American Journal of Entomology
2021; 5(2): 32-38
http://www.sciencepublishinggroup.com/j/aje
doi: 10.11648/j.aje.20210502.13
ISSN: 2640-0529 (Print); ISSN: 2640-0537 (Online)

Fauna Pests Infesting Pepper (*Piper nigrum* L.) in Penja-Cameroon

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To cite this article:
Victor Joly Dzokou, Nicaise Lontchi Fofe, Brice Hermann Kamgaing Kouam, Aoudou Yaouba, Joseph Lebel Tamesse. Fauna Pests Infesting Pepper (*Piper nigrum* L.) in Penja-Cameroon. *American Journal of Entomology*. Vol. 5, No. 2, 2021, pp. 32-38.
doi: 10.11648/j.aje.20210502.13

Received: April 18, 2021; **Accepted**: May 21, 2021; **Published**: June 22, 2021

Abstract: Pepper is one of the spices used in the fight against covid-19 in Cameroon. But its production faces many constraints, including arthropods and Molluscs. The purpose of this study in the Penja production basin was to invent the fauna associated with pepper and support trees, as well as pest damage for the development of an appropriate control program. To achieve this, a weekly fauna collection was conducted in 2020 on Lonpomg and Muntok pepper varieties and pest damage was identified. The individuals were captured using an entomological net and a mouth aspirator or with the hand and identified at the Phytopathology and Agricultural Zoology Research Unit, University of Dschang. The identification of this fauna was done under a binocular magnifying glass using the available identification keys. A total of 278 Insecta and Gastropoda were captured. The Insecta class consists of 9 orders (Coleoptera, Diptera, Hemiptera, Hymenoptera, Isoptera, Lepidoptera, Odonata, Orthoptera and Phasmatodea), and the order of Stylommatophora. Orthoptera was more representative in terms of individuals (85) and Isoptera and Odonata, the least representative (01 individual). Lonpomg variety was found to be the most attractive to pests. Fauna of useful insects is counted in Hymenoptera, others being pests. The presence of these useful insects shows that biological control is possible. The data collected provide a basis for preliminary knowledge of *Piper nigrum*'s fauna and should be taken into consideration in the design of integrated control strategies for pepper pests in Cameroon.

Keywords: *Piper nigrum*, Gastropoda, Insecta, Pests, Control Strategies

1. Introduction

1.1. Pepper Origin and Harvesting Methods

It is native to the tropical and subtropical regions of India specifically from the west coast of Malabar in Kerala State [1]. Pepper can be black, green, or white depending on the degree of ripeness and the processing method used after harvest. The spiciness of green pepper is lesser than that of black pepper, and it is harvested in the unripe state [2]. The degree of maturation and the color of the pepper fruit have a strong effect on the biological activity of the pepper fruit [3]. The white peppercorns are harvested ripe and those of black pepper not ripe, to be dried afterwards. This spicy spice is a pleasant accompaniment to meat dishes, grilled meats, sauces, mixed pickles, dressings, fish and cheese in other words, it can be used wherever you wish to give a special flavour to spicy dishes. As black peppercorns are bactericidal, they are also excellent for food preservation.

The cultivation of pepper in the Cameroon is practiced in

an intensive and extensive system with more or less significant inputs. In this type of crop, many small producers have yields two to five times less than optimal crop yields. The decline in pepper yield in newly created or formerly exploited plantations may be due to constraints of different natures, including pests. Changes in the climatic and edaphic components over time and space, leads to major attacks by crop depredators (pests) and diseases resulting in lower yields, thus reducing the standard of living of households especially in the rural areas.

