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# Inventory of the entomofauna associated with the cultivation of sweet corn in Senegal: Report of the fall armyworm *Spodoptera frugiperda*

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**Abstract**
**Objective:** The objective of this work was to draw up an inventory of the entomofauna associated with the cultivation of sweet corn (*Zea mays* L. ssp saccharata) in the Niayes in Senegal.
**Methodology and Results:** A monitoring and sampling was carried out between June and August 2017 at the experimental station of the Senegalese Institute for Agricultural Research (ISRA) in Sangalkam (Dakar), the insects collected were identified by the laboratory of terrestrial invertebrates from IFAN/ Cheikh Anta Diop University of Dakar. It has been listed 75 species divided into 10 orders for 28 families mainly Coleoptera (41%), Orthoptera (12%), Diptera (12%), Hymenoptera (12%) and Lepidoptera (11%). The Shannon H index indicates a diversity value of 3.4, and the regularity index gives the value of 0.78, which reveals an average diversity with a minority of species dominating the environment. A higher abundance and diversity of entomofauna associated with maize has been noted during the flowering stage to ear maturation this exploration work was able to detect an invasive pest in Senegal: the fall armyworm, *Spodoptera frugiperda*. The study also revealed a significant imbalance between pests and auxiliaries of maize in the environment with more than 80% of the insects encountered being pests. In addition, this study has enabled the reporting and confirmation of the fall armyworm in Senegal, which without monitoring and intervention could be a real threat to food security in Africa and in Senegal in particular.
**Conclusion and Application of Findings:** This study allowed the updating of the entomofauna of sweet corn in the Niayes area in Senegal. The results reveal in particular a significant imbalance of the maize entomofauna in favour of pests, but also the report of the polyphagous pest *S. frugiperda*. These results can constitute an important basis for the development of sweet corn crop protection strategies in Senegal

**Keywords:** Sweet corn, Entomofauna, *Spodoptera frugiperda*, Biodiversity

## Introduction

Maize (*Zea mays* L.) is the most cultivated plant in the world and the first cereal produced, ahead of wheat [1, 2]. In Senegal, maize has become the second most produced cereal after rice [15].

Sweet corn (*Zea mays* L. ssp. saccharata), or sweet corn, is intended for human consumption because of its high sugar content. Sweet corn is a promising sector in Senegal for its export outlets (because of its strong demand on the world market) and its local consumption, which is increasing, but also important for its nutritional quality (the staple food of many populations). However, this crop is confronted with insect pests that can damage the different parts of the plant and hinder its development, leading to reductions in yield and grain quality. To reduce the impact of these insects and increase maize productivity, control methods (chemical, cultural, biological, varietal) have been developed, but each method has its limits. According to [4], to successfully protect a crop, it is imperative to know its pests. Unfortunately, in Senegal, there is a lack of information on the entomofauna from the farming world and therefore the potential implications of their presence in the fields. Thus, knowledge of the entomofauna associated with the cultivation of sweet corn is essential for developing strategies for the integrated management of insect pests. Studies on the insects associated with this crop are non-existent in Senegal.

It is in this perspective that the present study is aimed at inventorying the insect pests of sweet corn and diagnosing those that are invasive.

The general objective of this work is to contribute to the knowledge of the entomological fauna of sweet corn cultivation in open fields in Senegal.

Study area this work was done in the ISRA/CDH Sangalkam experimental station which is located in the Niayes area. This area located along the northern coast, from Dakar to the south of the Senegal River Delta on a coastal strip 10 to 15 km wide at the Sahelian latitude, provides most of Senegal's market gardening production.

