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Population dynamic of *Diclidophlebia irvingiae*, Burckhardt et al. (Hemiptera: Psylloidea), psyllid pest of *Irvingia gabonensis* Baill (Irvingiaceae, Rutales) in Bamenda, North-West region of Cameroon

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ABSTRACT

Diclidophlebia irvingiae is a sap-sucking insect of *Irvingia gabonensis* inducing important damage to its host plant which has medicinal and nutritional importance in Africa particularly in Cameroon. The aim of the survey was to study numerical variation of the pest during the year and impact of biotic and abiotic factors on numerical variation. The study was carried in Bamenda from March 2018 to March 2019 where larvae and adults of *D. irvingiae* were collected monthly. The study permitted us to record 3290 individuals 1341 males, 1396 females and 553 larvae. Population fluctuation of the pest during the year showed five periods of individual outbreak corresponding to the generation number of the pest. As most tropical and sub-tropical psyllid species *D. irvingiae* is a multivoltine species with five annual generations. The outbreak periods depend principally on the phenology of host plant. The statistical test showed that the numerical individual variation of *D. irvingiae* is not directly related to climatic factors because they do not show significant probability.

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INTRODUCTION

Insects are the largest, diverse group of organisms in which a large portion is phytophagous (Burckhardt and Basset, 2000). Psyllids or jumping plant lice (Hemiptera: Psylloidea) are sap sucking insects that are typically monophytophagous or oligophytophagous. Psyllids are often

associated with Dicotyledonous plants and related host taxa (Burckhardt, 2005). Some species of psyllids are hosted by the conifers of Podocarpaceae family (Burckhardt, 2005). Higher psyllids taxa are typically associated with a single plant taxon, but a few members develop on unrelated plants suggesting an evolutionary process that includes both

co-speciation and host shift (Burckhardt and Ouvrard, 2007). The life cycle of psyllids is composed of the egg stage, five larval stages and adult (Hodkinson, 2009). The duration of the psyllid life cycle depends of climatic factors, phenology of the host plant, and the range of the host plants for the polyphagous species (Hodkinson, 2009). The fertility also depends of the temperature, duration of the sun, the phenology and the abundance of the host plants. The number of generations varies with the temperature, seasons, geographic localization and the species (Hodkinson, 2009). The life span of psyllids depends of the phenology of the host plant, climatic factors, and natural enemies (Tamesse, 2004). According to Hodkinson (2009), within the equitable warm and wet conditions of lowland tropical evergreen rainforests psyllid life cycle tend to be continuous with multiple generations per year. This probably typifies the environment under which psyllids originally radiated. Psyllids have adapted to exploit a range of host plants that have themselves over evolutionary time diversified their physiognomy, physiology, and phenology as they adapted to varying environmental conditions within widely different major climatic zones. Such evolution is conducted by two variables, temperature and precipitation which vary in response to site latitude, altitude and continentality.

Irvingia gabonensis is associated with *Diclodiphebia irvingiae* which constitute its potential pest. The adults of *D. irvingiae* are sucking the sap of the host plant; the larvae are free-living producing large quantities of whitish flocculent waxy secretions like psyllid of *Ficus lepriouri* described by Dzokou et al. (2017). The pest does not induce deformations of the leaves but during the proliferation periods, the leaves turn yellow, dry and drop prematurely. *D. irvingiae* was described for the first time by Burckhardt et al. (2006) from the specimens collected from Cameroon, Gabon, Nigeria and Uganda. *Irvingia gabonensis* is

important plant species in Cameroon because it has medicinal and nutritional values. In Cameroon, *I. gabonensis* has sweet edible fruit-pulp, while the bitter variety has bitter inedible pulp but is slimy and is added to soup for this quality. The nuts are opened and the cotyledons removed and dried; these cotyledons are a common item of market produce and are used in soups and as food flavouring. The kernel or seed is highly traded and is also transformed into a paste which is used in the preparation of sauces. *Irvingia* wood is used for timber, its dead branches for firewood and the bark is used as medicine. According to Houmenou et al. (2017), 90% of treatment came from medicinal plants. Bush mango leaf (*Irvingia gabonensis*) is commonly used locally in Nigeria to treat diarrhoea (Unaeze et al., 2017). The active extract of *Irvingia gabonensis* induces the reduction of systolic blood; reduction of plasma total cholesterol concentration (Ngondi et al., 2005). *Irvingia gabonensis* extract administered to healthy, overweight and obese individuals resulted in both weight reduction (body weight, body fat, waist size) and an improvement in metabolic parameters associated with insulin resistance (Ngondi et al., 2009). The main objective of this work was to determine numerical variation of the pest population during the year in order to improve pest management program. The abundance and migration data analyses of pest insect populations are the key to achieve successful pest management programs.

