

Population dynamics of *Cacopsylla* sp. (Hemiptera: Psyllodea: Psyllidae), pest insect of *Prunus africana* (Rosaceae), medicinal plant species in Cameroon

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Abstract

Prunus africana is threatened in Cameroon by xylophagous and sap-sucking pest as *Cacopsylla* sp. This last causes deformations of the young leaves and buds and the plant end up losing all its leaves. Effective control of phytophagous pests requires a thorough understanding of their seasonal population dynamics. The objective of this work carried out on 150 young plants of *P. africana* in the nursery in Dschang, was to study the population dynamics of *Cacopsylla* sp. and the impact of climatic factors on the population. From January 2006 to December 2007, monthly collections of larvae, males and females of *Cacopsylla* sp. were carried out. The results showed, in 2006, three peaks (March, August and December) and two peaks in 2007 (March and August) with larvae. The fluctuation of males' population showed five peaks with two peaks in 2006 (March and December) and three peaks in 2007 (March, June and December) while in females' population, four peaks with two peaks in 2006 (March and December) and two peaks in 2007 (March and November). The annual numerical variation of *Cacopsylla* sp. individual is statistically correlated with variation of precipitations and the insolation. The precipitations have a negative effect on the numerical variation of males ($r=-0.430$, $p<0.0360$) and females ($r=-0.434$, $p<0.0336$) of *Cacopsylla* sp. The insolation has a positive effect on the numerical variation of males ($r=0.732$, $p<0.000002$), females ($r=0.653$, $p<0.000523$) and the total individuals ($r=0.601$, $p<0.00197$) of *Cacopsylla* sp. With the larvae, the correlation was negative and non-significant. This work showed that March and December were better indicated to engage the fight against *Cacopsylla* sp. in Dschang.

Keywords: *Cacopsylla* sp., climatic factors, pest population, *Prunus africana*, Cameroon

Article Info

<https://doi.org/10.31018/jans.vi.2256>

Received: February 6, 2020

Revised: May 27, 2020

Accepted: June 8, 2020

How to Cite

Dzokou, V. J. *et al.* (2020). Population dynamics of *Cacopsylla* sp. (Hemiptera: Psyllodea: Psyllidae), pest insect of *Prunus africana* (Rosaceae), medicinal plant species in Cameroon. *Journal of Applied and Natural Science*, 12(2): 221 - 228 <https://doi.org/10.31018/jans.vi.2256>

INTRODUCTION

Cacopsylla Ossiannilsson is a Central-Asian and European species of the genus *Cacopsylla* (Lauterer, 1999) with over 450 described species (Ouvrard, 2018). For 12 species recorded from Iran, 8 species are recorded on Rosaceae, 2 species on Rhamnaceae and 2 species on Salicaceae (Burckhardt and Lauterer, 1993; Zendedel *et al.*, 2016). Certain species of the *Cacopsylla* genus are vectors of diseases. *C. pruni* is the vector of the European stone fruit yellows (ESFY) phytoplasma disease caused by pathogen 'Ca. *Phytoplasma prunorum*'. This ESFY induces serious

damages in cherry, sour cherry, peach, and apricot orchards, mostly in Europe (Bodnár *et al.*, 2018). According to Hodkinson (2009), plum psyllid is strictly oligophytophagous feeding on *Prunus* spp. and overwintering on conifers (*Picea abies*, *Pinus sylvestris*) and other evergreen plants. Plum psyllid is a serious pest because both mature and immature males and females can easily transmit phytoplasma in a persistent manner by feeding on the phloem (Carraro *et al.*, 2004). In Cameroon, several authors undertook work on the population dynamics of the psyllid pests: *Trioza erytreae*, African citrus psyllid (Tamesse and

