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Parasitism of plum tree (*Dacryodes edulis*, Burseraceae) by *Loranthaceae* in the locality of Fotetsa-Dschang (West-Cameroon)

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Plum tree (*Dacryodes edulis*) in Cameroon is a fruiting and shading tree in agro ecosystems. It is of nutritional, medicinal and economical values to local population. Its productivity is reduced partially in some localities by the *Loranthaceae* parasites. These parasites were censured on plum trees in all the nine villages of the locality Fotetsa (West Region of Cameroon) where they are mainly shading plants in coffee farms. In each village, all fruits bearing plum trees located in a perimeter of 1850 × 60 m were observed and characterized using the stem diameter, number of *Loranthaceae* present and the taxon of the parasite. At Fotetsa, four *Loranthaceae* species attack plum trees: these are *Tapinanthus apodanthus, Phragmanthera capitata, Tapinanthus oleifolius* and *Viscum congolense.* The rate of parasitism varied significantly (from 41.46 to 62.74%) between the nine villages of the locality of Fotetsa in function of the different classes of plum tree stem circumference. Also, the number of *Loranthaceae* per plum tree varied in function of localities with maxima within 17 and 29 *Loranthaceaae* per tree. In each village, average mean number of *Loranthaceaae* per tree and average mean stem circumference were correlated. Considering the negative impact of *Loranthaceae* parasite on fruiting plant production, it is imperative to envisage preventive methods (limitation of species propagation) and curative methods (mechanical destruction of species fixed on the host plant) for fight against these hemi-parasite phanerogames.

Key words: Cameroon, plum tree, *Loranthaceae*, inventory, identification.

INTRODUCTION

Plum tree (*Dacryodes edulis*) is an oleiferous fruiting plant that originated from humid inter-tropical regions of Africa (Aubreville, 1962; Okafor, 1983). The species is much diversified, but only two varieties are well identified up to now: var. *edsulis* and var. *parvicarpa* (Verheij, 2002). As many other non-timber products, plum trees

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are not yet domesticated. However, it is frequently used as a shading plant in coffee and cocoa farms. The fruits called plums are drupes with diameter varying between 3 and 18 cm (Kengue, 2002; Giacomo, 1982). These fruits are used by the local consumers as food and as exporting. In fact, the pulp of these fruits contains considerable amounts of carbohydrates, lipids, proteins, fibres and mineral salts: especially calcium, magnesium, potassium and sodium (Aiyelaegbe et al., 1998; Kiakouma and Silou, 1990). In addition, they contain non-saturated fats like linoleic acid (18.3%) and oleic acid (29.5%) and many amino-acids which give the plum the protective and energetic values (Umoti and Oky, 1987). The oil yield of plum is estimated at 7 tons per hectare (Kiakouma and Silou, 1990). Leaves, stems and stem backs are used in ethno-botany in the treatment of otitis, amoebic dysentery, leprosy, anaemia and yellow fever (Anon, 1991). With its non-neglected yearly production, plum tree occupied the 8th position amongst tropical fruit trees behind banana tree, coco tree, mango tree, pineapple, pawpaw tree, pear tree and orange tree (Anon, 1991).

In Cameroon, plum tree is mainly cultivated in the West, Centre and Littoral Regions. The yearly production is about 500 kg of fruit per tree (Kengue, 2001). However, its production is reduced by the attack of several pests. These pests are generally bacteria, viruses, fungi, insects and small animals which attack all plant organs and in particular flowers and fruits, provoking their falling before maturity (Silou, 1996; Onana, 1998). In the West Region of Cameroon, plum trees are mostly found in the area of Foumban and Fotetsa where coffee (*Coffea arabica*) is intensively grown and where it serves as shading tree in the coffee farms. In the locality of Fotetsa (05°20' latitude North and 10°03' longitude East), where the population (about 25310 inhabitants) is essentially made up of farmers who make a good part of their incomes through plum harvesting and marketing (Nkuekeng, 2006). But in addition to devastating effect of microorganisms, insects and small animals, plum production is limited due to parasitism by *Loranthaceae* on plum trees in farms (Dibong et al., 2009a). The *Loranthaceae* are hemi-parasite phanerogames who carry out photosynthesis using water and mineral salts from the host plant. No work has yet been done on the identification of this parasite and the control of their devastating action in the locality of Fotetsa. Hence, an inventory and identification of Loranthaceae found on plum trees was done in the nine villages that constitute the locality of Fotetsa. The rate of parasitism on plum trees and the mean number of Loranthaceae per tree were determined in each village.

