

DOI : <https://doi.org/10.24297/jaa.v11i.8840>**Insects Associated with Cucumbers (*Cucumis sativus* L.) at Bamunka-Ndop (North-West Region, Cameroon)**Esther Nadine Otiobo Atibita<sup>1</sup>, \*, Champlain Djieto-Lordon<sup>2</sup>, Fernand-Nestor Tchuenguem Fohouo<sup>3</sup><sup>1</sup>University of Bamenda, Faculty of Science, Department of Biological Sciences, Bamenda, Cameroon.<sup>2</sup>University of Yaounde I, Faculty of Science, Laboratory of Zoology, Yaounde, Cameroon.<sup>3</sup>University of Ngaoundere, Faculty of Science, Laboratory of Applied Zoology, Ngaoundere, Cameroon.\*Corresponding Author: [otibo@yahoo.fr](mailto:otibo@yahoo.fr)**Abstract**

Studies on insects associated with cucumbers (*Cucumis sativus*) in Bamunka-ndop (North-West, Cameroon) under field conditions were conducted in 2017 and 2018 from April to July. The insect species diversity, the relative abundance, the frequency of visits and guilds were recorded on the plant from 7 am to 6 pm in a 2 hours time slots. Insects were found on the stem, leaves and flowers of cucumber. There were 10 insect species belonging to four Orders. Out of these, four species belonged to Hymenoptera (54.15%), whereas the Coleoptera (33.18%), the Orthoptera (7.83%) and the Diptera (4.84%) owned two species each. *Formica* sp. being the most represented insect (24.42%) followed by *A. mellifera* (21.66%). Nectarivorous, pollinivorous, stems and leaves feeders, flowers and leaves feeders were found on the crop. The peak of activities of all the insect species was situated between 10 am and 12 pm even though the temperature and the relative humidity of the study site appear not to affect their activities on the plant. These studies therefore indicated that the insects associated to cucumber should be exploited to work on their activities on cucumber and enhancing yield and quality of the fruits.

**Keywords:** *Cucumis sativus*, Stem, Leaves, Flowers, Insect species.**Introduction**

Cucumber (*Cucumis sativus* L.) is a member of the Cucurbitaceae found in Asia and Africa (Renner *et al.*, 2007). Today cucumbers are grown worldwide for salad and pickling (Shah *et al.*, 2015). The fruit is commonly harvested while still green and are used as raw, cooked or pickled ((Reshma & Hossain, 2011; Shah *et al.*, 2015). Fresh cucumber is a good source of water, minerals, carbohydrates, protein, lipid, iron, vitamin, fibre and antioxidants (Rashid, 1999; Murad & Nyc, 2016).

Cucumber plant is usually monoecious vegetable where male and female flowers are present separately on the same plant (Tatlioglu, 1993; Shah *et al.*, 2015). The male flowers appear first and in considerably larger number than the female flowers and those male flowers usually appear 10 days before the first female flower appears (Judson, 1929). Both flowers produce nectar that attracts pollinator insects (Shah *et al.*, 2015; Hossain *et al.*, 2018). The female flowers produce higher volume of nectar as compared to male flowers, but sugar concentration is larger in male flowers of cucumber (Shah *et al.*, 2015). The plant typically produces small amount of pollen which are sticky and suitable for pollination by bees (Hossain *et al.*, 2018). The stigma is receptive during the day but much more receptive early in the morning (Collins, 2007).

One of the most important factors influencing the yield and quality of cucumber crop is insect activities (Connor, 1969). Some of the activities are destructive (Hernandez & Lemus, 1999) and others useful to the plant (McGegor, 1976). Insects like cucumber beetles feed on both the leaves and flowers (McGregor, 1976). They start to colonize cucumber plant after the species starts to form leaves and this persists till harvesting if not controlled (Connor & Martin, 1969; McGregor, 1976). Cucumbers is highly attacked by insect pests if pumpkins in the neighborhood (Kato & Nogueira-Couto, 2002). Insect pests on cucumber belong largely to the order Coleoptera (Pinero, 2018). Insects are also very important to cucumber plant mainly for pollination (Alderz, 1960). The flowers are not wind or self-pollinated and mainly insects are the major pollinators of cucumber flowers especially honey bees that visit a maximum number of flowers for nectar (Delaplane & Mayer, 2000; Nicodemo *et al.*, 2009; Taha & Bayoumi,

2009). The dusted pollinators with pollen grains drop on the stigma causing gynoecious fertilization (McGregor, 1976). Pollinators are needed for efficient pollen transfer from one flower to other to have good fruit set (Shah *et al.*, 2015). The major pollinators of cucumber belong mainly to the order Hymenoptera (Dorjav *et al.*, 2017). When incomplete pollination occurs; fruits do not develop properly (Hodges & Baxendale, 1991). Therefore, inadequate pollination results in small or misshapen fruit and low yield of marketable fruits (Hossain *et al.*, 2018).

