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LORANTHACEAE (MISTLETOE), A PHYTOPARASITIC DISPERSED BY BIRDS ON ANNUITY CROPS IN PERIURBAN AREAS OF THE DALOA DEPARTMENT, IN CENTRAL WEST CÔTE D'IVOIRE

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ABSTRACT

In Côte d'Ivoire, Loranthaceae invades numerous wild and cultivated woody species that they infest. The objective of this study is to show the major role of birds in the dispersion of phytoparasites on crops.

The botanical inventory identified five (5) species of Loranthaceae on annuity crops in periurban areas of the Daloa department. Among the species inventoried, *Tapinanthus bangwensis* is very infesting on cocoa trees and coffee trees, and *Phragmanthera capitata* more abundant on rubber trees. Cocoa trees are much infested with an average rate of 52.09%.

Observations on the behavior of visiting birds in the clumps of Loranthaceae confirmed the role of 13 bird species distributed in seven (7) genera and seven (7) families (Nectariniidae (3), Psittacidae (1), Capitonidae (5), sylviidae (1), Colombidae (1), Pycnonotidae (1) and Rhipiduridae (1)). Among these species, two (2) of the family Nectariniidae are very active in their clusters of flowers: *Nectarinia senegalensis* and *N. pulchella* and three (3) species of Capitonidae have a more active role in the consumption of berries and in the dissemination seeds. They are: *Pogoniulus atroflavus*, *P. chrysonocus* and *P. scolopaceu*s. These results obtained on the responsibility of birds in the dispersion of Loranthaceae on crops suggest upstream lines of struggle that must be taken into account in the defense of crops.

Keywords: Annuity crops, Loranthaceae, bird species, dispersal, crop defence.

1. INTRODUCTION

Loranthaceae (guis) are hemiparasitic vascular plants that live at the expense of other spontaneous and cultivated woody host species (Traoré et al., 2003). In West Africa, particularly in Côte d'Ivoire, in the countryside, these phytoparasites invade an abundance of trees and shrubs. In addition, within a host population, some woody plants are often parasitized much more than others (Amon, 2014). Indeed, these phytoparasites without being specific to hosts have found in certain crops such as cocoa trees, coffee trees, rubber trees, citrus fruits (orange, lemon, grapefruit, mandarin), cola trees, guavas and avocados prosperous subjects, they negatively affect their growth and yield (Soro 1999; Boussim, 2002; Salle 2004; Soro, 2010).

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Although several factors act their parasitism on woody plants, some studies have shown that the mechanisms of dispersal of these hemiparasites plants are vested in birds that disseminate their seeds (Dembélé et al., 1994; Boussim, 2002).

But, how do you explain this link between birds and parasitic vascular plants of the family Loranthaceae that proliferate from trees to trees of crops if we do not have information on the avian species involved? What are the plant populations dispersed by birds on the annuity crops of village plantations in periurban areas of Daloa, in central west Côte d'Ivoire? In Côte d'Ivoire, various studies have been carried out on the Loranthaceae (Balle and Halle, 1961; Traoré et al., 2003, Soro, 2006; Soro, 2010), however, these studies have been oriented more toward evaluation, infestation of their attacks on host woody plants.

However, the involvement of birds in the expansion of plant pests, particularly on cash crops, although real (Dembélé et al., 1994; Overton, 1994; Amon, 2014), remains very little studied and documented in Côte d'Ivoire.

However, the fight to be carried out in cultures against these hemiparasites requires to know the agents of their dispersion on the feet of the host subjects. The present study is concerned with the species of Loranthaceae that live at the expense of the host plants of cash crops, their degree of attack and the behavior of birds visiting these clumps in order to undertake control actions.

2. MATERIALS AND METHODS

2.1. Study site

The study was carried out in village plantations of annuity crops in periurban areas of the department of Daloa (Figure 1) located between 6°27′00" north latitude and 5°56'00" west longitude, in in central west Côte d'Ivoire, 383 km from Abidjan. The climate of the department of Daloa is of equatorial type of transition with 2 seasons of rain which alternate with two dry seasons (Eldin, 1971). The annual rainfall varies between 1300 and 1800 mm. The average annual temperature is 27.0 ºC. The vegetation belongs to the mesophilic sector of the Guinean domain (Guillaumet and Adjanohoun, 1971). It consists of mosaics of Guinean forests and savannahs.