MATERIALS AND METHODS

Collection and identification of *Loranthaceae*

Prospections were carried out in the agro ecosystems of the nine villages of the locality of Fotetsa: Melah, Megang, Makong, Zimlah, Tsekoug, Ngonlah, Toulah, Zimtetsa and Tdissang. These prospections were done between the months of April and July 2011 and 2012 which corresponded to the flowering and fructification periods of the Loranthaceae. In each locality, all the plum trees above 19 cm of stem circumference (Dibong et al., 2009a) located within a perimeter of 1850 x 60 m were observed. The area of study was divided into 111 quadrats of 1000 m^2 and the total numbers of 504 plants were prospected with a single replication. The pictures of *Loranthaceae* present within the prospected area and some of their organs (flowers, fruits, hostorium) that could enable their identification were made using a numerical camera (model Nikon). The identification of the collected samples of Loranthaceae was done by comparing them to the specimen at the national herbarium of Cameroon and by using the identification key for *Loranthaceae* of Cameroon (Balle, 1982). The species of *Loranthaceae* found without flowers and fruits to enable their identification were not taking into consideration.

Parameters measured and analysis

For each plum tree considered:

i. The stem circumference was assessed at 1.20 m above ground level to establish a relation between the parasitism by *Loranthaceae* and the host;
ii. The number of *Loranthaceae* carried by each plum tree was counted;
iii. The percentages of infected plum trees in the villages prospected were calculated. The variation of this parameter from one village to another was compared by analysis of variance (ANOVA) using Duncan test at $P \leq 0.05$.

A clustering of data into classes of circumferences was done according to Sturges (1926) which aided to determine the minimal number K of classes in function of the number N of a series studied trees:

$$K = 1 + [10 \log_{10} N / 3]$$

The size of the class was obtained by dividing the size of the series by K-1.
The analysis of the regression was done to verify the existence of a relation between the number of *Loranthaceae* and the circumferences of the plum tree observed.

RESULTS

Species of *Loranthaceae* found on plum tree in the different villages

Four species of *Loranthaceae* attack plum trees in the study area: *Tapinanthus apodanthus* (Sprague) characterized by violet inflorescences (Figure 1a), *Phragmanthera capitata* (Sprengel) S. Balle characterized by dark-yellow inflorescences (Figure 1b), *Tapinanthus oleifolius* (S. Moore and Sprague) characterized by pinkish inflorescences (Figure 1c) and *Viscum congolense* (De Wild) characterized by green-whitish inflorescences (Figure 1d). Some of these species can be found alone or in association with others on a plum tree individual. These species can be found on other host trees like pear, mango, cacao, guava, and some citrus.

Figure 1. Different species of Loranthaceae parasite of plum trees in the nine villages of the locality Fotetsa-Dschang (West-Cameroon): a-*Tapinanthus apodanthus*; b-*Phragmenthera capitata;* c-*Tapinanthus oleifolius*; d-*Viscum congolense*.

Rate of parasitism on plum tree

The percentages of plum trees attacked are relatively high and varied from 41.46% in the village of Meganh to 66.67% in the village of Ngonlah (Table 1). The percentage of infected tree was high in the villages of Ngonlah, Toulah and Makong; and lower in the villages of Meganh, Zimtetsa and Tsekoug. The circumference of prospected plum trees varied from 19 to 272 cm. Plum trees in the class 1 (19 to 47 cm) which were the youngest and individuals of classes 6 (157 to 187 cm), 7 (187-215 cm), 8 (215 to 243 cm) and 9 (243 to 271 cm) which were the oldest were slightly attacked compared to young individuals of classes 2 (47 to 75 cm), 3 (75 to 103 cm), 4 (103 to 131 cm) and 5 (131 to 159 cm) which were strongly attacked in almost all the villages of the locality Fotetsa (Figure 2).