1.2. Importance and Use of Pepper

Pepper has multiple uses. The pepper fruits contain 1.0-2.5% volatile oil, 5-9% alkaloids, of which the major ones are piperine, chavicine, piperidine, and piperetine, and a resin [4]. Black pepper had anti-bacterial, antioxidant, anti-cancer, digestive, antidepressant, insecticidal, antiplatelet, molluscicidal, antireproductive and cosmoperine activities [5]. The findings of Dae *et al*. [6] confirm that green pepper can be considered as a promising antioxidant and anti-inflammatory nutraceutical for the treatment of various inflammatory metabolic diseases. In their work in Nigeria, Kehinde *et al.* [7] concludes that *Piper nigrum* and *Curcuma longa* can serve as repellents against *A. gambiae*, and can be used in integrated vector management control programs. Piperine is an active component in pepper that contributes to its pungentness [8]. *Piper nigrum* is used as a preservative, and as a bio-regulatory agent [9, 10]. Its secondary metabolites act as a defence against infections by microbes, insects and animals [11-13]. The demand for black pepper and its product is increasing year by year in the world market, but production is limited to few countries [14].

1.3. Pests and Pepper Diseases

Several species of pests attack pepper in the field. *Lophobaris piperi* is a dark brown beetle from Indonesia and Malaysia [15]. As adults, it digs round holes in the bays and causes the branches to fall prematurely. To fight this enemy of pepper, it is necessary to prune from the support of the plant. Termites, locusts, defoliating caterpillars and nematodes are also mentioned [15]. The works of Byeoung-Soo *et al*. [16] determines the levels of toxicities of two piperidine alkaloids, pipernonaline and piperoctadecalidine, isolated from *Piper longum* L. against five species of arthropod pests *Spodoptera litura* F. (Lepidoptera: Noctuidae), *Myzus persicae* Sulzer (Hemiptera: Sternorrhyncha: Aphididae), *Tetranychus urti*cae Koch (Acari: Tetranychidae), *Nilaparvata lugens* Stäl (Hemiptera: Fulgoromorpha: Delphacidae) and *Plutella xylostella* L. (Lepidopetera: Yponomeutoidae). Reference [17] report on Piperaceae Coleoptera-Curculionidae genus *Naupactus* of 3 species; Scarabaeidae genus *Chasmodia* sp.; Elateridae genus *Conoderus fuscafascitus*. Lepidoptera-Papilionidae genus *Heraclides* of 2 species and Hesperiidae with *Quadrus u-lucida*. Finally Hemiptera Pentatomidae, *Edessa meditabunda* and *Sibaria armata*; Membracidae with *Membracis foliata* and *Callocanophora* sp.; Cicadellidae with *Sibovia sagata* and Aethalionidae with *Aethalion reticulatum*. According to Scott *et al*. [18], the effectiveness of *Piper* spp. extracts for the control of stored products pests has been proven and the extracts of *Piper nigrum*, *P. guineense* and *P. tuberculatum* has been tested against insect pests of the home and garden. Whole Piper extracts might be useful for the control of sawflies and tent caterpillars in small-scale applications, based on the demonstrated efficacy and reduced risk potential [19]. Pollu beetle is the most destructive pest causing 30 to 40% yield loss in humid, tropical evergreen forests of India [20].

Piper nigrum produced in Cameroon has long been recognized for its exceptional organoleptic quality. Diseases associated with pepper cultivation in Penja-Cameroon, have been studied [21]. Armillaria root rot, that causes the death of plants, attacks both pepper feet and support trees (*Spondias mombin*). But work on fauna and pepper pests are rare or not available in Cameroon. The overall objective of this study was to contribute to the increase in pepper yield through a better knowledge of the associated fauna, prior to the establishment of any biological or integrated pest control program in Penja-Cameroon.

2. Materials and Methods

2.1. Study Area

Penja is a town in the municipality of Njombé-Penja (4-38'20"N; 9-40'47"E; 148 m altitude), district of Moungo Department in the Cameroon Coastal Region. The city of Penja is located 95.8 km from the city of Douala, the capital of the Coastal region (Figure 1).