Messi, 2004); *Pseudophacopteron* spp., psyllid of *Dacryodes edulis* (Mapon *et al.*, 2014); *Diclidophlebia eastopi* and *Diclidophlebia harrisoni*, psyllid of *Triplochiton sclerxylon* (Noubissi *et al.*, 2014); *Blastopsylla occidentalis*, psyllid of *Eucalypts* (Soufo and Tamesse, 2015); *Phytolyma fusca*, psyllid of *Milicia excelsa* (Noubissi *et al.*, 2016). In the cameronian orchards, *T. erytrae* (Hemiptera: Psylloidea: Triozidae) generates pit galls on the upper face of the attacked leaves during its larval development (Tamesse *et al.*, 1999). Tamesse and Messi (2002) observed that the young seedlings of Citrus were attacked by *T. erytrae* 4 months only after germination. Those plants were stunted, and their leaves greatly deformed. According to the same authors, in the absence of pest management in the citrus nursery, citrus psylla can cause the loss of up to 91 % of young plants. In South Africa, Ethiopia, Rwanda, Burundi, Malawi and Cameroun, this psyllid species is a vector of "greening" or Huanglongbing, a disease of degeneration of citrus fruits (Aubert *et al.*, 1988).

Cacopsylla sp. is a sap-sucking insect of *Prunus africana* (Rosaceae) in Dschang. It induces deformations of the leaves and buds, as well as necrosis. The survey carried out by Dzokou (2010) notices the presence of another species on *Pittosporum viridiflorum* (Pittosporaceae) at Lingang, Menoua division. The feeding of the adults and especially of the larvae causes the irreversible rolling up of the leaves of the host plant which lodge at the same time the larvae.

The control of psyllid pests has for many years relied on the use of insecticides, but nowadays, following increasingly severe restrictions concerning the application of chemicals, Integrated Pest Management (IPM) has become the most successful alternative. This was reported by Civolani *et al.* (2010), Civolani and Pasqualini (2003), Erler (2004) concerning the control of *Cacopsylla pyri* (pear psyllid). Sanchez and Ortín-Angulo (2012) concluded at the end of their studies on the control of *Cacopsylla pyri* that natural enemies offer a good opportunity to develop biological and IPM programmes based on conservation of the native fauna in pear orchards in southern Spain. According to Wang (1981), Tsai *et al.* (2002), Aubert (1987), the three main weather factors influencing the development of *Diaphorina citri* populations are temperature, relative humidity and rainfall.

P. africana is an endemic species of the afro-mountain forests of Africa and Madagascar. Its ecological milieu generally ranges between 900 and 3000 m of altitude, in particular, the Highlands of the West, Mount Cameroon, Adamawa, Bakossi mounts and some species domesticate in Centre Region of Cameroon. This species reveals an economic, social and scientist importance for

the local populations and the international community. Its barks are used in western pharmaceutical industries to look after the benign hypertrophy of the prostate (Tasse, 2006). *P. africana* is classified by the International Union for the Nature Conservation as a rare and vulnerable species because of continues degradation of its ecosystem related to the strong pressure exerted on the resource and the application of the nondurable methods of harvest. Awono *et al.* (2015) underline the threats weighing on *P. africana* in the North-west and South-west regions of Cameroon because of its overexploitation. But the threats due to the pest insects are not signalled by those authors. *P. africana* is in domestication in Cameroon outwards its natural distribution area. But this fact faces threats of the various pests among which one is *Cacopsylla* sp. It is thus a question of having an idea about the evolution of this pest over different years. The objective of this study was to search the strong pullulating periods of the pest populations and the climatic factors which regulate them over the years for a better control strategy.

MATERIALS AND METHODS

From 2006 to 2007, larvae, males and females of *Cacopsylla* sp. were collected from 150 young plants of *P. africana* in the nursery in Dschang (10° 04'N, 5° 26'E, 1385 m). Regular visits of at least once a month were done. *Cacopsylla* sp. was captured with the aid of an entomological net and a mouth aspirator and introduced in tubes containing 70% ethanol. The maximum possible of *Cacopsylla* sp. individuals were collected on the whole young *P. africana*. In the laboratory, they were sorted into larvae, adult males and females and counted under a binocular lens. Insects are preserved in 70% ethanol at the Laboratory of Zoology of the University of Yaounde I (LZUY) and the Research Unit of Phytopathology and Agricultural Zoology (UR_PHYZA), Laboratory of Agricultural Zoology of the University of Dschang (LAZUDs). Two males, 2 females and 2 larvae from the same collection were deposited in the Naturhistorisches Museum Basel, Switzerland (NHMB). Data was collected on the population dynamics by recording the number of each stage, the number of generations and their peak periods. Based on earlier studies carried out in Austral Africa, population peaks were clearly separated by about 28 days, which corresponds to separate generations. Meteorological data (Table 1) of the years 2006 and 2007 of the study site were obtained from the Institute of Agricultural Research for Development (IRAD), Dschang. The software SPSS version 16.0 was used to analyse the results. The correlation test of Spearman was used to appreciate the numeric variations of different pest stages. Excel program was used to produce diagrams.