Cucumber has tremendous economic and dietetic importance (Hossain *et al.*, 2018). According to FAO (2018), Cameroon rank 17<sup>th</sup> with a total production of 319.616 tons. The production is still low in Cameroon compared to that of other developing countries. In order to contribute to the improvement of the yields of this cucurbit, the present investigations were designed with a view to identify various types of insect associated with cucumber plant and their activities in Bamunka-Ndop. The information gained will help farmers to develop management plans that could increase the overall quality and quantity of cucumber yields.

## Materials and methods

### Study site, experimental plot and biological material

The experiment was carried out twice, April to July 2017 and 2018 in Bamunka-Ndop, North-West Region of Cameroon. Ndop Plain is a highland intermountain plain within the Bamenda High Lava Plateau; it opens out to the South-East through which the river Noun flows; it is located between Latitude 5°40' and 6°10' North of the Equator and between Longitude 10°15' and 10°50' East; the relief of this plain varies and, consequently, the orographic conditions have an effect on precipitation. The average altitude is 1200 m above sea level and it has a humid tropical climate with the annual rainfall ranging from 1500 to 2000 mm, the wet season lasts from mid-March to mid-November; the rest of the months are dry. The annual average temperature is 21.3°C; large water deficits are experienced from the months of December to February (Babungo Agriculture Post, 2015). The experimental plot was 10 m long and 5 m wide (50 m<sup>2</sup>) and was bounded by various spontaneous and cultivated plants. The biological material was represented by insects naturally present in the environment. Seeds of cucumber were purchased from an agrishop in Ndop market.

### Sowing and weeding

The experimental plot was divided into four beds (10 m long x 1 m wide each). The sowing was done the 10<sup>th</sup> April, 2017 and 18<sup>th</sup> April, 2018, on one line per bed, the line has nine holes and in each hole, two seeds were placed. The space was 1 m between holes. Weeding was performed manually as necessary to maintain ridge weeds-free. Sowing was done using fowls manures and fertilizers NPK (20:10:10) first after two weeks of germination and secondly at four weeks of growth.

### Study of the of insects behavior on cucumber plant

The frequency of insects in the cucumber was determined based on observations on the stem, leaves and open flowers every day, during each of the following daily time frame, from 17<sup>th</sup> May to 30<sup>th</sup> June 2017 and from 25<sup>th</sup> May to 30<sup>th</sup> June 2018: 7-9 am, 10 am-12 pm, 1-3 pm and 4-6 pm. In a slow walk along all plants, the identity of all insects that visited *C. sativus* was recorded. Specimens of all insect taxa were caught with an insect net. For each species, two to five insect specimens were captured. These insects were conserved in 70% ethanol for subsequent taxonomy determination except for Lepidoptera which were conserved in wrapper following Borror & White (1991) recommendations. All insects encountered on stem, leaves and flowers were registered and the cumulated results expressed in number of visits to determine their relative frequency in the entomofauna of cucumber plant.

In addition to the determination of insect's frequency, direct observations of the feeding behavior on cucumber plant were made on insect fauna in the experimental field. The plant products harvested by insects during each visit were registered based on the foraging behavior. On a flower, nectar foragers were seen extending their proboscis to the base of the corolla while pollen gatherers scratched anthers with the mandibles or the legs; on the stem and the leaves, stem feeders and leave feeders were seen eating those parts of the plant.

During each daily period of observations, the temperature and the relative humidity of the station were registered using a mobile thermo-hygrometer, every one hour.