Temperatures are high all year round (over 24°C), and the annual average is 26.56°C. The average annual rainfall is 2434.69mm. Sunstroke is low: 2-4 hours of sunstroke/day in the rainy season and 4-6 hours in the dry season. The wind that blows here is the monsoon. The soils of the banana plain are of volcanic origin of little evolved types, eutrophic brown and ferralitic typical. The relief is formed from the plains along the Moungo River and the surroundings of Njombé-Penja; plateaus scattered throughout the department and finally the mountain ranges. The water system of the Municipality of Penja is of dense dendritic type. The waters of the area are drained by the Moungo to the west of Wouri and the Dibombé to the east. The area consists, with the exception of cultivated areas, of a primary forest composed of bili, naga, zingana, sappeli, doucier, pachi. Cash and food crops are sometimes grown in the said forest, after having removed a good number of trees and all the undergrowth. In industrial plantations, *Puereria pubescens* was introduced as a ground cover plant. The main crops are banana, oil palm, coffee, cocoa, papaya solo, pineapple, potato, macabo. Wildlife mainly includes antelopes, rats, hedgehogs, porcupine, monkeys.

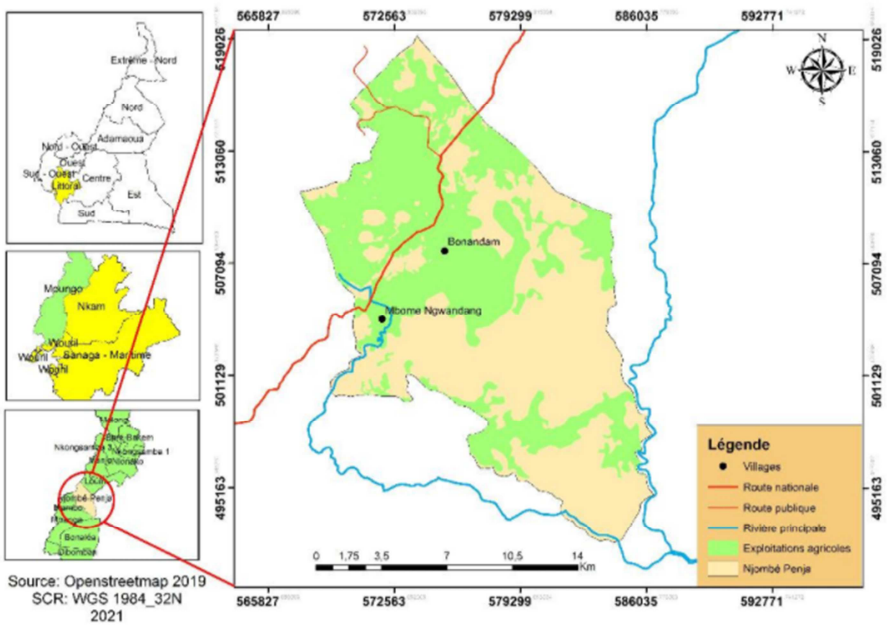

Figure 1. *Location of Njombé-Penja in the Cameroon Coastal Region.*

2.2. Plant Material

The plant material consists of *Piper nigrum* feet of two varieties: the type Lonpomg or Kawur commonly referred to as large grains with large leaves, long ears and small berries and the type Muntok or Bangka called by small-leaf, short-leafed and large berry producers. Lonpomg variety is growing rapidly, the plant is vigorous, with erected port and deep rooting. It can reach up to 5 to 6 m in height, very susceptible to attacks of diseases and pests, producing pregnancies seeds, resistant to drought, its production is late. Muntok variety grows less rapidly, the plant is less vigorous, with erect port but deep rooting. As an adult, it can reach up to 6 m in height. This variety is more resistant to disease and pests, but sensitive to drought. It enters production only 3 years after planting. The 4 farms investigated do not have the same area, but the plants are all 4 years old. The support trees (*Spondias mombin*) are not the other way around, as they can be reservoirs for pests.