RESULTS

Faunistic and population dynamics of *Cacopsylla* sp.: The 24 monthly visits at Dschang, the psyllids were regularly met, corresponding to a frequency of 100%; with 426 individuals (145 males, 139 females, 142 larvae). *Cacopsylla* sp. (Fig. 1) was a very frequent species known in Menoua Division.

Cacopsylla sp., psyllid of *Prunus africana* (Rosaceae). Dschang : 13 January 2006, 4 ♂, 8 ♀, 2 larvae ; 4 February 2006, 2 ♂, 4 ♀, 2 larvae ; 9 March 2006, 16 ♂, 25 ♀, 18 larvae ; 23 April 2006, 9 ♂, 7 ♀, 3 larvae ; 3 May 2006, 7 ♂, 5 ♀, 4 larvae ; 22 June 2006, 7 ♂, 7 ♀, 1 larva ; 9 July 2006, 3 ♂, 2 ♀, 4 larvae ; 2 August 2006, 4 ♂, 1 ♀, 7 larvae ; 27 September 2006, 2 ♀, 6 larvae ; 23 October 2006, 1 ♂, 1 ♀, 2 larvae ; 25 November 2006, 8 ♂, 5 ♀, 1 larva ; 3 December 2006, 23 ♂, 16 ♀, 58 larvae ; 8 January 2007, 5 ♂, 6 ♀, 2 larvae ; 8 February 2007, 3 ♂, 2 ♀ ; 17 March

2007, 9 ♂, 7 ♀, 6 larvae ; 10 April 2007, 6 ♂, 5 ♀, 2 larvae ; 17 May 2007, 5 ♂, 5 ♀, 2 larvae ; 27 June 2007, 6 ♂, 4 ♀, 1 larva ; 10 July 2007, 3 ♂, 5 ♀, 5 larvae ; 15 August 2007, 2 ♂, 2 ♀, 6 larvae ; 21 September 2007, 3 ♂, 4 ♀, 2 larvae ; 11 October 2007, 3 ♂, 3 ♀, 1 larva ; 8 November 2007, 7 ♂, 7 ♀, 2 larvae ; 21 December 2007, 9 ♂, 6 ♀, 5 larvae.

The first peaks were observed in March 2006, two months only after the beginning of the rains. In March, the rains were average, whereas in December, the rains were null and the insolation maximal. Also, the largest peak of females was located in March 2006. The lifting of dormancy of the buds began with the arrival of rains. The second peak of the adults was observed in December 2006, in the high dry season. Indeed, there were no rains in December 2006 and January 2007 in Dschang (Fig. 2).

Ombrothermic diagram of Dschang (2006 and 2007): From the diagram (Fig. 3), we had 6

Table 1. Meteorological data of Dschang years 2006-2007 obtained from the Institute of Agricultural Research for Development (IRAD).