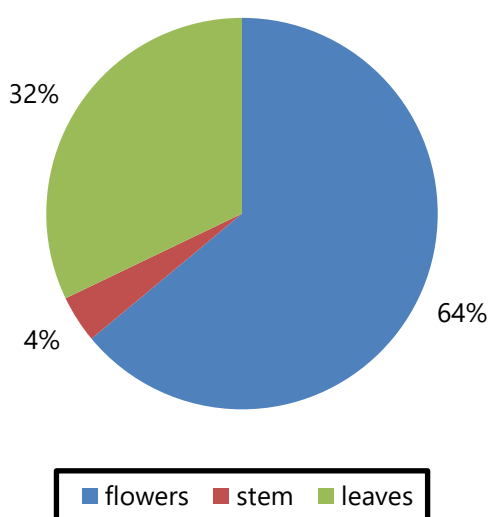
### Data analysis

Data were analyzed using descriptive statistics, correlation coefficient ( $r$ ) for the study of the association between two variables, chi-square ( $\chi^2$ ) test for the comparison of two percentages using SPSS statistical software (version 19.0; SPSS, Inc., Chicago, Illinois, USA) and Microsoft Excel 2010.

## Results

### Insects found on the cucumber plant

Many insect species visited cucumber plant in different way. The percentage of insects visitors was higher on the flowers (64%), followed by the leaves (32%) and finally on the stem (4%) (Fig. 1).



**Figure 1: Distribution of insect visitors on the different parts of cucumber plant at Bamunka-Ndop in 2017 and 2018**

In total, 10 insect's species belonging to six Families under four Orders visiting the cucumber plant were recorded during the two studied period (table 1). Out of these, four species belonged to Hymenoptera (54.15%), two to Coleoptera (33.18%), Orthoptera (7.83%) and Diptera (4.84%) respectively. The Hymenopterans were mostly found on the flowers (table 1). This result is similar of that of Sajjanar *et al.* (2004) in India. Among the hymenopteran species, *Formica* sp. was the most frequent (24.42%) insect visitor followed by *Apis mellifera* (21.66%). *Acalymma vittatum* and *Galerucina* sp. (Coleoptera) were found feeding actively on both leaves and flowers (table 1) of cucumber plant. Order Orthoptera represented by *Zonocerus variegatus* and *Acanthacris ruficornis* were found only when the plant germinated till when the plant produced strong stem and broad leaves. They actively cut the stem and leaves of cucumber plant up to about three weeks of germination where the stem became stronger to be cut and leaves strong and broad. The Dipterans represented by *Episyrphus balteatus* and *Musca domestica* species were found only on the cucumber flowers (table 1).

**Table 1: Diversity of insect species and the part visited on cucumber plant in 2017 and 2018 at Bamunka-ndop**

Order	Family	Genus, species	Part of the plant
Coleoptera	Chrysomelidae	<i>Acalymma vittatum</i>	Flowers & leaves
		<i>Galerucina</i> sp.	

Diptera	Syrphidae	<i>Episyrphus balteatus</i>	Flowers
	Muscidae	<i>Musca domestica</i>	
Hymenoptera	Apidae	<i>Apis mellifera</i>	
		<i>Ceratina</i> sp.	
		<i>Melipoluna erythra</i>	
	Formicidae	<i>Formica</i> sp.	Flowers & leaves
Orthoptera	Acrididae	<i>Zonocerus variegatus</i>	Stem & leaves
		<i>Acanthacris ruficornis</i>	

### Feeding modes by insects

For our field observations and based on the feeding strategies of the insects recorded, four guilds associated with cucumber plant were found (table 2). The guild of pollinivorous included mainly pollen grains collectors like *A. mellifera*, *Ceratina* sp. and *Melipoluna erythra*. The guild of nectarivorous included insect species which were seen extending their proboscises to the nectary for nectar harvesting. *A. mellifera* and *Formica* sp. species appeared as the most efficient. Stem and leaves feeders included insect species (*A. ruficornis* and *Z. variegatus*) which ate stem and leaves; whereas flowers and leaves feeders included insect species (*A. vittatum* and *Galerucina* sp.) which ate flowers and leaves. Globally, pollinivorous and nectarivorous insects were numerically predominant, representing up to 59% of the number of visits of individuals collected on cucumber plant.

**Table 2: Functional groups associated with cucumber plant at Bamunka-Ndop in 2017 and 2018**

Guilds	Family	Insects pecies	Activities on plant
Pollinivorous	Apidae	<i>Apis mellifera</i>	Active pollen harvesting on flowers
		<i>Ceratina</i> sp.	
		<i>Melipoluna erythra</i>	
	Formicidae	<i>Formica</i> sp.	
Nectarivorous	Apidae	<i>Apis mellifera</i>	Nectar gathering on flowers
		<i>Ceratina</i> sp.	
		<i>Melipoluna erythra</i>	
	Muscidae	<i>Musca domestica</i>	
	Syrphidae	<i>Episyrphus balteatus</i>	
Flowers and leaves feeders	Chrysomelidae	<i>Acalymma vittatum</i>	Consumption of leaves and floral pieces
		<i>Galerucina</i> sp.	
Stem and leaves feeders	Acrididae	<i>Acanthacris ruficornis</i>	Consumption of stem and leaves
		<i>Zonocerus variegatus</i>	