2.3. Animal Material

2.3.1. Capture of Arthropods and Damage

Weekly capture of arthropods took place in 2020, using an entomological net, mesh less than 0.5mm. Pepper plants were systematically mowed in all 4 farms and captured arthropods were kept in boxes containing 70% ethanol. To identify the damage, five plants were randomly selected from each plot. All parts of the plant were carefully examined with special manual attention in search of possible damage to stems, leaves, flowers and fruits, also on support trees. The damage described has been associated with the various pests.

2.3.2. Identification of Arthropods

The identification was made at the Laboratory of Agricultural Zoology of the Plant Pathology and Agricultural Zoology Research Unit of the University of Dschang. The different specimens were sorted according to their morphological characteristics and counted under a Motic-branded binocular magnifying glass. Using the identification keys [22, 23] and by consulting our entomological collection, the families were determined. The specimens are kept in 70% ethanol at the Laboratory of Agricultural Zoology, University of Dschang (LAZUDs).

2.4. Statistical Analysis

All data collected was stored in Microsoft's Excel 2010 software. The Pearson's Chi-squared test at $P \leq 0.05$ was used to compare the data.

3. Results

3.1. Inventory of Fauna

A total of 278 specimens belonging to Insecta and Gastropoda classes were collected from the 4 pepper farms in Penja production basin. Insecta class consists of 9 orders: Orthoptera (85 individuals), Coleoptera (64 individuals), Hemiptera (42 individuals), Hymenoptera (21 individuals), Diptera (4 individuals), Lepidoptera (3 individuals), Phasmatoda (3 individus), Isoptera and Odonata (1 individual each). Stylommatophora have 54 individuals (Table 1). The order of Orthoptera (30.57%) is the most represented followed by Coleoptera (23.02%) then the order of Stylommatophora (19.42%). Then the Hemiptera (15.11%) and in the end the order of Hymenoptera (7.55%). The least represented are Diptera (1.44%), Lepidoptera and Phasmatoda (1.08% each), and Isoptera and Odonata (0.36% each).

Lonpomg variety of farm 1 has the highest number of arthropods (29.85%), followed by Muntok variety of farm 2

(26.26%), farm 4 (22.66%) and finally farm 3 (21.22%) (Table 1). This variable abundance of individual numbers could be explained by the size of the different fields, the varietal sensitivity, the care given or even the vegetative stage of the plants. Different orders of arthropods were not observed in all the sampled farms. Diptera and Lepidoptera were absent on Lonpomg variety of farm 1. Diptera, Isoptera, Odonata and Phasmatoda were also absent on Muntok variety of farms 2 and 3, with the exception of Phasmatodea, which are present in farms 2 and the Isoptera, Lepidoptera and Odonata, which were also absent in farm 4. Orthoptera-Acrididae are present in the 4 farms as well as Coleoptera-Chrysomelidae, Hemiptera-Scutelliridae and Stylommatophora-Helicidae.

Table 1. *Number of individuals of different orders by field and variety.*

Class	Orders	Families	Lonpomg variety	Muntok variety			Total
			Farm 1	Farm 2	Farm 3	Farm 4	
Insecta	Orthoptera	Acrididae	23	23	18	21	85
	Coleoptera	Chrysomelidae	14	24	05	19	64
		Dascillidae	01	00	00	00	
		Carabidae	00	01	00	00	
	Hymenoptera	Formicidae	03	00	00	00	21
		Anthophoridae	06	02	02	01	
		Sphecidae	03	01	00	00	
		Vespidae	00	01	02	00	
	Lepidoptera	Nymphalidae	00	01	00	02	03
	Diptera	Bibionidae	00	00	01	00	04
		Opomyzidae	00	00	03	00	
		Scutelleridae	18	08	11	03	
	Hemiptera	Pentatomidae	00	01	00	00	42
		Pyrrhocoridae	00	00	01	00	
	Isoptera	Termitidae	01	00	00	00	01
	Odonata	Aeschnidae	01	00	00	00	01
	Phasmatodea	Phasmatidae	02	00	00	01	03
Gastropoda	Stylommatophora	Helicidae	11	11	16	16	54
Total	10	18	83	73	59	63	278