MATERIALS AND METHODS

The psyllids were collected monthly during a period of 13 months from March 2018 to March 2019 in Mezam Division, North West Region of Cameroon. The host plant where the psyllids were collected is located in front of Linguistic Centre of Bamenda building with Altitude: 1614 m; Latitude: 5°57'340''N; Longitude: 10°80'450''E. The only tree available was used to record insect data for this

survey. The climatic data of the locality where the work was carried out were recorded through Weather database.com web site. Adult psyllids were captured with entomological sweep net of 0.5 mm mesh size and mouth aspirator; larvae were sampled directly from buds and leaves of the host plant. All specimens were preserved in 70% ethanol. The damage caused by the psyllids on the host plant was observed and photographed. The host plant specimen was collected for the confirmation of its identification by Professor Bonaventure Sonke, botanist in the Higher Teacher's Training College, University of Yaounde I. The specimens were examined under a stereomicroscope in the Laboratory of Zoology of the Higher Teacher's Training College of the University of Yaounde I. The psyllids collected are separated according to females, males and larvae and the number of each group is recorded per month. The Microsoft Office Excel 2007 program was used for graphics while the SPSS version 16.0 program was used to perform Spearman's correlations between climatic factors that may regulate the population dynamics of *D. irvingiae* in Bamenda North-West Region of Cameroon. Meteorological data of Bamenda were recorded from World Wide Web: <http://www.weatherdatabase.com>.

RESULTS

Meteorological data during the study period

In Bamenda, the climate is warm and temperate. During the rainy season, there is much less rainfall than in the dry season. During the period of the study, the average temperature was 22.1 °C with an average rainfall of 407.3 mm while the average of humidity was 66.4% and average of air wind was 4.01 km/h. The driest month was December with 0 mm of precipitation while most precipitation falls in September, with an average of 1151 mm. February was the warmest month with an average of 27 °C while the lowest average temperature was noticed in

June, July, August and September with 19 °C. The ombrothermic diagram (Figure 1), shows two seasons: a short dry season from November to March and a long rainy season from April to October.

Numerical variation of *D. irvingiae* individuals

A total of 3290 individuals of *D. irvingiae* psyllid were recorded during the survey with 1341 males, 1396 females and 553 larvae. The sex ratio is 0.96 in favour of females. According to Figure 2 there are five peaks with four moderate peaks and one important peak. Those peaks are corresponding to generation of population, and then *D. irvingiae* counts five annual generations of population. The first generation appeared in March and disappeared in May 2018 with the dominance of male and female individuals, the second appeared in May and disappeared in August 2018 with the dominance of females and larvae, the third appeared in September and disappeared in November 2018 with the dominance of males and females, and the fourth appeared in November and disappeared in February 2019 with the dominance of larvae while the fifth appeared in February and disappeared in March 2019 with the dominance of females and males. This means the annual population of *D. irvingiae* is multivoltine with five generations. The larvae population is high during the period of March to July and November to January while the population of males and females is approximately identical. According to Figure 2, the number of individual dropped drastically in the period of August to September. This can be justified by the fact that it is the period of heavy precipitation, which is not favourable of the pest proliferation. Heavy rainfall induces the washing of individuals on the host plant and many immature stages cannot survive. While the period of February to March showed high proliferation of the pest on the host plant this is corresponding to the period where the host

plant renews its leaves after the dry season and the beginning of the rainy season.

Impact of temperature on numerical variation of *D. irvingiae* individuals

Numerical variation of *D. irvingiae* individuals is not directly correlated with the annual variation of temperature (Figure 3). But numerical variation of individuals is correlated with the phenology of the host plant which is influenced by temperature. When the temperature is high during the dry season the host plant is dominated by mature leaves which reduce the population of the pest. The correlation of spearman is positive with the larvae; negative with the males, females and total but not significant with temperature. This means that, numerical variation of *D. irvingiae* individuals in the year is not directly linked with annual variation of temperature (Table 1).

