants going there. However, the majority of known harvesting ant species are the Myrmicinae of the *Pheidole* genus (Kenne et al., 1999). They are characterised by big colonies (Mony et al., 2009) and are a bit agressive toward inter and intra-specific competitors (Hölldobler et Wilson, 1990). Ants of the *Pheidole* genus most of time attack abundant plant species (Kenne et al., 1999) and the *P. capitata* case shows this well. This angiosperm has a 76.14% parasitism in the littoral region and corresponds to all the country ecologic variations (Dibong et al., 2008).

The sub families of the Myrmicinae, *Solenopsis germinata* and *Tetramorium* are fed with petals, flowers tissues and fruits of long life plants like lemon and cocoa trees (Veeresh, 1984; personal observation).

Conclusion

Fructification in *P. capitata* is low and inversely proportional to the number of floral buds and full grown flowers. According to the ant species, labourers can cause lesions on underground and aerial parts of this Loranthaceae (buds, leaves, flowers and fruits) in order to exploit directly, nutritious liquids or internal tissues of the plant. Hence, most of the flowers do not reach maturity. The magnitude of loss caused can vary from simple lesions to the cutting of soft parts of the plant, leading to its death.

Another aspect concerning Loranthaceae eco-physiology comes from this work and requires particular attention: limited development of Loranthaceae on some host trees such as mangoes trees in the study area can present important ramifications. These trees, when used for fruit bearing are not parasitized by *P. capitata*. Is this behaviour linked to the fact that ramifications are incidental to the displacement of avian disseminators or is it contrary to the fact that an important ramification implies a more close leave crown? For that, artificial infestations should be released on mangoes trees.

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