3.2. Attractiveness of Both Varieties of Pepper to Associated Fauna

Based on the averages of the different orders of fauna, Pearson's tailings table shows the contribution of each order of fauna to Chi-squared value. Hymenoptera are the most attracted by Lonpomg variety, followed by Diptera (p=0.0313). Lepidoptera, Stylommatophora and Coleoptera are less attractive by Lonpomg variety respectively. Conversely, Lepidoptera and Stylommatophora are weakly attracted by Muntok variety. Hymenoptera seem to regrow by the Muntok variety as well as Diptera (Table 2).

Table 2. *Contribution of different fauna orders to Chi-square value.*

Orders	Lonpomg variety	Muntok variety
Orthoptera	0.6	0.3
Coleoptera	3.7	1.5
Hymenoptera	31.2	12.8
Lepidoptera	9.5	3.9
Diptera	11.7	4.8
Hemiptera	3.2	1.3
Isoptera	1.7	0.7
Odonata	1.7	0.7
Phasmatodea	0.2	0.1
Stylommatophora	7.6	3.1

Pearson's Chi-squared test: X-squared=18.35, df=9, p-value=0.03132

Based on the averages of the different families of fauna, Pearson's tailings table shows the contribution of each family of fauna to Chi-squared value. The families of Formicidae, Sphecidae, Scutellecidae, Anthophoridae and Dascillidae were most attracted by the Lonpomg variety respectively (p=0.0108). Nymphalidae, Helicidae and Chrysomelidae are weakly attracted by the same variety (Table 3).

Table 3. *Contribution of different fauna families to Chi-squared value.*

Families	Lonpomg variety	Muntok variety
Acrididae	0.6	0.3
Chrysomelidae	4.8	2.0
Dascillidae	9.5	3.9
Carabidae	1.6	0.6
Formicidae	28.4	11.6
Anthophoridae	13.5	5.5
Sphecidae	15.9	6.5
Vespidae	4.7	1.9
Nymphalidae	9.5	3.9
Bibionidae	1.6	0.6
Opomyzidae	4.7	1.9
Scutelleridae	19.2	7.8
Pentatomidae	1.6	0.6
Pyrrhocoridae	1.6	0.6
Termitidae	1.7	0.7
Aeschnidae	1.7	0.7
Phasmatidae	0.2	0.1
Helicidae	7.6	3.1

Pearson's Chi-squared test: X-squared=33.145, df=17, p-value=0.0108

3.3. Fauna Status Collected on Peppers

Fauna collected on peppers belong to the Insecta and Gastropoda class and are among other pests, natural enemies (predators or parasitoids) and pollinators.

3.3.1. Fauna Pests of Pepper

Orthoptera (Figure 2A), Coleoptera (Figure 2B), Hemiptera (Figure 2C), Lepidoptera (Figure 2D), Stylommatophora (Figure 2E), Diptera, Isoptera, Odonata and Phasmatodea are pests that cause yield declines or fall of support trees in Penja-Cameroon. Only the order of Hymenoptera counts useful insects (Figure 2F).

3.3.2. Arthropods Useful to Pepper Shakers

Arthropods useful to peppers are recruited in Hymenoptera which includes 4 families, Formicidae, Anthophoridae, Sphecidae and Vespidae (Figure 2F). Individuals from these families are known for their predatory action (Formicidae), parasitoid or predator (Vespidae, Sphecidae) and pollinators (Anthophoridae). They can reduce pest populations under natural conditions. However, the status of Formicidae seems controversial, they would cause leaf deformations and attack other insects.