### Relative abundance of insect visitors in the entomofauna of cucumber

The relative abundance of insects (table 3) revealed that 241 and 193 visits of 10 and 8 insect species were found on the different part of the plant respectively. *Formica* sp. was the most represented insect with 106 visits (24.42%) followed by *A. mellifera* with 94 visits (21.66%); *A. vittatum* with 79 visits (18.20%) and *Galerucina* sp. with 65 visits (14.98%). The other insect species have a percentage less than 6%.

**Table 3: Number and percentage of visits of different insects on cucumber plant in 2017 and 2018 at Bamunka-ndop**

Order	Genus, species	2017		2018		Total		% visits of insect Order
		$n_1$	$P_1$ (%)	$n_2$	$P_2$ (%)	$n_T$	$P_T$	
Coleoptera	<i>Acalymma vittatum</i>	47	19.50	32	16.58	79	18.20	33.18
	<i>Galerucina</i> sp.	36	14.94	29	15.03	65	14.98	
Diptera	<i>Episyrphus balteatus</i>	5	2.07	3	1.55	8	1.84	4.84
	<i>Musca domestica</i>	13	5.39	0	0	13	3.00	
Hymenoptera	<i>Apis mellifera</i>	43	17.84	51	26.42	94	21.66	54.15
	<i>Ceratina</i> sp.	10	4.15	0	0	10	2.30	
	<i>Melipoluna erythra</i>	15	6.22	10	5.18	25	5.76	
	<i>Formica</i> sp.	59	24.48	47	24.35	106	24.42	
Orthoptera	<i>Zonocerus variegatus</i>	7	2.90	12	6.22	19	4.38	7.83
	<i>Acanthacris ruficornis</i>	6	2.49	9	4.66	15	3.46	
<b>Total</b>	<b>10 insect species</b>	<b>241</b>	<b>100</b>	<b>193</b>	<b>100</b>	<b>434</b>	<b>100</b>	<b>100</b>

$n_1$ : number of visits in 15 days;  $n_2$ : number of visits in 15 days;  $P_1$  and  $P_2$ : percentages of visits;  $p_1 = (n_1 / 241) \times 100$ ;  $p_2 = (n_2 / 193) \times 100$ .

### Frequency of insect visits

The frequency of insect visiting the cucumber depends on the part of the plant visited and the time slots for observation. On the leaves (table 4), all the insects have their peak of activity between 10 am and 12 pm with a frequency of visits of 34.75%. *Formica* sp. was constant along the day till 2 pm when their number started decreasing.

**Table 4: Frequency of insects visit on the leaves at different time slots of the day at Bamunka-Ndop in 2017 and 2018**

Insect species	Time slots								A
	7-9 am		10 am-12 pm		1-3 pm		4-6 pm		
	$n$	$p$ (%)	$n$	$p$ (%)	$n$	$p$ (%)	$n$	$p$ (%)	
<i>Acalymma vittatum</i>	9	6.38	19	13.48	13	9.22	9	6.38	50
<i>Acanthacris ruficornis</i>	2	1.42	3	2.13	2	1.42	2	1.42	9
<i>Formica</i> sp.	8	5.67	8	5.67	8	5.67	6	4.26	30
<i>Galerucina</i> sp.	6	4.26	15	10.64	12	8.51	9	6.38	42
<i>Zonocerus variegatus</i>	3	2.13	4	2.84	2	1.42	1	0.71	10
<b>Total</b>	<b>28</b>	<b>19.86</b>	<b>49</b>	<b>34.75</b>	<b>37</b>	<b>26.24</b>	<b>27</b>	<b>19.15</b>	<b>141</b>

$n$ : cumulated number of visits of an insect during the two seasons on the leaves;  $P$ : percentage of visits =  $(n / 141) \times 100$ ; A: total number of visit

On the flowers (table 5), all the insects have their peak of activity between 10 am and 12 pm with a frequency of visits of 41.73%.