2.2. Material

The material consists of biological material composed of specimens of Loranthaceae and individuals of cultures. Technical equipment consisting of a survey sheet, a tape measure, a geographic positioning device (GPS), a pair of binoculars, a digital camera and pruning shears.

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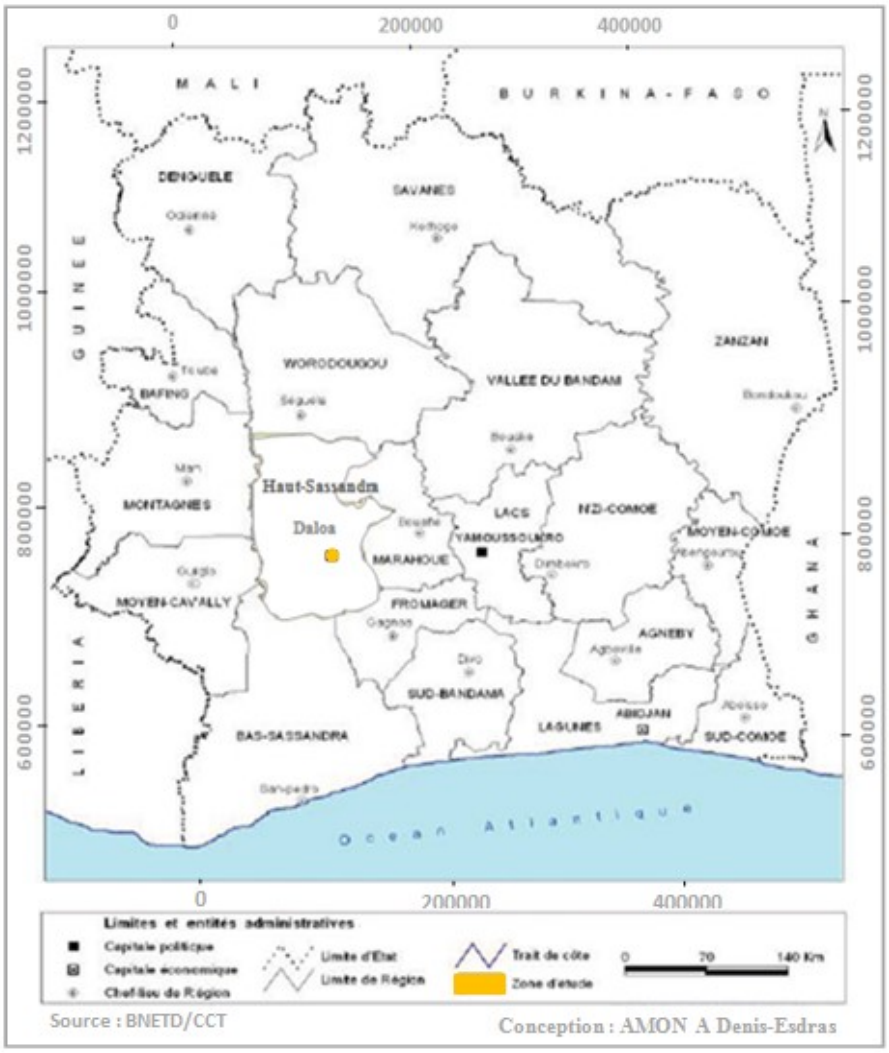

Figure 1: Location of Daloa department, study area

2.3. Methods

Field investigations took place in 15 cocoa, coffee and rubber plantations in the periurban areas of Daloa, in west-central Côte d'Ivoire. The criteria for choosing these plantations were their area (≥ 2.5 ha) and their accessibility.