Average number of *Loranthaceae* per attacked plum tree

The analysis of the average number of *Loranthaceae* per tree and the circumference of the stem of the host plant in the nine villages showed significant differences. The highest average number of *Loranthaceae* per attacked tree was significantly higher (S = 0.013) in the localities Meganh and Tsegoug (5.24 ± 6.73 and 5.18 ± 6.00) (Table 2) compared to the one in the localities of Toulah (4.94 ± 7.72) and Zimtetsa (4.79 ± 7.48). Lowest number of *Loranthaceae* was obtained in plants from the localities of Zimlah (4.23 ± 4.23); Melah (4.19 ± 7.31); Ngonlah (3.61 ± 7.48); Makon (2.62 ± 5.30) and Tdissang (2.04 ± 2.83); and these means were not significantly different (Table 2). The mean plant stem circumference was significantly the same in all localities except that of Tsekoug which was higher (83.11 ± 37.33). These numbers compared between the different villages aided in the distribution of attacked trees into three different groups: Highly attacked (Ngonlah, Toulah and Makong), averagely attacked (Tdissang, Zimlah and Melah), lowly attacked (Tsekoug, Zimtetsa and Meganh) (Table 1). The linear regression analysis between the stem circumference and the mean number of *Loranthaceae* per plum tree in all the villages showed a relation between these two parameters (Figures 3a, b, c, d, e, f, g, h and i).

DISCUSSION

The results showed that in the locality of Fotetsa-

Table 1. Distribution of investigated plum tree in the village Fotetsa per locality and per class of stem circumference in function of their attack by Loranthaceae parasite species.

Localities	Attacked plum tree	Classe de circumference (cm)							Total	Infected tree (%)
		19-47	48-75	76-103	104-131	132-159	160-187	>188		
Melah	No	2	14	9	7	3	3	1	39	-
	Yes	25	11	9	0	1	0	0	46	43.90
Meganh	No	4	20	17	3	3	1	0	48	-
	Yes	13	13	7	1	0	0	0	34	58.53
Makong	No	1	18	16	2	3	9	1	41	-
	Yes	28	22	13	2	0	0	0	65	36.60
Tdissang	No	2	3	3	0	1	0	0	9	-
	Yes	6	3	2	1	0	0	0	12	42.85
Tsekoug	No	1	11	16	8	3	2	1	42	-
	Yes	10	13	4	1	0	0	0	28	60
Zimlah	No	1	1	2	4	1	0	0	11	-
	Yes	3	3	3	3	0	0	0	14	42.85
Toulah	No	0	3	8	5	3	2	1	19	-
	Yes	15	13	4	0	0	0	0	32	38.88
Zimtetsa	No	1	10	8	1	0	2	1	23	-
	Yes	9	7	4	0	0	0	0	20	53.50
Ngonlah	No	0	0	3	1	3	0	0	7	-
	Yes	9	4	1	0	0	0	0	14	33.33

Dschang (West –Cameroon), plum trees were attacked by four species of *Loranthaceae* family. This number of species is comparable to the one observed by Sonke et al. (2000) on pear tree in the locality of Yaoundé (Centre Region Cameroon). Among these four species of *Loranthaceae* observed on plum trees in the study area, one of them (*P. Capitata)* was also observed on pear trees in the Centre Region of Cameroon by Sonke et al. (2000). Others of these species were found on other plant trees like *Mangifera indica* and *Psidium guajava* in the locality of Tubah (North West-Region, Cameroon) by Feguem (2011). Therefore, it can be seen that *Loranthaceae* parasites are not specific to a host plant, or to a locality.