Factors & Years	Temperature (°C)		Precipitations (mm)				Insolation (H 1/10)				Wind speed (m/s)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007		
Months	Mean	Mean	Qt	ND	Qt	ND	Qt	ND	Qt	ND	Qt	ND
January	21.5	20.25	19.9	02	00	0	129.2	28	224.7	31	886.7	1313.9
February	21.85	21.75	90.2	08	15.2	02	61.9	24	124.2	26	687.4	930.4
March	22.2	22.6	174.2	14	74.4	08	129.2	24	142.7	30	899.6	1331.4
April	21.75	21.55	108.3	13	181.7	22	134.4	28	139.5	29	850.1	1061.8
May	20.6	21.25	279.8	25	167.7	16	124.8	28	187.3	29	741.0	1304.5
June	20.9	20.9	210.5	14	233.3	20	130.4	27	136.9	29	733.9	673.9
July	20.25	19.95	240.2	24	249.6	22	85.5	29	98.0	28	738.6	567.5
August	20.25	19.65	177.6	22	248.2	24	72.5	24	62.5	26	531.5	633.1
September	20.7	20	305.9	26	319.0	25	74.6	26	90.1	28	716.0	857.4
October	20.85	20.3	116.2	22	148.6	25	81.2	27	134.0	30	1264.8	1795.0
November	20.45	20.25	24.6	07	86.7	12	175.8	30	163.0	27	1174.4	1453.5
December	20.2	19.6	0.0	0	0.8	01	218.5	30	203.1	31	967.2	1890.1

Qt: Quantity, ND: Number of Days



Fig. 1: *Cacopsylla* sp., A: male; B: female; C: fifth instar larva.

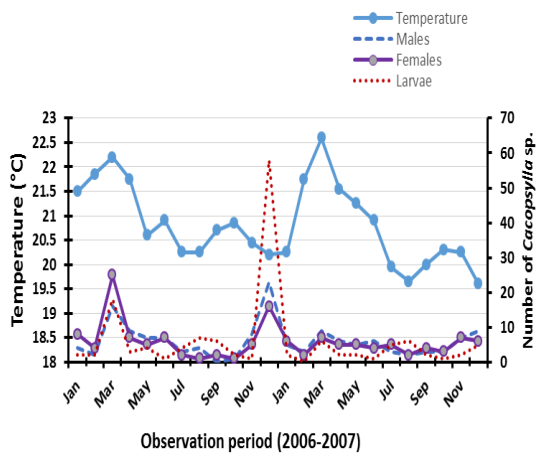


Fig. 2: Abundance of males, females and larvae of *Cacopsylla* sp. on *P. africana* and the temperature variation in Dschang from January 2006 to December 2007.

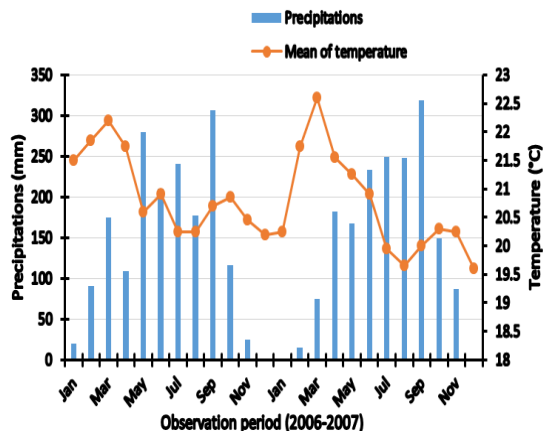


Fig. 3: Ombrothermic diagram of the locality of Dschang (years 2006 and 2007).

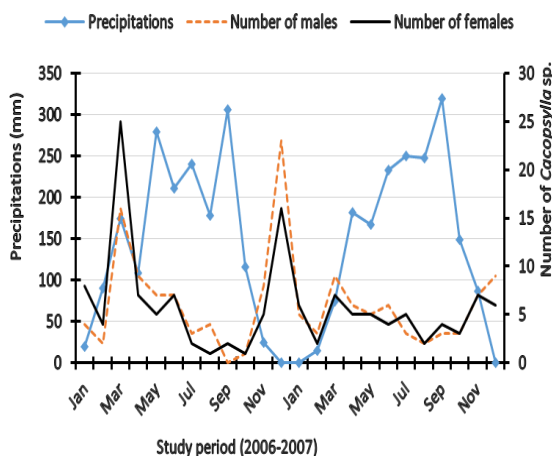


Fig. 4: Abundance of males and females of *Cacopsylla* sp. on *P. africana* and the precipitations variation in Dschang from January 2006 to December 2007.

months of dryness than 3 months per year. It is noticed that dryness is signalled when precipitations are inferior to 50 mm for a given month. Dryness occurred the months of November, December and January for the year 2006 and December, January and February for the year 2007. The month of September is considered as the month with most precipitations with 305.9 mm during 26 days in 2006 and 319 mm during 25 days in 2007. The months of January and February 2006 were the warmest with respectively 29.2°C and 29°C while the less warm months were July (25.6°C) and August (25°C). As for the year 2007, the months of February (30.4°C) and March (30.3°C) while the less warm months were July and August with 25.1°C each.