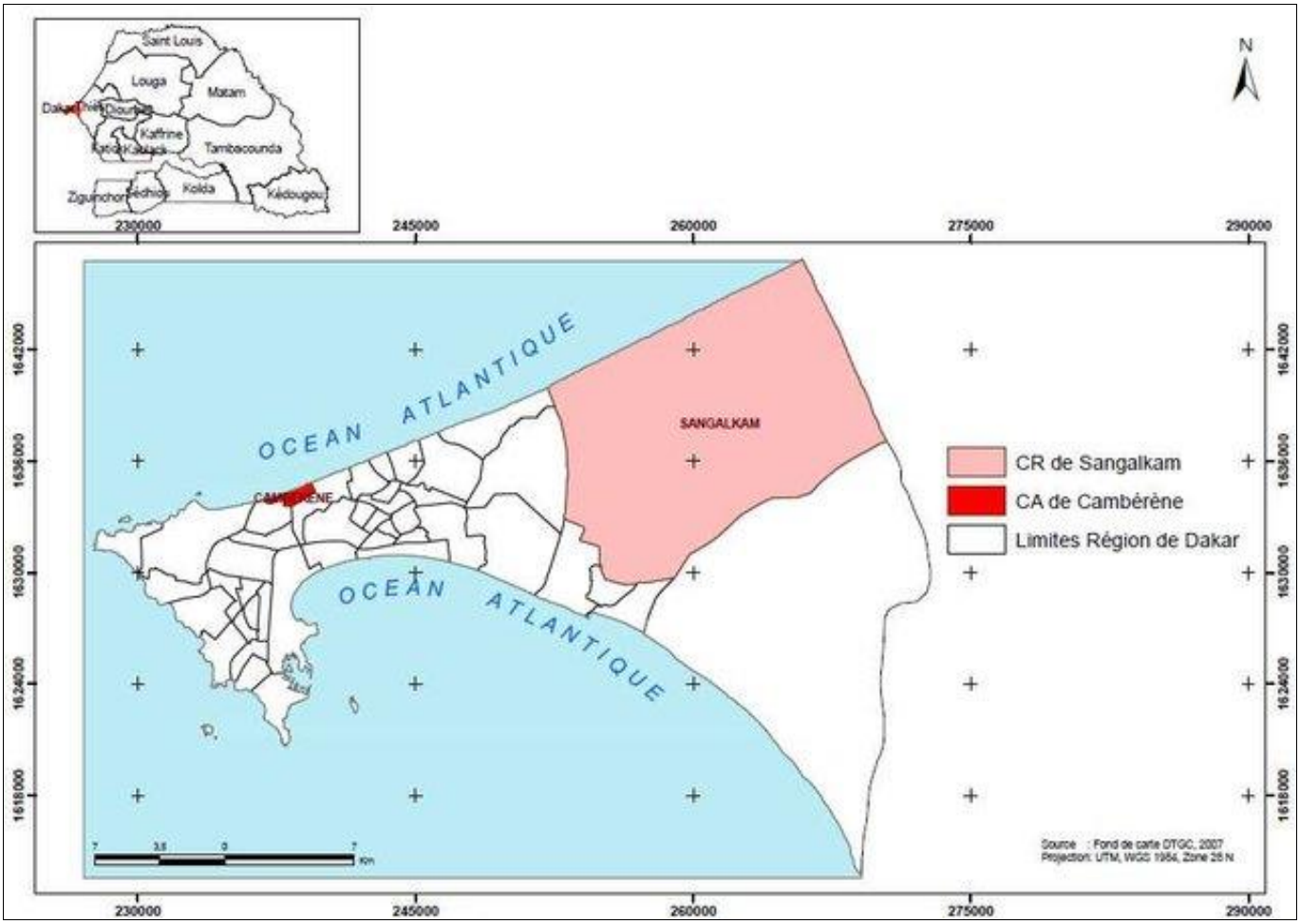



**Fig 1:** Study area

**Sample collection and identification:** The entomofauna was collected by direct observations and captures on plants (by hand, pliers, sweep net, mouth aspirator), and by trapping using buried traps (pitfall traps). The collections were carried out between June and August 2017. The trapped insects were harvested weekly (12 records in total) and stored in a 75% ethanol solution. They were identified in the laboratory down to the taxonomic level of the family, and for the most part down to the species, using identification keys [5, 6, 7]. The identification results were supported and completed by the terrestrial invertebrate laboratory of IFAN / Cheikh Anta Diop University of Dakar.

**Data analysis:** The data collected in the field are first recorded and arranged in a workbook with Excel software. The different ecological parameters were calculated on an Excel spreadsheet and with the R software.

Ecological parameters such as abundance (number of individuals recorded for a given taxon), specific richness (number of distinct taxa present), frequency of occurrence (Fo% = Pi/P*100 where Pi = number of records where species i is found, P = total number of records), the Shannon-Weaver species diversity index

(H' = - Σ pi x log2 (pi), where pi is the proportion of a species i compared to the total number of species (S) in the study environment (or specific richness of the environment) which is calculated as follows: pi=ni/N where ni is the number of individuals for species i and N is the total number of individuals collected for all species) were established.

**Results**

Distribution of the different insects collected

A total of 656 individuals (insects) were collected from the sweet corn fields in Sangalkam, divided into 11 orders, 28 families and 75 species. The most represented orders are Coleoptera (47%), Orthoptera (12%), Diptera (12%) Hymenoptera (12%) and Lepidoptera (11%) (Fig. 1).