In fact, Balle (1982) has shown that the area of distribution of *Loranthaceae* parasite in Africa

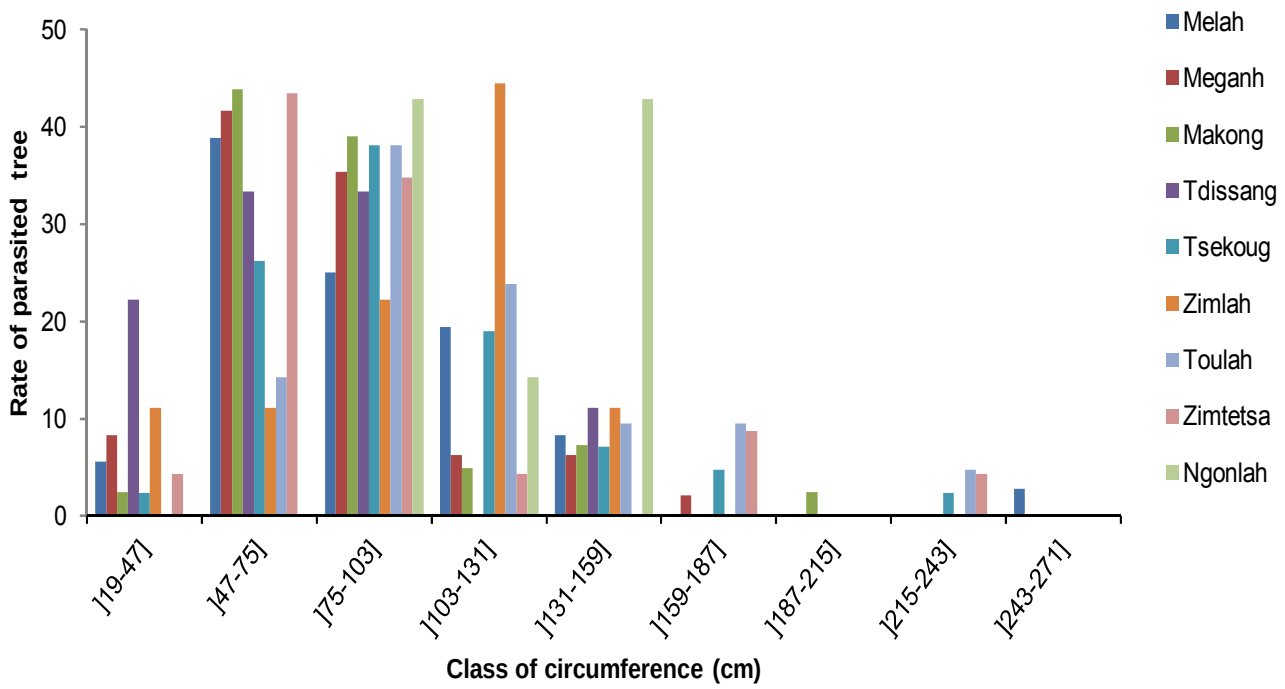

Figure 2. Variation of the rate (%) of plum trees attacked by Loranthaceae in the nine localities of the village Fotetsa- Dschang (West-Cameroon) in function of the plant stem circumference classes.

Table 2. Average number of tufts of Loranthaceae and prospected mean plum stem circumferences in the nine prospected localities of the village Fotetsa-Dschang (West-Cameroon).

Localities	Mean tuft number ± Sd	Mean plant stem circumference ± Sd	Number of prospected plum trees
Melah	4.19 ± 7.31^{a}	68.36 ± 39.82^{a}	85
Meganh	5.24 ± 6.73^{c}	71.36 ± 28.47^{a}	82
Makong	2.62 ± 5.30^{a}	68.29 ± 32.17^{a}	106
Tdissang	2.04 ± 2.83^{a}	65.29 ± 32.98^{a}	21
Tsekoug	5.18 ± 6.00^{bc}	83.11 ± 37.33^{c}	70
Zimlah	4.23 ± 4.23^{ab}	71.97 ± 23.55^{ab}	25
Toulah	4.94 ± 7.72^{bc}	73.66 ± 43.82^{ab}	51
Zimtetsa	4.79 ± 7.48^{bc}	73.02 ± 39.018^{ab}	43
Ngonlah	3.61 ± 7.48^{a}	69.23 ± 41.40^{a}	21
F- value	2.549	12.806	
Significance	0.013	0.049	

Means with the same letter in the same column are not significantly different at $P < 0.05$ (Duncan test).

in general and in Cameroon in particular is very wide. It extends from the south of the 7th North parallel, passing through Atlantic costal forest and continues to the transition area between the Biafrean forest and the Congolese forest, prolonging into the mountain forest and then the Guinean savannah. The association between *Loranthaceae* species and host plant species as well as the density of parasite that were observed from one host plant to the other might be conditioned by many factors such as: the climate type (Raynal-Roques and Paré, 1998), the variety and sensitivity of the host (Balle, 1982; Sallé and Aber, 1986), the geographical positioning and floristic parameters (Dibong et al., 2009a; b).