Impact of precipitations on numerical variation of *D. irvingiae* individuals

Numerical variation of *D. irvingiae* individuals is not directly correlated with the annual variation of precipitations (Figure 4). But numerical variation of individuals is correlated with the phenology of the host plant which is influenced by rainfall. When the precipitations are abundant, the host plant renews its leaves and it is dominated by young leaves and buds which increase the population of the pest. The correlation of spearman is negative with the larvae; positive with the males, females and total but not significant with precipitations. This means that, numerical variation of *D. irvingiae* individuals in the year is not directly linked with annual variation of precipitations (Table 1).

Impact of humidity on numerical variation of *D. irvingiae* individuals

Numerical variation of *D. irvingiae* individuals is not directly correlated with the annual variation of humidity (Figure 5). The

correlation of spearman is negative with the larvae, males and total; positive with females but not significant with humidity. This means that, numerical variation of *D. irvingiae* individuals in the year is not directly linked with annual variation of humidity (Table 1).

Impact of wind on numerical variation of *D. irvingiae* individuals

Numerical variation of *D. irvingiae* individuals is not directly correlated with the annual variation of wind (Figure 6). The correlation of spearman is positive with the larvae; negative with females, males, and total but not significant with wind. This means that, numerical variation of *D. irvingiae* individuals in the year is not directly linked with annual variation of wind (Table 1).

Host plant of *D. irvingiae* and Biology

Diclidophlebia irvingiae life cycle typically comprises of an egg stage, first, second, third, fourth and fifth instar larvae and a sexually reproducing adult stage composed of males and females (Figures 7a,b,c). Parthenogenetic reproduction does not exist because permanently the male individuals are available. The females laid their eggs on young leaves and buds. Eggs are inserted along the veins of the young leaves and buds. After the hatching of eggs, the larvae remain on those young leaves and buds to feed because young leaves and buds are composed of soft tissues which are favourable for feeding. The larvae are producing large quantities of whitish flocculent waxy secretions. They also producing honeydew which attracting ants and inducing development of fungi. *Diclidophlebia irvingiae* does not induce formation of galls on the host plant; also it does not induce deformations of the leaves but during the proliferation period of the pest, the leaves change the colour from green to yellow, they dry and fall prematurely (Figure 7d).

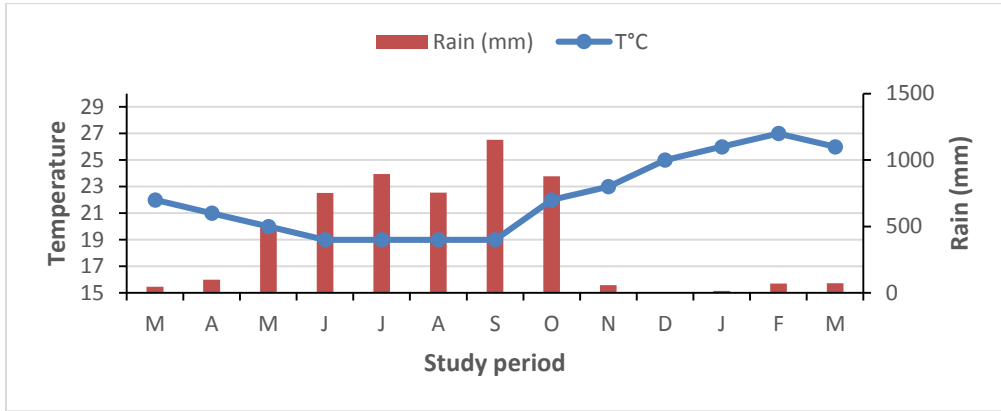


Figure 1: Ombrothermic diagram of Bamenda from March 2018 to March 2019.