Wind speed and insolation variation in the locality of Dschang (2006 and 2007): The wind speed data showed that the maximal speed is 1890.1 m/s in the month of December 2007 and the minimal speed of 531.5 m/s in the month of August 2006. The maximal insolation was observed in the month of January 2007 with a value of 224.7 H1/10 during 31 days. The months of February 2006 and August 2007 were the less sunny with respectively 61.9 H1/10 during 24 days and 62.5 H1/10 during 26 days.

Effects of rainfall on the numerical variations of *Cacopsylla* sp.: The correlation of Spearman between the numerical individuals variation of different developmental stages of *Cacopsylla* sp. and the rainfall (Fig. 4) was: $r = -0.430$, $p = 0.0360$ for males; $r = -0.434$, $p = 0.0336$ for females; $r = 0.412$, $p = 0.847$ for larvae; $r = -0.369$, $p = 0.0746$ for the total. According to the correlation test (Table 2), correlation coefficient (r) was negative and significant with the variation of males and females individuals with the variation of rainfall. The numerical variations of males and females *Cacopsylla* sp. were correlated with rainfall. This means less abundance precipitation induced the increase of adults individuals of *Cacopsylla* sp. The correlation coefficient (r) was positive and negative, and non-significant for the larvae and the whole individuals, respectively.

Effects of insolation on numerical variations of *Cacopsylla* sp.: The Spearman correlation test between the numerical variations of the individuals of the different developmental stages of *Cacopsylla* sp. and insolation (Fig. 5) were: $r = -0.171$, $p = 0.421$ for the larvae; $r = 0.732$, $ddl = 24$, $p = 0.0000002$ for the males; $r = 0.653$, $p = 0.000523$ for the females; $r = 0.601$, $p = 0.00197$ for the whole individuals. According to the correlation test (Table 2), the correlation coefficient (r) was negative and non-significant with larvae; positive and very highly significant with males and females; positive and highly significant with the whole individuals of *Cacopsylla* sp.

Effects of temperature on the numerical variations of *Cacopsylla* sp.: The Spearman correla-

Table 2. Spearman correlation test between the developmental stages of *Cacopsylla* sp. and some climatic parameters in Dschang from January 2006 to December 2007.

Parameters	Developmental stages				
	Larvae	Males	Females	Whole individuals	
Temperature	r	-0.104	0.239	0.324	0.138
	P	0.626	0.257	0.121	0.515
Rainfall	r	-0.0412	-0.430	-0.434	-0.369
	P	0.847	0.0360*	0.0336*	0.0746
Insolation	r	-0.171	0.732	0.653	0.601
	P	0.421	0.0000002**	0.000523**	0.00197*
wind speed	r	-0.253	0.171	0.0721	0.0514
	P	0.230	0.419	0.734	0.809

P<0.05, ddl=24, *= significant, **= very highly significant

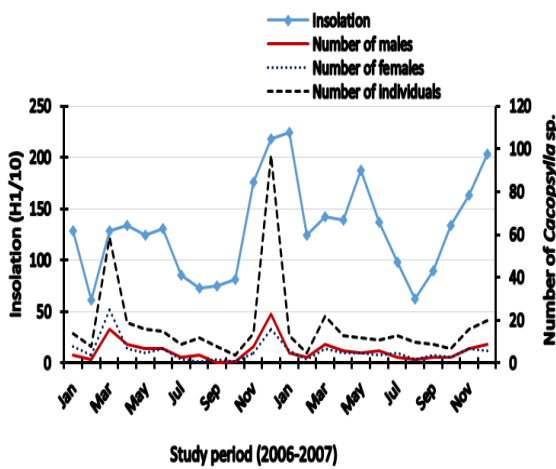


Fig. 5: Population dynamics of *Cacopsylla* sp. on *P. Africana* and the Insolation variation in Dschang from January 2006 to December 2007.