**Table 5: Frequency of insects visit on the flowers at different time slots of the day at Bamunka-Ndop in 2017 and 2018**

Insect species	Time slots								A
	7-9 am		10 am-12 pm		1-3 pm		4-6 pm		
	<i>n</i>	<i>p</i> (%)	<i>n</i>	<i>p</i> (%)	<i>n</i>	<i>p</i> (%)	<i>n</i>	<i>p</i> (%)	
<i>Acalymma vittatum</i>	5	1.80	10	3.60	8	2.88	6	2.16	29
<i>Apis mellifera</i>	13	4.68	44	15.83	25	8.99	12	4.32	94
<i>Ceratina</i> sp.	2	0.72	5	1.80	3	1.08	0	0	10
<i>Episyrphus balteatus</i>	1	0.36	4	1.44	2	0.72	1	0.36	8
<i>Formica</i> sp.	16	5.76	27	9.41	21	7.55	12	4.32	76
<i>Galerucina</i> sp.	4	1.44	9	3.24	6	2.16	4	1.44	23
<i>Melipoluna erythra</i>	5	1.80	12	4.32	6	2.16	2	0.72	25
<i>Musca domestica</i>	3	1.08	5	1.80	4	1.44	1	0.36	13
<b>Total</b>	<b>49</b>	<b>17.63</b>	<b>116</b>	<b>41.73</b>	<b>75</b>	<b>26.98</b>	<b>38</b>	<b>13.67</b>	<b>278</b>

*n*: cumulated number of visits of an insect during the two seasons on the flowers; *P*: percentage of visits =  $(n / 278) \times 100$ ; A: total number of visit

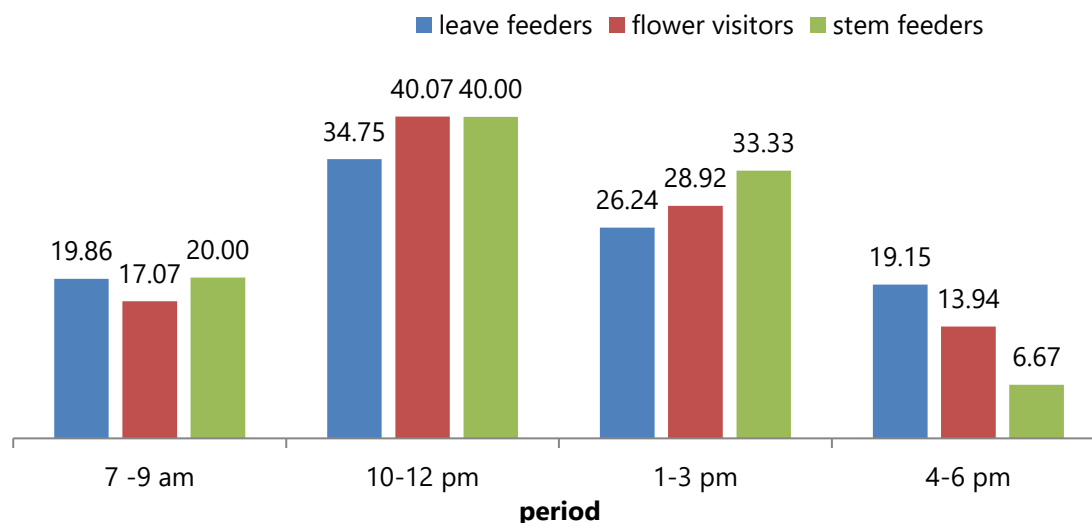
Table 6 shows that *A. ruficornis* and *Z. variegatus* present on the stem have their peak of activity between 10 am and 12 pm with a frequency of visits of 40%.

**Table 6: Frequency of insects visit on the stem at different time slots of the day at Bamunka-Ndop in 2017 and 2018**

Insect species	Time slots								A
	7-9 am		10 am-12 pm		1-3 pm		4-6 pm		
	<i>n</i>	<i>p</i> (%)	<i>n</i>	<i>p</i> (%)	<i>n</i>	<i>p</i> (%)	<i>n</i>	<i>p</i> (%)	
<i>Acanthacris ruficornis</i>	2	13.33	4	26.67	3	20	0	0	9
<i>Zonocerus variegatus</i>	1	6.67	2	13.33	2	13.33	1	6.67	6
<b>Total</b>	<b>3</b>	<b>20</b>	<b>6</b>	<b>40</b>	<b>5</b>	<b>33.33</b>	<b>1</b>	<b>6.67</b>	<b>15</b>

*n*: cumulated number of visits of an insect during the two seasons on the stem; *P*: percentage of visits =  $(n / 15) \times 100$ ; A: total number of visit

Globally, the peak of activity on cucumber crop is situated between 10 am and 12 pm (fig. 2).