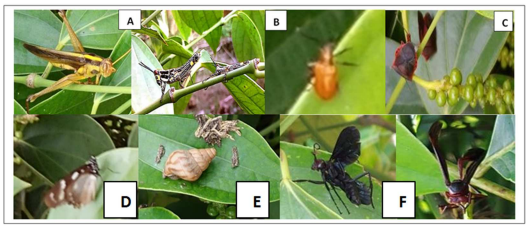

Figure 2. *Some specimens of the fauna associated with pepper in Penja-Cameroon.*

A: Orthoptera-Acrididae (*Acanthacris* sp., *Zonocerus variegatus*); B: Coleoptera-Chrysomelidae (*Longitarsus* sp.); C: Hemiptera-Scutelleridae; D: Lepidoptera-Nymphalidae; E: Gastropoda-Stylommatophora-Helicidae (*Helix* sp.) and leaf droppings; F: Hymenoptera-Sphecidae (*Chalybion californicum*) and Vespidae (*Mischocyttarus* sp.).

3.4. Damage Caused by Different Pests on Pepper

The damage caused by pests was numerous and diverse. They vary depending on the pest and organs attacked.

3.4.1. Damage on Pepper Leaves and Stems

The most visible damage was that caused by the Orthoptera (Figure 3A), as they cut and grind the leaves of growing peppers causing defoliation. Hemiptera-Scutelleridae, by their bites on the surfaces of the leaves, cause remarkable galls (Figure 3B). These leaves lose their green color and eventually fall out early. Coleoptera caterpillars also dig galleries on pepper vines causing chlorosis. This damage blocks the flow of the sap and eventually the drying of the vines. These caterpillars feed large from the green leaves. These black caterpillars puncture the bark of the vine and penetrate to the inside, then consume the up or down sap and stop the growth, which will lead to the premature death of the pepper plants. They are formidable enemies to fight quickly as soon as the first symptoms on peppers appeared, because in just a few days they can devour all the vegetation. Snails also feed mainly on pepper leaves. The high number of snails is a danger to plants. Diptera such as flies and Hemiptera are major vectors of viral diseases from plant leaves.

3.4.2. Damage on Fruit or Berries

The most remarkable damage to fruit and berries was caused by Hemiptera stingers and suckers and Orthoptera Acrididae shredders. The puncture points are not visible, but some fruits dry out early after stings and whole clusters fall off after grinding (Figure 3C). If a fight is not envisaged, it should cause very economic damage to the yield of the crop.

3.4.3. Damage on Support Trees

The Orthoptera-Acrididae *Zonecerus varigatus* and *Cyrtacanthacris* sp. can fully devour all the leaves of *Spondias mombin*, support trees (Figure 3D). This damage limits the growth of the plant and causes it to die in the event of prolonged drought. These Orthoptera would not be the only pest to the support trees, but would also cause damage to peppers especially since many individuals were captured on different pepper organs. Adults of Lepidoptera appear when precipitation becomes abundant. The caterpillars of Coleoptera-Chrysomelidae and Lepidoptera-Nymphalidae are said to be great destroyers of pepper vines and support trees leaves. Damage caused by Orthoptera and Coleoptera seems identical on leaves.

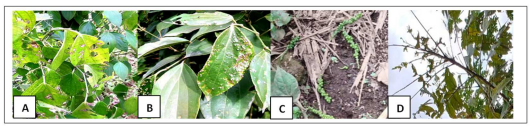

Figure 3. *Some damage observed in the field.*

A: Holes on pepper leaves; B: Galls on pepper leaves; C: Pepper berries cut by arthropods; D: Defoliation of *Spondias mombin* leaves, support tree.