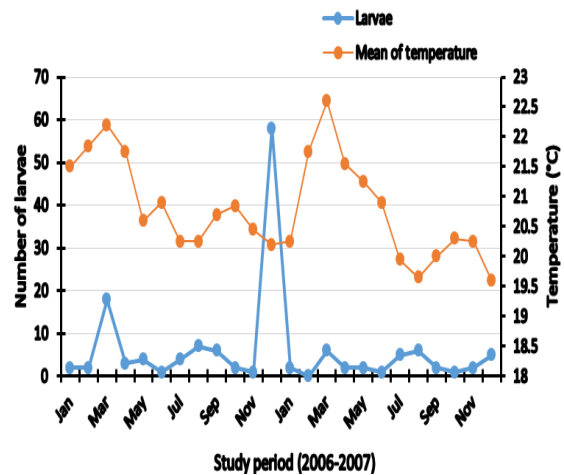


Fig. 6: Abundance of *Cacopsylla* sp. larvae on *P. africana* and the mean of temperature variation in Dschang from January 2006 to December 2007.

tion test between the numerical variations of individuals of different developmental stages of *Cacopsylla* sp. and the temperature was: $r = -0.104$, $p = 0.626$ for larvae (Fig. 6); $r = 0.239$, $p = 0.257$ for males; $r = 0.324$, $p = 0.121$ for females; $r = 0.138$, $p = 0.515$ for total individuals. According to the correlation test (Table 2), the correlation coefficient (r) was negative and non-significant with the larvae; it was positive and non-significant with the males, females and the whole individuals in our area of study. This meant annual numerical variation of *Cacopsylla* sp. was not directly linked with the annual variation of temperature.

Effects of wind speed on the numerical variations of *Cacopsylla* sp.: The Spearman correlation between the numerical variation of individuals of different stages of development of *Cacopsylla* sp. and the wind speed was: $r = -0.253$, $p = 0.230$ for the larvae; $r = 0.171$, $p = 0.419$ for the males; $r = 0.0721$, $p = 0.734$ for the females; $r = 0.0514$, $p = 0.809$ for the total individuals. According to the correlation test (Table 2), the correlation coefficient

(r) was negative and non-significant for larvae. For the males, the females and the total individuals, the correlation coefficient (r) was positive and non-significant. This meant annual numerical variation of *Cacopsylla* sp. individuals was not directly linked with the annual variation of wind speed.

Impact of damages caused by *P. africana* (Rosaceae): The psyllids attacked the young leaves and buds in the nursery. The leaves lodging the young larvae became deformed while being folded upon their lower faces. These deformations were followed by the drying of the bodies attacked after the last moult of the insects. The larvae produced a white wax which appeared at the end of the anal pore. The damage in the nursery was remarkable since young plants of 3 month-old lodged the adults and the larvae of psyllids.

DISCUSSION

The numerical fluctuations of the populations of *Cacopsylla* sp. enabled us to identify in Dschang