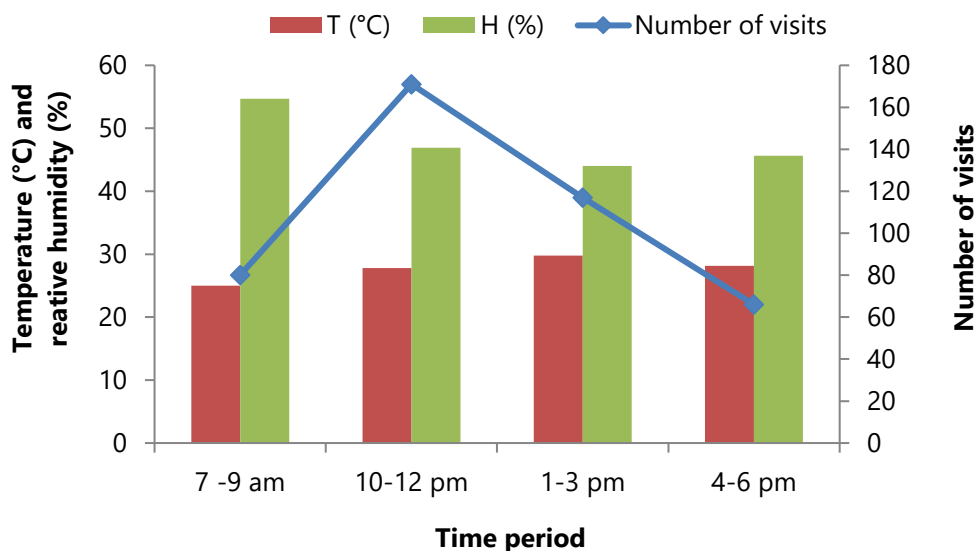
**Figure 2: Frequency of insects visit on the different parts of the cucumber according to the daily time slots in 2017 and 2018 at Bamunka-ndop**

Climatic conditions seem not to influence the activity of insects as shown in table 7. The correlation was: positive and not significant in 2017 ( $r_{2017} = 0.27$  [df = 6;  $p > 0.05$ ]) and 2018 ( $r_{2018} = 0.25$  [df = 6;  $p > 0.05$ ]), between the number of insects visits on cucumber plant and the temperature. It was negative and not significant in 2017 ( $r_{2017} = -0.46$  [df = 6;  $p > 0.05$ ]) between the number of insects visits on cucumber plant and the relative humidity; positive and not significant ( $r_{2018} = 0.12$  [df = 6;  $p > 0.05$ ]) between the number of visits and the relative humidity in 2018.

**Table 7: Daily distribution of insect visits on cucumber plant during 15 days in 2017 and 2018 respectively, mean temperature and mean humidity of the study site**

Year	Parameters	Daily period (hours)			
		7-9 am	10 am-12 pm	1-3 pm	4-6 pm
2017	Number of visits	47	94	66	34
	Temperature (°C)	24.06	27.80	29.76	28.18
	Hygrometry (%)	53.87	46.94	44	48.53
2018	Number of visits	33	77	51	32
	Temperature (°C)	25.96	29.09	31.91	30.07
	Hygrometry (%)	55.47	51.17	42.87	42.8

For the two cumulated years, fig. 3 shows that in the morning (7-9 am), the number of visits is low. The temperature is low and the relative humidity is high; during the peak of insect activities, the relative humidity decreases and the temperature increases. In the evening (4-6 pm), the number of visits decreases, the temperature decreases and the relative humidity increases.



**Figure 3: Daily variation in temperature, relative air humidity and number of insect visits on cucumber flowers for the two cumulated year at Bamunka-Ndop**