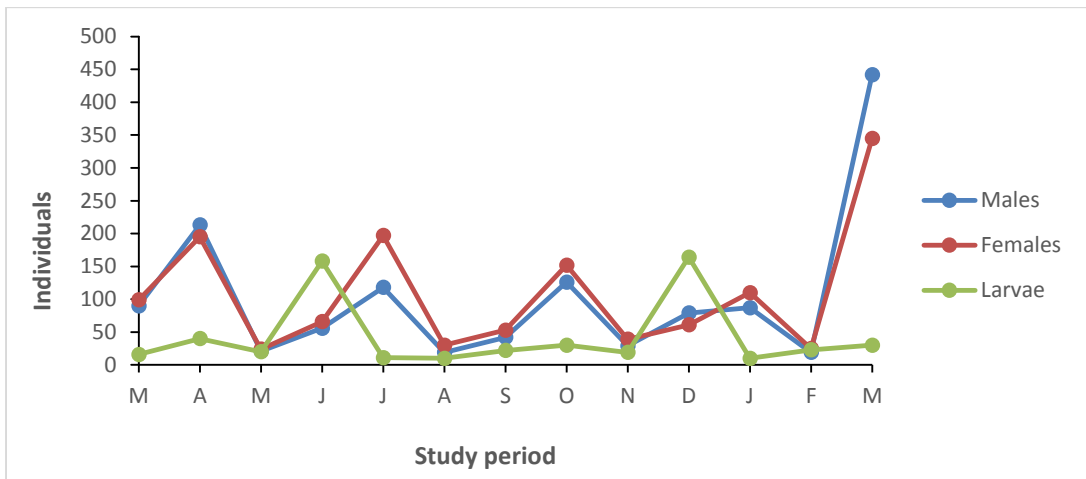


Figure 2: Numerical variation of *D. irvingiae* individuals in Bamenda from March 2018 to March 2019.

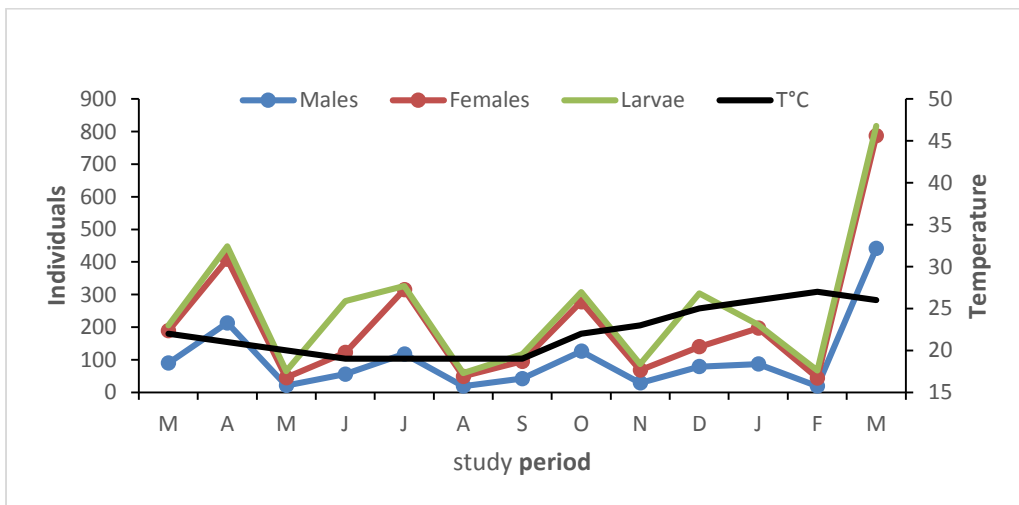


Figure 3: Correlation between numerical variation of *D. irvingiae* individuals and temperature in Bamenda from March 2018 to March 2019.

Table 1: Spearman correlation between *D. irvingiae* population and some climatic parameters of Bamenda from March 2018 to March 2019.

Individuals	Statistical values	parameters			
		Temperature	Precipitations	Humidity	Wind
Larvae	R	0.102	-0.0666	-0.277	0.0783
	P	0.733 ^{NS}	0.817 ^{NS}	0.364 ^{NS}	0.800 ^{NS}
Males	R	-0.0125	0.00701	-0.0280	-0.00702
	P	0.956 ^{NS}	0.874 ^{NS}	0.921 ^{NS}	0.974 ^{NS}
Females	R	-0.103	0.105	0.112	-0.0946
	P	0.733 ^{NS}	0.733 ^{NS}	0.716 ^{NS}	0.748 ^{NS}
Total	R	-0.0250	0.035	-0.0420	-0.102
	P	0.921 ^{NS}	0.904 ^{NS}	0.886 ^{NS}	0.733 ^{NS}