In the locality of Fotetsa, the percentage of attacked plum trees varied significantly from one village to another with a maximum of 66.67% in Ngonlah and a minimum of 41.46% in Meganh. Similar results were obtained by Dabou (2009) for the same species in the locality of Manjo (Littoral Region, Cameroon) but, only two of the four species recorded in Fotetsa were found in this locality (*T. Apodanthus* and *P. Capitata).* The variation of the parasitism rate from one village to another could be

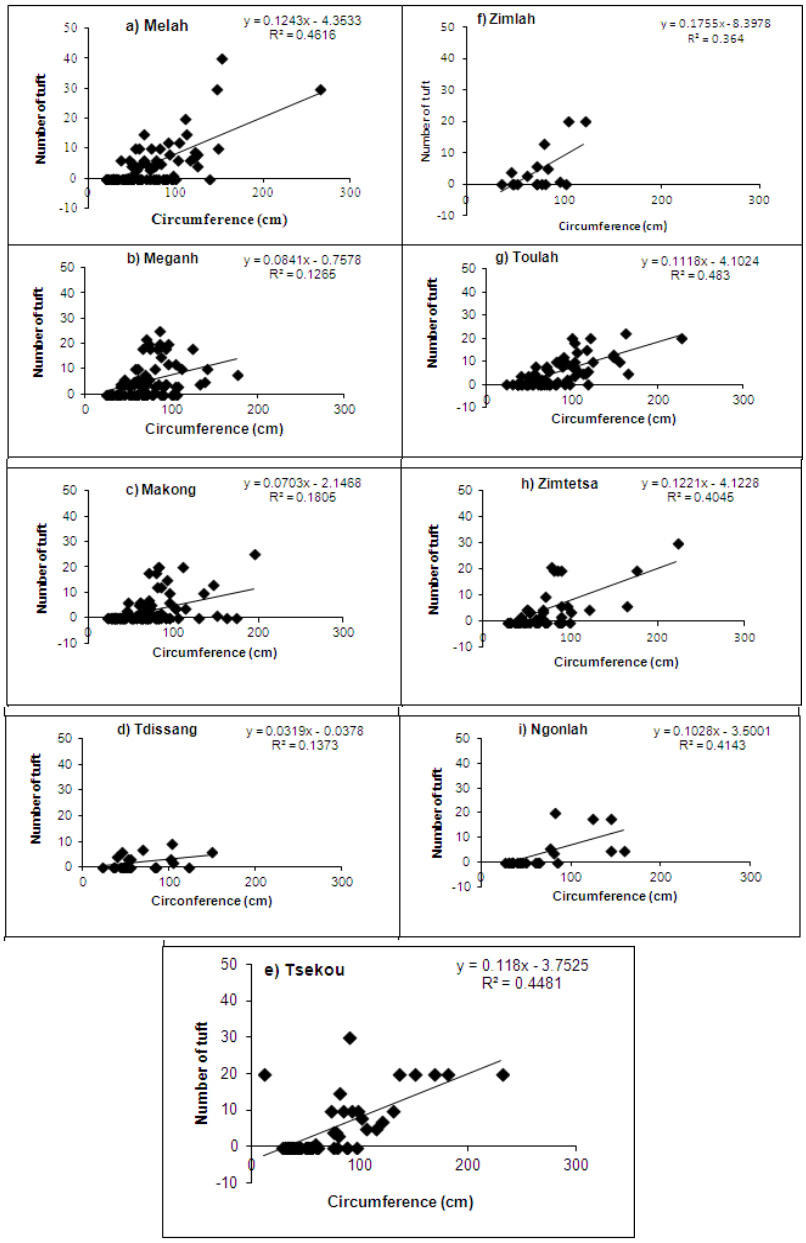

Figure 3. Regression lines between mean tufts number of Loranthaceae on prospected plum tree and mean plant stem circumference in the nine prospected localities of the village Fotetsa-Dschang (West-Cameroon).

explained at least partly by a change in the microclimate when passing from one village to another (Balle, 1982).