### Discussion

The studies revealed that cucumber plant attracted wide variety of insects. 10 insect species were recorded during the study period with, four species belonging to Hymenoptera (54.15%), two to Coleoptera (33.18%), Orthoptera (7.83%) and Diptera (4.84%) respectively. In India, Dorjav *et al.*, (2017) at (Chatha Jammu) recorded 21 insect species belonging to 11 Families under four Order where 10 species belonged to Hymenoptera, seven to Diptera, two to Lepidoptera and one to Coleoptera; Thakur & Rana (2008) at Nauni (Solan) recorded 12 insect species belonging to seven Families with six species to Hymenoptera, four to Coleoptera and two to Diptera while Sajjanar *et al.* (2004) recorded 10 insects visiting cucumber crop with four species belonging to Hymenoptera, four to Coleoptera and two to Diptera; Prakash *et al.* (2004) reported that the cucumber crop was visited by 27 insect species, of which 16 belonged to Hymenoptera and four each to Diptera, Lepidoptera and Coleoptera. It has been established that the abundance and diversity of insect fauna of a plant species vary over time (Moffett *et al.*, 1975; Elfawal *et al.*, 1976; Tchuenguem, 2005) and depend on the regions (Roubik, 2000; Tchuenguem, 2005; Michener, 2007; Gallai *et al.*, 2009). Among these insects, *Formica* sp. was the most frequent visitor insect followed by *A. mellifera*. This result is in accordance with the work of Rana *et al.* (2005) who found that the main visitors of cucumber were small ants (15.7%), followed by *A. mellifera* (4.32%) and comparatively to Dorjav *et al.* (2017) works who found that *A. mellifera* was the most common (47.52%) visitor insect on cucumber flowers. Free (1993) and Malerbo *et al.* (1999) reported that ants and bees are the abundant pollinators of cucurbits.

The Hymenopterans were mostly found on the cucumber crop precisely on the flowers. Baker (1983) also showed that Hymenoptera is the most important order of anthophilous insects visiting cucumber flowers. The ant (*Formica* sp.) was found in great number at all times on the flowers during the experiment. They moved up and down linearly from the male to the female flowers and to other parts of the plant. They foraged on pollen and the stigmatic surfaces. Several authors have acknowledged the fact that ants could aid in pollination in different ways (Oliveira *et al.*, 1999; Gomez, 2000; Ghazoul, 2001; Philpott *et al.*, 2006). The bees were the dominant insect recorded in this study and include *A. mellifera*, *Melipoluna erythra* and *Ceratina* sp. These species of bees settle on the flowers and forage on the pollen and nectar. In doing this, they transfer the viable pollen to the receptacle of stigmas. Most of the pollen got attached to the bees' appendages and other body parts. While flying to the female flower in search of nectar, the bees deposit the pollen on the receptive stigmas thereby pollinating the flowers. This observation is similar to that of Ekeke *et al.* (2018) in Nigeria on the same plant. Moreover, *A. mellifera* species are primary visitors and pollinators of most members of Cucurbitaceae (dos Santos *et al.*, 2008;



Cane *et al.*, 2011; Bhardwaj *et al.*, 2012; Coelho *et al.*, 2012; Henne *et al.*, 2012; De Lima *et al.*, 2014; Bezerra, 2014) like *Cucurbita moschata* (Agbagwa *et al.*, 2007), *C. melo* (Celli, 1982) and *C. pepo* (Couto *et al.*, 1990; Nepi & Pacini, 1993).

The beetles species found in cucumber crop during the experiment were found on both leaves and flowers of the plant. This is attributed to the fact that they are herbivores and eats away the tender tissues of the plant as reported Malerbo *et al.* (1999) and Brandt (2012). These authors supported that *A. vittatum*, *Diabrotica vittata* and *Galerucina* species always found feeding on leaves and flowers of cucumber plant from germination till fruit formation if not treated. *A. vittatum* is a serious insect pest of fresh market cucurbits (Ellers-Kirk & Fleischer, 2006) with those feeding modes that result in severe defoliation. *A. vittatum* shows a strong preference for plants in the family Cucurbitaceae. The cotyledons of seedlings and wilting plants are particularly attractive to *A. vittatum* since they contain a high concentration of cucurbitacins, the metabolites produced by the plants in response to herbivorous attack. This is an example of coevolution between *A. vittatum* and cucurbits, whereby a repellent defense evolved by the host plant has been adopted as a feeding stimulant by the herbivorous beetle (Hoffmann & Zitter, 1994). When feeding on cucurbits, adult male *A. vittatum* produce an aggregation pheromone, which attracts more individuals into the area (Boucher, 2003).

Flies species found in cucumber crop during the experiment were represented by *E. balteatus* and *M. domestica*. This result is in accordance with the work of Deka (2014) in India (Assam). This author noted the presence of *M. domestica* in cucumber crops. The two insect species gathered nectar on the flowers of the studied plant. The Dipterans are considered to be primitive pollinators as they were infrequent visitors and had no notable role in pollination as direct observation revealed general absence of pollen; they contribute to the pollination of wild, domesticated plants and some members of cucurbits (Hurd, 1964; McGregor, 1976; Free, 1993; Delaplane & Mayer, 2000; Rodger *et al.*, 2004; Philpott *et al.*, 2006). *Musca domestica* is known in Cameroon as insect visiting the flowers of other plant species such as *Phaseolus vulgaris* in Ngaoundere (Kingha *et al.*, 2012), *Gossypium hirsutum* in Maroua (Dounia & Tchuenguem, 2013), *Phaseolus vulgaris* in Maroua (Douka & Fohouo 2013), *Ricinus communis* in Maroua (Douka & Fohouo, 2014).