4. Discussion

4.1. Pepper Fauna Inventory

Work on fauna associated with peppers is rare. In Penja, we obtained 9 orders from the Insecta class and a Gastropoda, thus, 18 families in total. The work of Teshale *et al*. [14] reports that 22 species of pests live on *Piper nigrum* in southwestern Ethiopia. This result is achieved in 5 districts while in Cameroon the same work was done in a single district, but with 18 families identified. The results found in Penja- Cameroon are similar to those found in Ethiopia for certain orders. In the fauna of the insects associated with *Piper nigrum* in southwestern Ethiopia, the order of Coleoptera, Orthoptera, Hemiptera, Hymenoptera, Isoptera and Lepidoptera obtained were also seem in Penja-Cameroon. Our work does not indicate the presence of Thysanoptera and Acarina. Similarly, the Gastropoda-Stylommatophora collected in Penja are not reported in the works of Teshale *et al*. [14] in southwestern Ethiopia. The work of Sergio *et al*. [17] in Sao Paulo, reports 3 orders of insects (Coleoptera, Lepidoptera and Hemiptera) on different species of Piperaceae including *Piper nigrum*. The fauna associated with Piperaceae in Cameroon includes, in addition to orders

encountered in Sao Paulo, insects belonging to the order of Orthoptera, Hymenoptera, Diptera, Odonata, Phasmatodea, Isoptera and molluscs of the order Stylommatophora. Coleoptera includes 2 families in Penja-Cameroon, Chrysomelidae and Dascillidae. In Sao Paulo, Sergio *et al*. [17] mention 3 families on Piperaceae, Curculionidae, Elateridae and Scarabaeidae. In this work, the Lepidoptera are represented by a single family, that of Nymphalidae. In Sao Paulo and according to the same author, the Lepidoptera on Piperaceae are from Hesperiidae and Papilionidae families. Hemiptera-Pentatomidae was met in Cameroon and Brazil on Piperaceae. Scutelleridae and Pyrrhocoridae in Cameroon have not been observed in Sao Paulo. Similarly, the families of Membracidae, Cicadellidae and Aethlionidae present in Brazil [17] were not obtained in Penja-Cameroon. The fauna associated with *Piper nigrum* from Cameroon is rich with 7 families than that of Sao Paulo in Brazil. In addition to insect pests, Teshale *et al*. [14] observed on *Piper nigrum*, different natural enemies which included different flies (Diptera-Syrphidae), bugs (Hemiptera-Reduviidae), lady beetles (Coccinellidae), green lacewings (Chrysopidae), spiders (Salticidae and Thomisidae), wasps (Vespidae and Braconidae) and praying mantids in southwestern part of Ethiopia. In Penja-Cameroon, Hymenoptera Vespidae and Formicidae and a Coleoptera Carabidae were collected. But the character of natural enemies is mixed for Formicidae and Carabidae, because the individuals of these families are polyphagous (Carnivores and phytophagous).

4.2. Nutritional Preference on Pepper Varieties

Lonpomg variety attracts more Hymenoptera Formicidae, Sphecidae and Anthophoridae. Taken as a whole, the Order of Diptera would have a great affinity with the Lonpomg variety, but not the corresponding families. In the same logic, the order of Hemiptera seems to have no attraction towards Lonpomg variety and yet one of the corresponding families, that of Scutelleridae would have a strong attraction. Thus, this varietal dependence test shows that when individuals are considered in larger or smaller groups, the results vary from group to group and depending on the taxonomic level. Lompong variety was found to be the most pest-sensitive variety than Muntok. Yet, pepper Muntok has a denser vegetative port in terms of biomass, leaf surface, plant heights and the size of clusters and fruits. This would also be justified by the greater number of snails caught on it. Snails need the shade that gives them moisture. But the Lonpomg variety has the highest number of arthropod pests compared to the average of the Muntok variety. From analysis of specificity between fourteen insects and about fifty Piperaceae species, Sergio *et al*. [17] revealed a remarkable narrow feeding preference. Carterpillar species were observed predominately on lignan/neolignans-containing species such as *Piper solmsianum* and *P. regnellii*; beetles and sap-sucking Hemiptera species preferred *P. aduncum* and *P. gaudichaudianum* with prenylated benzoic acids as major compounds. Coleoptera species preferred *P. gaudichaudianum* and *P. regnellii* [17]. The work of Dzokou *et al*. [24] on the entomofauna of 3 varieties of sweet pepper (*Capsicum annuum*) in Cameroon showed that the Simbad variety was the most sensitive to the 9 insect orders of 85 families identified.