Therefore, the fact that Meganh and Zimlah presented the same parasitism rate (41%) could imply that these two localities may have the same microclimate and the same flora diversity of the host plants (Dabou, 2009; Boussin et al., 1993a). The results of this study showed differences in the prevalence of parasitism in the different villages. These differences could be due to some factors such as the variety of the plum tree, the history and age of the tree, the sensitivity and degree of infestation of the host plant (Dabou, 2009; Boussin et al.,1993b) as well as the availability of avian species responsible for the dissemination of the *Loranthaceae* seeds (Jiofack, 2005). In fact, plum trees observed in the study area could belong to different varieties, therefore presenting different degree of sensitivity towards the parasites as reported by Sonké et al. *(*2000). In addition, the pruning of attacked branches as a curative practice in many of these villages, the flora composition of the agro ecosystems and the

vicinity between the hosts plant could also explained the difference in the prevalence between the different villages (Raynal-Roques and Paré, 1998; Dabou, 2009; Dibong et al., 2009c). The maxima number of *Loranthaceaae* (17; Melah, Zimla, Toulah, Zimtetsa and 29; Meganh, Tsekoug) observed in some trees in the study area are in the same range with the results of Feguem (2011) on *Psidium guajava* in the locality of Tubah (North-West Region, Cameroon) and Dibong et al. (2009a; c) on fruiting trees in the Littoral Region of Cameroon. Such a high parasite density (≥ 20 *Loranthaceaae* per tree) can lead to the total death of the host plant (Boussin et al., 2009a). A variation and significant correlation between the mean stem circumference and the number of *Loranthaceae* on attacked plum trees was also noticed.

Similar observations were made by Sonké et al. (2000) and Tatchou (2009) on pear tree in the locality of Yaoundé (Centre Region, Cameroon) and Banganté (West-Region, Cameroon) respectively. Dongmo (1998) also reported similar facts on *Hevea brasilensis* in the Fako Division (South–West Region, Cameroon). Such variation and correlation could at least partially be explained by the genetic and microclimatic factors associated to the growth and development of the host and parasite (Okafor, 1983; Sallé and Aber, 1986; Sallé, 1994), the degree of sensitivity and resistance of the host plant tissues to the fixation by the parasite (Dibong et al., 2009a) and the efficacy of protection method carried out in the study area.

The fight against *Loranthaceae* parasite on fruiting plants in general and plum tree in particular can be envisaged preventively or curatively. The preventive measure will consist into limiting considerably the propagation of the parasite seeds in the agro ecosystems (Boussin et al., 1993a). Genetic and biotechnological methods of fight can be used to produce improved host plant individuals which can resist the parasites. Curative measure will consist to fight against these parasites by pruning or cutting down the attacked branches. This cultural method which seems for now very effective however presents certain limits when considering the high density of parasites on certain trees in the investigated area. In fact, cutting down the attacked branches may lead to the destruction of all the branches of the tree therefore leading to the death of the plant and subsequently decrease in the productivity of plum fruits in the study area. The physical elimination of only parasite at the level of the contact point (haustorium) seems to be the best fighting method against parasites while maintaining the host plant alive and avoiding a drastic reduction in plum productivity.

Conclusion

This work shows that plum trees in the locality of Fotetsa (West-Cameroon) are attacked by four species of the *Loranthaceae* family. These *Loranthaceae* which can be found alone or in association on the same plum tree were not specific to this host plant. In fact, they are found on other fruiting plant trees in the study area. The rate of attacked plants and the parasite density varied with villages and host plant stem circumference.

Conflict of Interests

The authors have not declared any conflict of interests.

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