To identify parasitic Loranthaceae species dispersed on crops and the categories of birds involved in their dispersal, two complementary data collection techniques were used. These are surface surveys and direct observations. The surface surveys consisted in delimiting in the plantations single plots of a maximum dimension of one hectare (100m x 100m) each subdivided into strips of 10m. In each unit plot, the number of tufts of Loranthaceae, the total number of parasitized and non-parasitized crop feet were counted and the name of each parasite species encountered was noted. The data collected made it possible to calculate (Amon, 2006):

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- Infestation rate :

$$Txi = \frac{Nip}{Nti} \times 100$$

with (Txi):- Infestation rate; Nip - Number of individuals infected, Nti - Total number of individuals enumerated

- Infestation intensity (Ii):

$$Ii = \frac{Nt}{Nii}$$

with Ii - Intensity of infestation; Nt - Total number of tufts of Loranthaceae; Ntii - Total number of infested individuals identified.

Analysis of variance (ANOVA) using STATISTICA version 7.1 software was carried out and a comparison of means by the Newman-Keuls test at the threshold of $\alpha = 5\%$ for cases of significant differences.

For direct observations, they consisted of standing near 30 tufts of Loranthaceae chosen at random from the crop feet in the unit plots and monitoring the behavior of visiting birds using a binocular (Figure 2) in these tufts, and to identify their role. Among these tufts identified, fifteen (15) are in the flowering phase and the fifteen (15) others in the fruiting phase.

These observations were made from 8 a.m. to 12 p.m., twice a week for three months. This method allowed close-up photography and capture of some bird species. These birds observed were divided into two groups according to their behavior within the tufts. They were later identified using appropriate literature (Serle and Morel, 1988; Borrow and Demey, 2008) and documents viewed on the Internet. The observations made were supplemented by information collected from farmers encountered in the plantations studied, often in contact with these bird species.

Figure 2: Pair of binoculars to monitor bird behavior in the tufts of Loranthaceae

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3. RESULTS

3.1. Phytoparasites scattered by birds on annuity crops

Five (5) parasitic species of the Loranthaceae family, divided into 3 genera, were inventoried and identified on the annuity crop from the suburban areas of the Daloa department. These are: *Globimetula braunii* (Engl.) Van Tiegh, *Phragmanthera capitata* (Spreng.) Ballé (Figure 3), *Tapinanthus bangwensis* (Engl. And K. Krause) Dancer (Figure 4), *T. globiferus* (A. Rich.) Tiegh. et *T. sessilifolius* var. *glaber* (P. Beauv.) Van Tiegh.

Figure 3: *Phragmanthera capitata*, parasite

Figure 4: *Tapinanthus bangensis*, parasite

3.2. Birds propagating phytoparasites observed and identified

Four hundred and fifty (450) birds grouped into 13 species, divided into 7 genera and 7 families, visiting the flowering and fruiting shoots of phytoparasitic species have been identified (Table 1). The most diversified family in terms of species is that of Capittonidae with five (5) species, a rate of 71.42%, followed by Nectariniidae (42.85%). Among these 450 birds, 213 with a tapered and curved nose (47.33%) and 237 with a beak, or 52.67% were observed.

Considering the phenological stages of the tufts visited by birds and the shape of their beaks, two groups of birds are distinguished (Table 1). Group I pollinator birds are less diversified with four (4) species, or 30.76%. These are *Nectarinia senegalensis* L., 1766 (Figure5), *N. pulchella* L., 1766 (Figure6), *N. coccinigaster* Latham, 1802 of the family of the Nectariniidae and *Acanthiza nana* Vigors and Horfield, 1827 of the Psittacidae family. They are small, small, very mobile and active birds within clumps of flowers. Among these species, *Nectarinia pulchella* and *N. senegalensis* with relative frequencies of visits of the respective flowering clumps of the order of 41.80% and 47.35% are the most active. The most diversified group II comprises 9 species, or 69.23%. They are *Pogoniulus atroflavus* Hermann, 1783 or barbion with red rump (Figure 7), *P.*

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chrysonocus Temmick, 1832 or little bearded with yellow forehead, *P. bilineatus* Sundevall, 1850 or barbion with yellow rump, *P. pusillus* Dumont, 1816 and *P. scolopaceus* Hermann, 1804 (Figure8), all of the family Capitonidae, *Sylvia communis* Latham, 1787 or Blackcap (Sylviidae), Streptopelia turtur L., 1758 (Columbidae), *Pycnonotus barbatus* Smith, 1858 of the family Pycnonotidae and *Rhipidura fuscorufa* Sclater, 1882 of the family Rhipiduridae. Two Capitonidae*: P. chrysonocus* and *P. scolopaceus* with relative frequencies of tufts of fruit in the order of 33.33% and 28.62% are the most active.