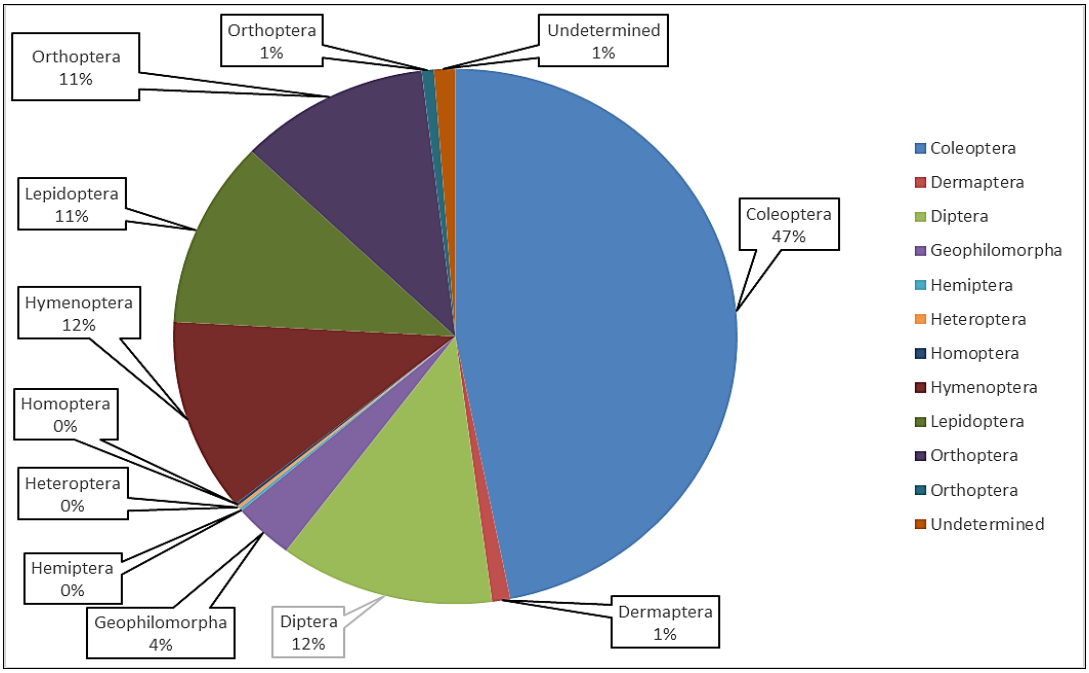



**Fig 2:** Distribution of the different insects' orders

The analysis of figure 1 shows that the Coleoptera order is the most represented order in the maize field. It largely dominates the other 10 orders and alone represents 47% of the workforce. The order Hymenoptera also represents an important part with 12% of the workforce. The same applies to Lepidoptera, Orthoptera and Diptera, representing approximately 11%, 12% and 12% respectively. The shares of the five other orders are low compared to the others with 04% for the Geophilomorphs, 01% for the Dermoptera while those of the Homoptera, Heteroptera and Hemiptera are substantially equal to zero.

**Abundance and dominance of the various species collected**

With respective numbers of 107 and 84 individuals in total, the species *Carpophilus hemipterus* (Coleoptera, Nitidulidae) and *Camponotus maculatus* (Hymenoptera, Formicidae) are the most abundant. It should also be noted the presence of *Onthophagus viridicatus* from Orb. (Coleoptera, Scarabaeidae) with 7.2% of the total individuals, of *Sarcophaga sp*. (Diptera, Sarcophaginae) and *Zonocerus variegatus* (Orthoptera, Pyrgomorphidae) each representing 7.0% of the individuals sampled. The invasive pest, *Spodoptera frugiperda* (Lepidoptera, Noctuidae), represents 5.6% of the individuals collected. Other species such as *Camponotus sp* (Hymenoptera, Formicidae), *Pseudaletia unipuncta* (Lepidoptera, Noctuidae), *Phyllophaga anxia* (Coleoptera, Scarabaeidae) and *Brachypeplus sp* have also been observed. (Coleoptera, Nitidulidae) with respective dominances of 3.4%, 3.0%, 2.9% and 2.4%.

Of the 656 insects collected throughout the study, 534 individuals (i.e. 81.4%) are considered pests while the rest, i.e. the 122 (i.e. 18.59%) individuals are useful insects for maize attesting to a significant imbalance in the culture medium between auxiliaries and pests.

**Frequency of occurrence of different species**

Figure 3 presents the respective frequencies of the different species collected during the study.