4.3. Pest Damage on Peppers

Damage caused by pests on *Piper nigrum* in Penja-Cameroon was diverse. Multiple perforations and cuts of the leaves by Orthoptera-Acrididae, Coleoptera-Chrysomelidae and Hemiptera-Scutelleridae were observed. The work of Teshale *et al*. [14] in 5 districts in Ethiopia showed the varying levels of damage from one district to another and from one pest to another. Thus, according to these authors, the Hymenoptera-Formicidae cause more damage in the districts of Guraferda and Sheko in Bench-Mmaji; Godere in Majang and Andracha in Sheka. But in Yeki district in Sheka, the highest level of damage was caused by Hemiptera-Pentatomidae of the genus *Euschistus* spp. It was noted in all districts that the Coleoptera-Chrysomelidae, the Orthoptera-Acrididae and the Hemiptera-Pentatomidae caused high-level damage. On support trees (*Spondias mombin*) in Penja-Cameroon, leaf defoliation was caused by Orthoptera and Coleoptera. On stem or vine, the black pepper stem borer and Lepidoptera caterpillar dig galleries in the vine, which can block the flow of sap and cause the peppers to turn yellow. On berries or clusters, Orthoptera and Coleoptera caused fruit clusters to fall. Stylommatophora-Helicidae consumed leaves and young buds. The damage observed in Penja-Cameroon, was almost similar to that reported in southwestern Ethiopia [14]. Thysanoptera-Phlaeotripidae (Leaf gal trips) found in Ethiopia have not been observed in Cameroon. Yet galls were very present on pepper leaves in Cameroon and Stylommatophora-Helicidae observed in Cameroon were not reported in Ethiopia [14]. Additional surveys will help to better appreciate the situation. The proximity of some *Spondias mombin* insect pests may eventually cause these pests to adapt to the pepper, increasing the potential pests of this crop.

5. Conclusion

The present survey provided some clues to understand the importance of pests and damages in the largest production basin on pepper in Penja-Cameroon. From this survey, it can be concluded that Orthoptera-Acredidae, Coleoptera-Chrysomelidae, Gasteropoda-Stylommatophora-Helicidae and Hemiptera-Scutelleridae which were the most recorded in all sampled farms and whose damage was most observed may be considered major pests. Hymenoptera-Formicidae, Lepidoptera- Nymphalidae, Diptera-Opomyzidae and Phasmatodea-Phasmatidae as intermediate pests because they were the second largest pests in the sampled area. Diptera-Bibionidae, Hemiptera-Pentatomidae and Pyrrhocoridae, Isoptera-Termitidae and Odonata-Aeschnidae were considered as minor pests. Fauna pest that have been less present may become formidable pests in the future due to significant variations in climatic factors and adaptations. Lonpomg variety was found to be the most attractive toward pests. Damage observed was numerous: bite of berries, fall of entire clusters, destruction of pepper foliage and support,

galls on the bottom surface of the leaves, chlorosis of leaves. The order of Hymenoptera was the only one with useful insects. Pepper producers should be informed of the presence of these pests and strictly monitor cultural practices, reduce shade to decrease snail populations. In-depth, studies will be required for the adoption of a crop protection scheme based on pests and auxiliaries actually present during pepper cultivation in Penja-Cameroon and a possible change or variation of the support trees.

Acknowledgements

We thank Mrs. Tiani Huguette for accepting us on her farm in Penja for data collection and Mr. Etame Georges, doctorate student in our faculty for statistical analysis.

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