R=Spearman correlation coefficient; P=probability value; NS=not significant

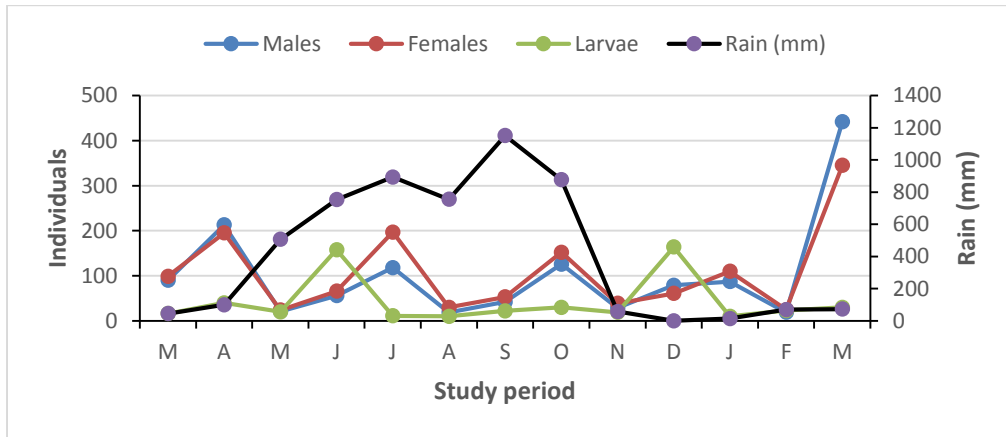


Figure 4: Correlation between numerical variation of *D. irvingiae* individuals and precipitations in Bamenda from March 2018 to March 2019.

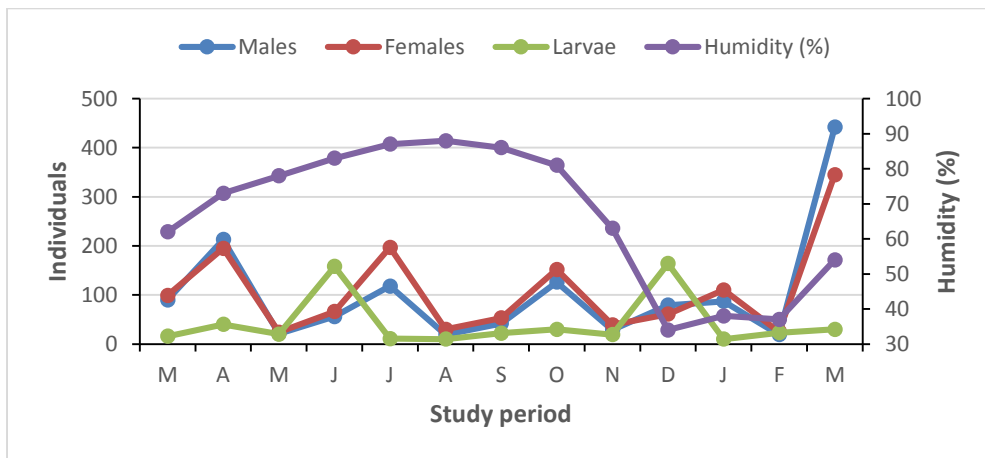


Figure 5: Correlation between numerical variation of *D. irvingiae* individuals and humidity in Bamenda from March 2018 to March 2019.