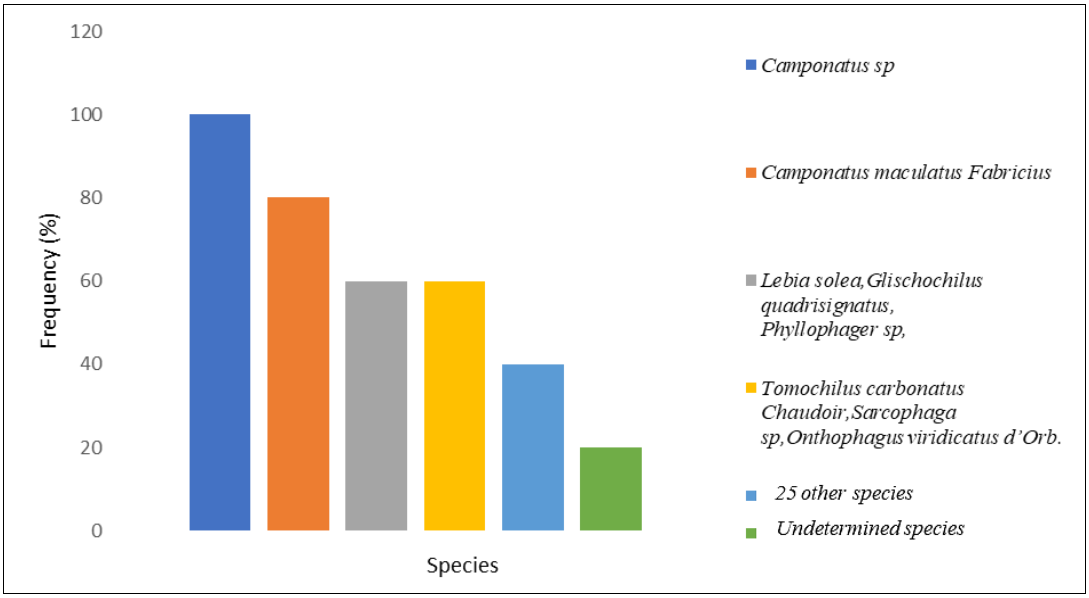


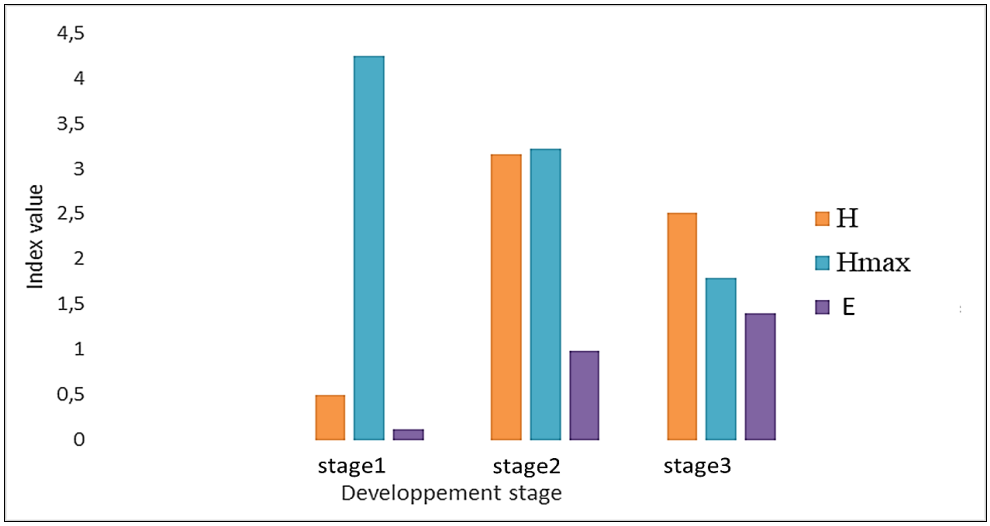

**Fig 3:** Frequency of occurrence of the 75 species in percentage

The analysis of the frequency of occurrence shows that the species *Camponatus sp* is very present (100%). The species *Camponatus maculatus* Fabricius is observed with a frequency of 80%. A frequency of 60% is noted for *G. quadrisignatus, L. solea, T. carbonatus, O. viridicatus, Sarcophaga sp. and Phyllophaga sp*.

**Diversity and species richness**

The Shannon H index indicates a diversity value of 3.4, and the regularity index gives the value of 0.78. This reflects a moderately high specific diversity with a high specific richness [8].

The Shannon index was calculated for the different phenological stages (Seedling to bolting, Bolting to flowering, Maturation of the ear of the plant) as shown in Figure 4.