in 2006, 2 annual generations and 2 others in 2007. The presence of young buds and young leaves on *P. africana* would at least partly explain the abundance of the adult stages in March. We noticed that the number of annual generations of psyllid did not vary from one year to another. However, the 2 generations of 2006 had more significant peaks. The results were contrary to the findings of Noubissi et al. (2016) who had indicated that the numbers of the generation of *Phytolyma fusca* varied from one year to another in Yaounde. The same statement was made by various authors studying the population dynamic of psyllids in the same region (*Diclidophlebia eastopi* and *D. harrisoni* (Noubissi et al., 2014); *B. occidentalis* (Soufo and Tamesse, 2014); and *Pseudophacopteron* spp. (Mapon and Tamesse, 2014). The number of generations of psyllid species varied with the geographical location of the host plant. *Cacopsylla* sp. presented two annual generations in West region of Cameroon, while in the centre region of Cameroon, the species presented three generations; the first generation appeared in February and disappeared in June, second appeared in June and disappeared in August, while the third appeared on October and disappeared on February (Yana, 2012). The number of generations of psyllid species also can vary with the psyllid species and for a year to another. The number of generations found by Tamesse and Messi (2004) was 8 in 1992 and 3 in 1993 on the citrus psyllid in Yaounde. This can be explained by the fact that climate change affected the stability of climatic factors and the phenology of the host plant, which directly links with the fluctuation of psyllid populations. Aubert (1988) stated that *D. citri* mortality increased with higher rainfall and relative humidity, but it was very low under hot and dry climates. The numerical variations of males, females and the total individuals were correlated with insolation. The increasing of insolation induced the increase of the number of adults of *Cacopsylla* sp. in Dschang. The correlation coefficient (r) was negative and non-significant with the larvae. This means annual numerical variation of larvae was not directly linked with the annual variation of insolation. From early April in 1999 and 2000, according to Teck et al. (2011), generations of adult and nymph of *D. citri* were increased progressively, and population density increased exponentially as the dry season (April to September) progressed in Sarawak.

The greatest number of larvae was met in December 2006. For the same period, the wind speed was maximum, the temperature and the insolation were average, whereas precipitations were null. Teck et al. (2011) on the seasonal population dynamics of *Diaphorina citri* (Hemiptera-Psyllidae-Diaphorininae) in Sarawak showed higher populations of larvae during the rainy season than during

the dry season but heavy rainfall reduced population of larvae because eggs, first and second instar nymphs, were washed from October 1999-January 2000 in Sarawak. This was similar to what we observed with *Cacopsylla* sp. where heavy rainfall occurred on September 2006 and 2007 in Dschang, and the number of larvae was very low during September. Also advanced larvae stages (L4 to L5), which moved on the organs of the host plant in search of food, would be washed by heavy rainfall. According to De Queiroz et al. (2012), the decrease of *Glycopsis brimblecombei* (Hemiptera-Psyllidae-Spondyliaspidae) population observed in São Paulo, Brazil at the end of spring, and beginning of summer in 2003, was attributed to the heavy rainfall. Other factors not taken into consideration in this work would control the numerical variation of *Cacopsylla* sp. larvae in Dschang. Evidently, the presence of parasitoids and predators of *Cacopsylla* sp. had an impact on its population. The correlation was negative and significant between the adult stages of *Cacopsylla* sp. and precipitations. This abundance of the adults can be explained by this absence of rains whose presence would impact negatively on the adults of *Cacopsylla* sp. This is why the adult populations of *Cacopsylla* sp. were weak between May-September 2006 and April-October 2007, which corresponded to the rainiest periods. Also, Tamesse and Messi (2004) showed that the populations of *T. erytrae* were higher between December and March during the great dry season and lowered between September and November during the great rainy season in Yaounde. The coefficient of correlation (r) was negative and non-significant for the wind speed. The results of the present study showed that there was a correlation between the annual variation of insolation, rainfall and *Cacopsylla* sp. population variation. This corroborated what was noticed on citrus orchards in Abohar-India for *D. citris* by Arora et al. (1997), but different than that was observed in Yaounde on *P. africana* by Yana (2012) where no climatic factor was correlated with numerical variation of *Cacopsylla* sp.

Conclusion

In Dschang, *Cacopsylla* sp. populations could colonise and breed on *P. africana* trees throughout the year (2006-2007). During the two years of study, generations with a higher number of individuals were obtained in March and December months. The current study showed that the beginning of the rain season in March favoured increasing adult populations of *Cacopsylla* sp. through the lifting of dormancy of the buds of *P. africana*. The correlation values from the present studies showed that the insolation and rainfall appeared to have a greater impact on *Cacopsylla* sp. population than temperature and wind speed. Any biolog-

ical or integrated pest management against this significant pest of *P. africana* in the Western Highlands of Cameroon should take into consideration these periods of strong concentrations of the pest. It is suggested that, in addition to the climatic factors, the physiological state of the trees, the edaphic conditions and the farming care, will allow a better justification of the seasonal variations of the populations of *P. africana* psyllid in Cameroon.

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