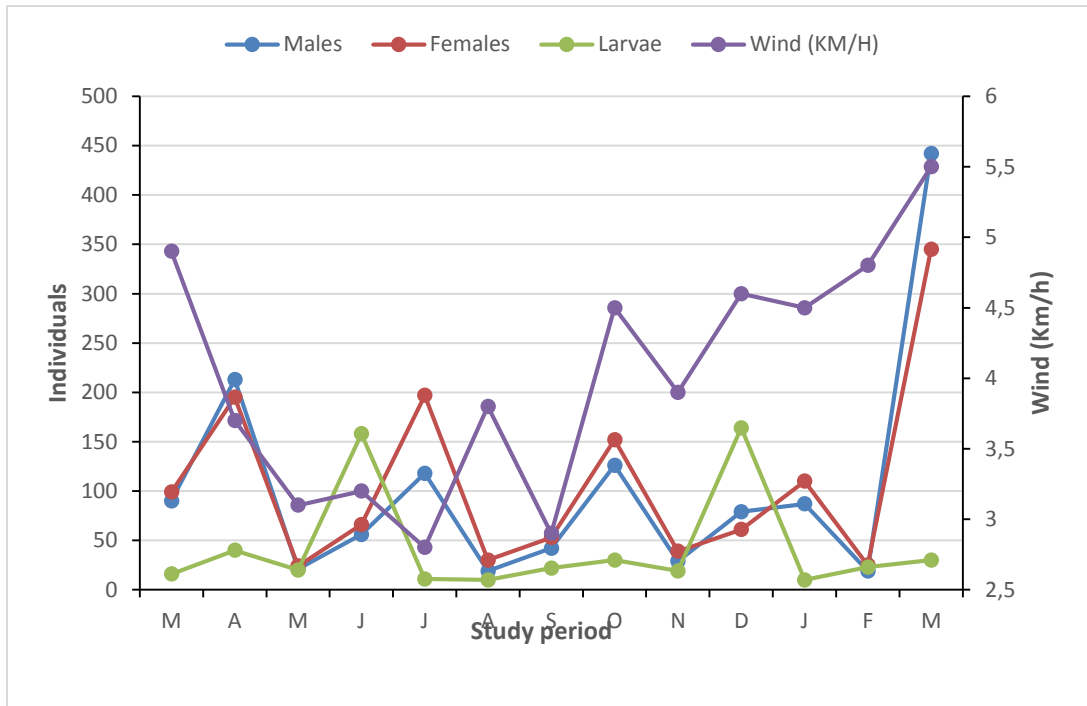
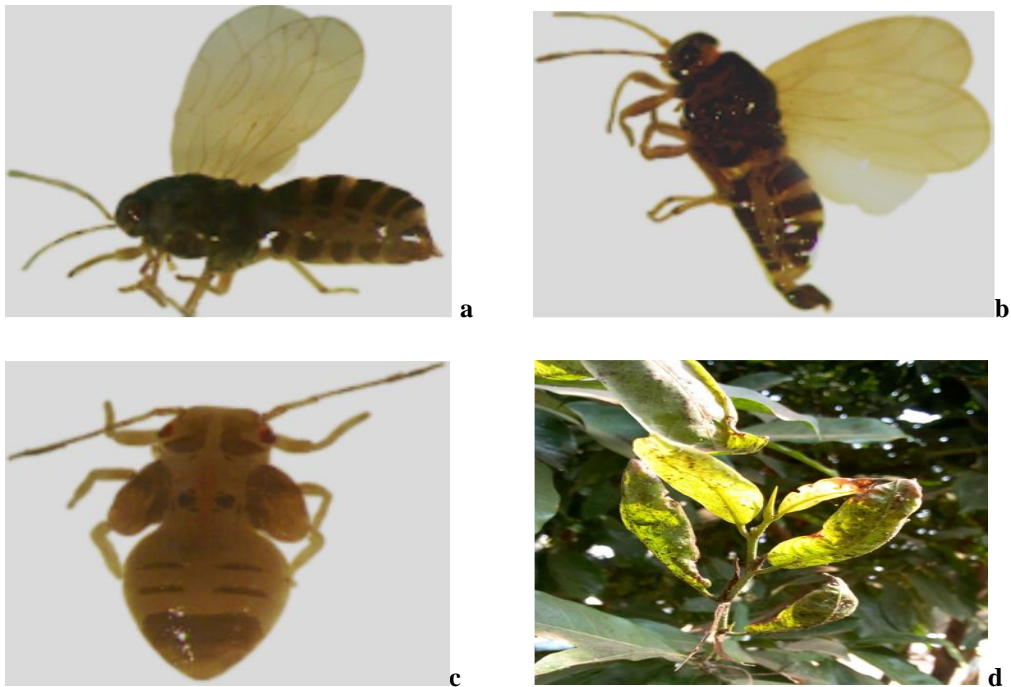


Figure 5: Correlation between numerical variation of *D. irvingiae* individuals and wind in Bamenda from March 2018 to March 2019.



Figures 7: a) female of *D. irvingiae*; b) male of *D. irvingiae* ; c) fifth instar larva of *D. irvingiae* ; d) damage of the host plant (*Irvingia gabonensis*).