Stage 1: seedling to rising; Stage 2: Rising to flowering stage; Stage 3: Ripening of the plant ear

**Fig 4:** Specific diversity of the entomofauna according to the phenological stage of the plants

The analysis of Figure 4 shows that the diversity is greater at the stage of elongation at flowering because His high there (3.15). Maximum diversity (Hmax) and regularity (E) are also greater here than during the other stages. This phase of grain filling and ear maturation is therefore subject to high parasitic pressure, which can impact yields. The first stage has the lowest diversity with low regularity because Hmax is high there and H low.

The calculated biodiversity index, that of Shannon, shows that there is an average diversity in the sweet corn field and that a small part of insect species largely dominates the environment. Among these species we can cite: *Carpophilus hemipterus* Linnaeus with 107 individuals, *Camponotus maculatus* Fabricius; 84 individuals constituting the two most abundant and most frequent species in the area. There are also the *Onthophagus viridicatus* species of Orb.; 47 individuals, *Sarcophaga sp*; 46 individuals and *Zonocerus variegatus* with 46 individuals while the numbers of individuals of other species vary from 37 to 01 individuals.

**Discussion**

The general objective of this work was to contribute to the knowledge of the entomofauna of corn cultivation, sweet corn more in the open field.

The results clearly show that the diversity and abundance of insects are relatively linked to the different development phases of maize. These parameters are higher at the stage of elongation at flowering but also from flowering to grain maturation. These results are close to those obtained by **[9]**. Diversity and abundance of insects pests of corn (Zea mays Poaceae) grown in a rural environment in the city of M'Bahiakro (East Central Cote d'ivoire). Indeed, the majority of insects that attack maize during these stages belong to the Nitidulidae, Pyrgomorphidae and Noctuidae families, but also to the Scarabaeidae family. The first and the last family belong to the order Coleoptera which is the most represented order with 41% of the workforce. These results are similar to those of N'goran *et al*., in 2017 who with 8 orders obtained 30.80% predominant beetles over the other orders. Individuals of this order are localized directly on the ear, rarely on the stems and leaves. Pyrgomorphidae are of the order Orthoptera, they are phytophagous. During this stage (from flowering to maturation), the corn plant has different nutrient varieties sufficient for a wide variety of insects [10, 11]. This is the most vulnerable stage of maize [16].

The calculated frequency of occurrence indicates that a single species *Camponotus sp* (Black Ant) has a Fo of 100% therefore present in all 05 records because this species is a visitor species but it is not really attracted by the corn. Only one species is constant in the medium with a Fo between 75 and 100%; it is the species *Camponotus maculatus* Fabricius (light ant) that can also be considered as a visitor species. Species such as *Glischochilus quadrisignatus*, *Lebia solea*, *Nebria lafresnayei* and *Phyllophaga anxia* which are present in 03 of the 05 records are regular species in the environment. Only 09 species are considered as accessories in the environment with a frequency of 40% while the remaining 18 species with a frequency of 20% are accidental species in the environment and they are the most numerous.

The Shannon biodiversity index shows that there is an average diversity in the sweet corn field and that a small part of insect species largely dominates the environment. The low value obtained for the Piélou regularity index (0.78) also shows that there is an average diversity in the site because this value is too low compared to the theoretical maximum (5.087). These two parameters (Shannon index and Piélou regularity) calculated during the different phenological stages (vegetative, elongation and maturation) show that the diversity is greater at the stage of elongation at flowering with a more balanced distribution of individuals. The last stage

(from flowering to maturation) has more species but with a lower diversity than the second stage because there is one species (*Carpophilus hemipterus*) with a large number of individuals (107) dominating others widely. This species, despite its large numbers, was only encountered during this stage, which can be explained by the fact that it only consumes ripe maize grains [13].

The discovery of *Spodoptera frigiperda* (Fall armyworm) as a new maize pest in Senegal for the first time by this study can be explained by favourable conditions in a context of climate change.

## Conclusion

This study is a contribution to the knowledge of the entomofauna of sweet corn in Senegal. It has been listed 75 species divided into 10 orders for 28 families mainly Coleoptera with *Carpophilus hemipterus* but also Hymenoptera with *Camponotus maculatus*. The study revealed a significant imbalance between pests and auxiliaries of maize in the environment with more than 80% of the insects encountered being pests. Similarly, a higher abundance and diversity of entomofauna associated with maize has been noted during the flowering stage to ear maturation.

However, despite the large number of individuals captured, the diversity in the maize field is average because the site is dominated by a certain number of insects.

In addition, this study allowed the reporting and confirmation of the fall armyworm in Senegal. Without monitoring and intervention or in the absence of biological protection, the fall armyworm can be a real threat to food security in Africa and in Senegal in particular.

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