Table 1: Bird species and relative frequencies of visits in clutches of parasites

Bird species	Family	Local name	Total ind	Nbv tfl	Frv	Nbv tfr	Frv
Acanthiza nana	Psittacidae	*Adondor*	5	7	1,85	0	0
Nectarinia coccinigaster	Nectariniidae	*Adondôblè*	26	34	9	0	0
Nectarinia pulchella	Nectariniidae	*Tintin 'blè*	95	158	41,80	0	0
Nectarinia senegalensis	Nectariniidae	*Srika*	87	179	47,35	0	0
Pogoniulus atroflavus	Capittonidae	*Agbitié kanliè*	75	0	0	52	17,51
Pogoniulus bilineatus	Capittonidae	*Agbitiéblè*	28	0	0	20	6,73
Pogoniulus chrysonocus	Capittonidae	*Agbitié valè*	77	0	0	99	33,33
Pogoniulus pusillus	Capittonidae	*Agbitiépinplé*	11	0	0	15	5,05
Pogoniulus scolopaceus	Capittonidae	*Agbitié ktokrô*	22	0	0	85	28,62
Pycnonotusbarbatus	Pycnonotidae	*Pitchôkrô*	19	0	0	21	7,07
Rhipidura fuscorufa	Rhipiduridae	-	3	0	0	3	1,01
Sylvia communis	Sylviidae	*Kpaku/'lohle*	1	0	0	1	0,33
Streptopelia turtur	Colombidae	*Aboubléblè*	1	0	0	1	0,33
Total			450	378	100	297	100

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Figure 5: *Nectarinia pulchella*

Figure 6: *N. pulchella*

Figure 7: *P. atroflavus*

Figure 8: *Pogoniulus scolopaceus*

3.3. Distribution of Loranthaceae on crops

Table II shows the proportions of clumps of Loranthaceae per crop. Five (5) parasitic species invade cash crops. Among these species, *P. capitata* and *T. bangwensis* dominate all crops. However, *T. bangwensis* with 52.09% and 22.80% of total tufts respectively dominate cocoa and cocoa trees. As for *P. capitata*, it is more predominant on rubber trees (51.76%).

Table 2: Proportion (%) of Loranthaceae tufts per crop

Parasitic species	Total number of tufts	Annuity crops					
		Cocoa		Cocoa		Cocoa	
		Number tufts	% presence	Number tufts	% presence	Number tufts	% presence
Globimetula brunii	1308	1308	100	0	0	0	0
Phragmanthera capitata	6901	2941	42,62	740	10,72	3220	46,66
Tapinanthus bangwensis	10549	5894	55,87	2220	21,05	2435	23,08
T. globiferus	2207	2207	100	0	0	0	0
Total	20965	12350	58,91	2960	14,12	5655	26,97

Meaning of abbreviations: tfs - tufts

3.4. Ecological habitat of Loranthaceae identified

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On the ecological level:

- *G. braunii*: heliophilus, inhabits aerated biotopes (upper branches) preferably;

- *P. capitata*: Present in many moist and aerated places (helio-sciaphile), living both outside and inside the host's crown;