Grasshopper species found in cucumber crop during the work feed on stem and leaves of the plant. The chewing mouthparts they possess allow them to tear away plant tissue that may cause serious defoliation. Azo'o *et al.* (2017) equally mentioned the presence of grasshopper species (*Z. variegatus*) on watermelon plant, specifically on the flower petals.

Insect species recorded have been active on cucumber crop from 7 am to 6 pm, with a peak of visits between 10 am and 12 pm in 2017 as well as in 2018.

The bee abundance is higher on the flowers in the morning than in the evening especially on the female flowers; this can be due to the fact that this period of the day corresponds to the highest availability of floral product (nectar and pollen) on cucumber flowers. Furthermore, this nectar and pollen is produced in large quantities and is easily accessible to insects (Mousinha *et al.*, 2008; Mendes *et al.*, 2009; Worbs *et al.*, 2011; Rizzardo *et al.*, 2012). In Philippines, on *C. sativus*, it was documented that the intense morning activity of bee species is synchronized with the higher nectar secretion which occurs 2 to 3 hours after flowers opening at dawn (Cervancia & Bergonia, 1990). However, in the evening, the number of insect visitors on the flowers is low due to the reduction in volume of pollen and nectar. Similar observations were made on cucumber by Sattigi *et al.* (1996) who noted that in general foraging activity of honey bees was noticed throughout the day with a peak of activity between 8am and 12pm depending of the different season and the foraging activity was low during other hours of the day. In the same vein, some bee species such as *A. mellifera* species are primary visitors and pollinators of most members of Cucurbitaceae (Free, 1993; dos Santos *et al.*, 2008; Cane *et al.*, 2011; Bhardwaj *et al.*, 2012; Petersen *et al.*, 2013; De Lima *et al.*, 2014). These bees get pollen and nectar as their reward (Nicodemo *et al.*, 2009), which is similar to our findings. Bees depend on the pollen and nectar produced by *Cucurbita* flowers for their survival (Hurd *et al.*, 1971) and this is important in helping to transfer pollen from the male to female flowers.

Coleoptera, Orthoptera and Diptera species of the experimental field were also found in abundance in the morning hours (10 am-12 pm) and few in the evening (4-6 pm). This is attributed to the fact that the

environmental conditions in the morning (Fig. 3) allow good activity on the plant and as reported Khan *et al.* (2015), cucumber pests mostly beetles are very active at low temperature, high humidity and low precipitation.

The temperature and the relative humidity of the study site seem not to influence insect activities on cucumber crop. Bramel *et al.* (2004) and Tuell & Isaacs (2010) reported that the weather during bloom affects abundance and foraging of insect pollinators. Moreover flowering insects preferred warm or sunny days for the good floral activity (Kasper *et al.*, 2008). Globally, Free (1993), Cervancia & Bergonia (1990), Chen (1996) and Sajjanar *et al.* (2004) reported that ants, beetles, flies and bees are insects visiting mostly cucurbits in the morning hours which correspond to the flower opening and stigma receptivity.

## Conclusion

In Bamunka-Ndop, cucumber is a plant species that attracted a wide range of insect species found on the stem, leaves and flowers of the plant. They belong to orders Hymenoptera, Coleoptera, Orthoptera and Diptera with the hymenopterans predominant. Among the hymenopterans, ants and honeybees were the major visitor insects found. Based on their feeding strategies, four guilds associated with cucumber plant were noted: The guild of pollinivorous, the guild of nectarivorous, the guild of stem and leaves feeders and the guild of flowers and leaves feeders. During the experiment, the insect species recorded were present on the plant from 7 am to 6 pm, with a peak of visits between 10 am and 12 pm. Moreover, the temperature and the relative humidity of the study site seem not to influence their activities on cucumber crop. These studies therefore indicated that the insects associated to cucumber should be exploited to work on their activities on the plant and enhancing yield and quality of the fruits as the crop is an important fruit vegetable since its cultivation and consumption have recently increased.

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## Conflicts of Interest

There are no conflicts of interest.

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