DISCUSSION

The fluctuation of psyllid populations can be correlated with the phenology of the host plant, natural enemies as predators and parasitoids, sometimes climatic factors like temperature, precipitations, humidity, wind etc. The population dynamic of psyllid also depends of the psyllid species, geographical localization of the host plant, season of the locality, duration of the life cycle. The survey carried out to study the population dynamic of *D. irvingiae* in Bamenda enabled us to identify that the pest presents five generations per year and can be considered as a multivoltine species. This is in concordance with what was reported by Hodkinson (2009) that most of tropical and subtropical species as *Heteropsylla cubana*, *Diaphorina citri*, *Trioza erythrae* and *Trioza magnicauda* present many generations per year thus multivoltine species. *Diclidophlebia irvingiae* shares the generation number with *D. harrisoni* psyllid of *Triplochiton scleroxylon* reported by Noubissi Youmbi et al. (2014) in the locality of Yaounde. Contrary to *D. eastopi* psyllid of *Triplochiton scleroxylon* which presented six annual generations in Yaounde (Noubissi Youmbi et al., 2014); also *D. xuani* psyllid of *Ricinodendron heudelotii* in which generations followed one to another in the year without any break (Aléné et al., 2005a). The generation number of psyllid species per year can vary with host plant spectrum; monophytophagous species like *D. irvingiae* which is feeding only on *I. gabonensis* presents less number of generations while polyphytophagous species like *Trioza erythrae* which is feeding on Rutaceae plants presents more generations (eight) per year (Tamesse and Messi, 2004). We noticed that numerical individual variation of *D. irvingiae* during the year is not directly correlated with any climatic factors; it is correlated with the phenology of the host plant; this is similar to what was observed by Yana (2012) in many psyllid species in the centre

region of Cameroon. Contrary to what was reported by Noubissi Youmbi et al. (2014) in the locality of Yaounde where some climatic factors are correlated with numerical individual variation of *D. eastopi* and *D. harrisoni*. Humidity and precipitations are very highly significantly correlated with numerical individual variation of the two species while temperature is significantly correlated only with numerical variation of female for *D. eastopi* and significantly correlated with numerical variation of males, females and larvae for *D. harrisoni*. Concerning the wind there is no correlation between numerical individual variations of the two species and the wind variation during the year.

Conclusion

Population dynamic of *Diclidophlebia irvingiae* pest of *I. gabonensis* in Bamenda presents five annual generations of population with unequal abundance and duration. For this reason, it is considered as a multivoltine species as well as many of tropical and subtropical species. The fluctuation of population during the year is not directly related with the variation of climatic factors but it is correlated directly with the phenology of the host plant. Identification and population dynamic are the prerequisites for control methods of the pest. This means to put in place a specific control method, the fluctuation of the population should be taken in consideration.

COMPETING INTERESTS

The authors declare that they have no competing interests and the manuscript has not been submitted elsewhere.

AUTHORS' CONTRIBUTIONS

WY: collecting data on the field, preparing the manuscript, writing and illustrations; VJD and YPMN: preparing and editing the manuscript; JLT: supervising the writing and editing of the manuscript.