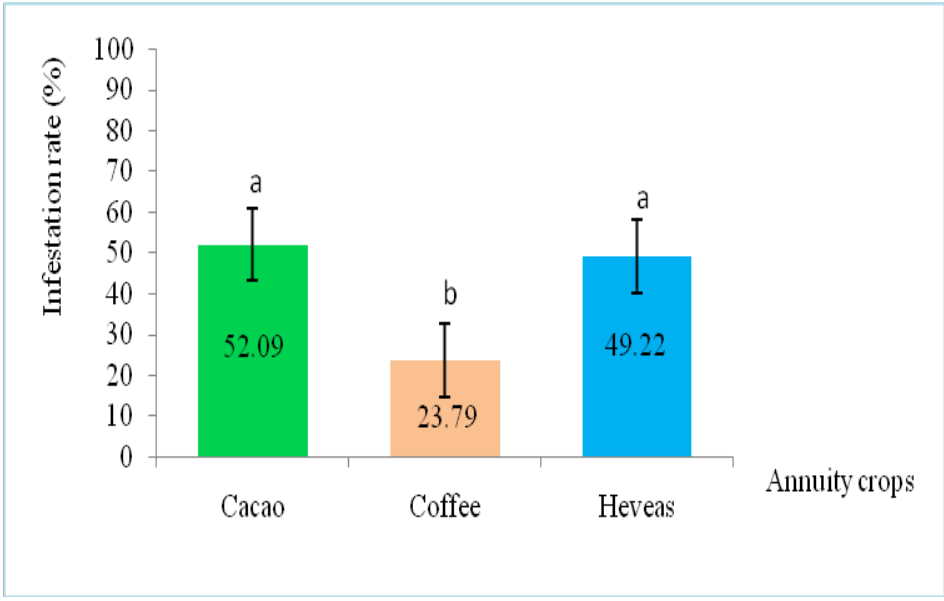
- *T. bangwensis*: a heliophilus species present in several stations where it lives around the crown of its hosts;

- *T. globiferus* (A. Rich.) Tiegh: heliophilus parasitic plant that grows inside the crown of its hosts;

- *T. sessilifolius* var. *glaber*: heliophilus parasitic plant that prefers aerated biotopes. It attaches mostly to the edge of the host's crown.

3.5. Degrees of infestation of crops with parasitic Loranthaceae

The Figures 9 and 10 show infestation rates and intensities by crop. The analysis of variance performed indicates two statically different groups (a and b). The most infested group concerns cocoa and rubber trees with pairs of infestation values (rate and intensity) high respectively of (52.09% and 4.75 tufts/plant) and (49.22% and 3.25 tufts/plant). Coffee trees (23.79% and 1.04 tufts/plant).



The letters a and b are statistically different (Newman-keuls test, P <0.05).

Figure 9: Rate of infestation of cash crops by Loranthaceae from plantations

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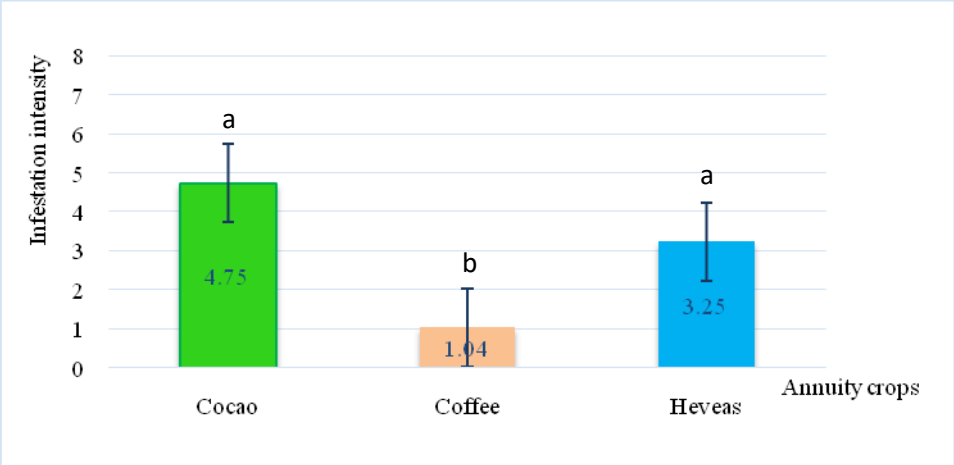

The letters a and b are statistically different (Newman-keuls test, P <0.05).

Figure 10: Loranthaceae infestation intensities by annuity crop

It is also noted that cocoa trees have recorded a high infestation rate compared to that of rubber trees. However, the analysis of variance carried out did not show any significant difference between cocoa trees and rubber trees (Figures 9 and 10).

4. DISCUSSION

Four (4) species of Loranthaceae are identified on the cash crops of plantations in periurban areas of the department of Daloa, in central west Côte d'Ivoire. This result is similar to that of Mrankpa (2018) who inventoried these same 4 species on the site of the Jean Lorougnon Guédé University. On the other hand, this number is much lower than the seven (7) species inventoried by Amon (2014) in the South-East of the country. The presence of these species on cash crops in this part of the country would depend on their wide distribution in Côte d'Ivoire.

T. bangwensis and *P. capitata*, by their number of tufts on crops, are the most infesting parasites among the Loranthaceae species encountered in the plantations visited. Soro (2010) made the same observations in the West of the Côte d'Ivoire on the infesting character of *T. bangwensis* on the cocoa trees and *P. capitata* on the rubber trees.

Thirteen (13) bird species split into two groups visiting the flowering and fruiting tufts of Loranthaceae have been identified as agents involved in their expansion on crops. Four (4) of them including *Nectarinia senegalensis*, *N. pulchella* and *N. coccinigaster* have already been reported in their flowering tufts elsewhere in Africa (Dembelé et al., 1994; Boussim, 2002; Traoré et al., 2003). As for *Acanthiza nana*, it is newly identified in the tufts of Loranthaceae in Côte d'Ivoire.

Of the nine (9) short-beaked species visiting the Loranthaceae fruit tufts: *Pogoniulus. atroflavus*, *P. bilineatus*, *P. chrysonocus*, *P. pusillus*, *P. scolopaceus*, *Pycnonotus barbatus*, *Rhipidura fuscorufa*, *Streptopelia turtur* and *Sylvia communis*, only *P. scolopaceus*, *Pycnonotus barbatus* and *Rhipidura fuscorufa* were first reported as consumers berries and seed dispersers of

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Loranthaceae. In contrast, six (6) other species, including *P. atroflavus*, *P. bilineatus, P. chrysonocus* and *P. pusillus* were observed by Dembelé et al. (1994) in Mali and Boussim (2002) in Burkina Faso.

The largest attack of Loranthaceae on annuity crops was recorded in cocoa trees with an average infestation rate of 52.09%. Coffee trees are the least attacked (23.79%). These results corroborate those of Soro (2010) west of Côte d'Ivoire. The author justifies the heavy infestation of cocoa trees by the density of their foliage which would provide more security to the birds.

Of the four (4) species of Loranthaceae identified, *T. bangwensis* is predominant in terms of number of tufts on cocoa and coffee trees, just as *P. capitata* is on rubber trees. The uneven distribution of phytoparasites recorded is justified by the preference of certain species for a specific crop. This is the case with *P. capitata*, which infests rubber trees more (Gill and Onybe, 1990). These results confirm the work of and Guyot and Ntawanga Omanda (1998) in Gabon and that of Koffi (2004) in Côte d'Ivoire.
The most diverse genus in terms of species parasitizing cocoa and coffee trees is the genus *Tapinanthus* with two species: *T. bangwensis* and *T. globiferus*. This seems all the more worrying when you consider the enormous damage that the *Tapinanthus* genus causes to shea in Africa as pointed out by Traoré and Da (1996) and Soro (1999).

5. CONCLUSION

The Loranthaceae which infest the annuity crops of plantations in periurban areas of the department are four in number and include 3 genera. *T. bangwensis* is more distributed on cocoa and coffee trees, and *P. capitata* more infestant on rubber trees. Cocoa trees are the most infested and coffee trees the least infested.

Thirteen (13) species of birds divided into seven (7) genera and 7 families have been identified in the tufts of Loranthaceae as agents accountable for their dispersion. Two species of birds of the family Nectariniidae and three of the Capitonidae identified had a more active part in the flowering and fruiting tufts of phytoparasites.

Conflict of interest

The authors of this manuscript declare that there is no conflict of interest between them.

Acknowledgements

Village and peasant chiefdoms.

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