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REFERENCES

- Aléné DC, Messi J, Quilici S. 2005. Quelques aspects de la biologie de *Diclidophlebia xuani* (Hemiptera : Psyllidae), ravageur de *Ricinodendron heudelotii* Baill. (Euphorbiaceae) au Cameroun. *Fruits*, **60**: 279-287. DOI: 10.1051/fruits:2005034.
- Burckhardt D. 2005. *Ehrendorferiana*, a new genus of Neotropical jumping plant lice (Insecta: Hemiptera: Psylloidea) associated with conifers (Cupressaceae). *Organisms Diversity & Evolution*, **5**(12): 1-10. URL: <http://www.senckenberg.de/odes/05-12.htm>; URN: urn:nbn:de:0028-odes0512-3.
- Burckhardt D, Basset Y. 2000. The jumping plant-lice (Hemiptera, Psylloidea) associated with *Schinus* (Anacardiaceae): systematics, biogeography and host plant relationships. *J. Nat. Hist.*, **34**: 57-155. DOI: [org/10.15468/39omei](https://doi.org/10.15468/39omei).
- Burckhardt D, Ouvrard D. 2007. The taxonomy, biogeography and host plant relationship of jumping plant-lice (Hemiptera: Psylloidea) associated with creosote bushes (*Larrea* spp., Zygophyllaceae). *Systemic Entomology*, **32**: 136-155. DOI: 10.1111/j.1365-3113.2006.00352.x
- Burckhardt D, Aléné DC, Ouvrard D, Tamesse JL, Messi J. 2006a. Afrotropical members of the jumping plant-lice genus *Diclidophlebia* (Hemiptera: Psylloidea). *Invertebrate Systematics*, **20**: 367-393. DOI: 10.1071/IS05039 1445-5226/06/030367.
- Dzokou VJ, Yana W, Tamesse JL, De Coninck E. 2017. *Pseudoeriopsylla etoundii* sp.n., a new species of Psyllids (Hemiptera-Homotomidae), pest of *Ficus lepriouri* (Moraceae) from West-Cameroon. *Int. J. Biol. Chem. Sci.*, **11**(4): 1592-1600. DOI: <https://dx.doi.org/10.4314/ijbcs.v11i4.15>
- Hodkinson ID. 2009. Life cycle variation and adaptation in jumping plant lice (Insecta: Hemiptera: Psylloidea): a global synthesis. *Journal of Natural History*, **43**(1-2): 65-179. DOI: 10.1080/00222930802354167.
- Houmenou V, Adjatin A, Tossou MG, Yedomonhan H, Dansi A, Gbenou J, Akoegninou A. 2017. Etude ethnobotanique des plantes utilisées dans le traitement de la stérilité féminine dans les départements de l'Ouémé et du plateau au Sud Bénin. *Int. J. Biol. Chem. Sci.*, **11**(4): 1851-1871. DOI: <http://dx.doi.org/10.4314/ijbcs.v11i4.34>.
- Ngondi JL, Oben JE, Minka SR. 2005. The effect of *Irvingia gabonensis* seeds on body weight and blood lipids of obese subjects in Cameroon. *Lipids in Health and Disease* 2005, **4**(12): 1-4. DOI: 10.1186/1476-511X-4-12.
- Ngondi JL, Etoundi BC, Nyangono CB, Mbofung CMF, Oben JE. 2009. IGOB131, a novel seed extract of the West African plant *Irvingia gabonensis*, significantly reduces body weight and improves metabolic parameters in overweight humans in a randomized double-blind placebo controlled investigation. *Lipids in Health and Disease* 2005, **8**(7): 1-7. DOI: 10.1186/1476-511X-8-7.
- Noubissi YE, Yana W, Tamesse JL. 2014. Population dynamic of *Diclidophlebia eastopi* Vondráček and *Diclidophlebia harrisoni* Osisanya, psyllids pest of *Triplochiton scleroxylon* (K. Schum) (Urticales: Sterculiaceae) in Yaoundé,

- Cameroon. *Journal of Entomology*, **11**(4): 182-197. DOI: 10.3923/je.2014.182.197.
- Olivier M, Zerbo P, Boussim J, Guinko S. 2012. Les plantes des galeries forestières à usage traditionnel par les tradipraticiens de santé et les chasseurs Dozo Sénoufo du Burkina Faso. *Int. J. Biol. Chem. Sci.*, **6**(5): 2170-2191, DOI: <http://dx.doi.org/10.4314/ijbcs.v6i5.24>.
- Tamesse JL, Messi J. 2004. Facteurs influenc,ant la dynamique des populations du psylle africain des agrumes *Trioza erythrae* Del Guercio (Hemiptera: Triozidae) au Cameroun. *International Journal of Tropical Insect Science*, **24**(3): 213–227. DOI: 10.1079/IJT200429.
- Unaeze BC, Nwobu RU, Ilo CE, Ejike EC. 2017. Effect of methanol, n-hexane and aqueous extract of *Irvingia gabonensis* leaf on castor oil-induced diarrhoea in albino rats. *Int. J. Biol. Chem. Sci.*, **11**(4): 1878-1883. DOI: <http://dx.doi.org/10.4314/ijbcs.v11i4.36>.
- Yana W. 2012. Bioécologie, faunistique des psylles (Hemiptera : Psylloidea) de la région du Centre et taxonomie des Ciriacreminae Enderlein 1910 du Cameroun. Thèse de Doctorat/Ph.D, Faculté des Sciences, Université de Yaoundé I, Cameroun, P. 220.
- web: <http://www.weatherdatabase.com> [date accessed, February 10, 2020].