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Contribution to the inventorier and establishment of a collection of agricultural entomofauna from the Niayes area of Dakar

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ABSTRACT

Our study, which was intended to contribute to the inventory and establishment of an entomofauna collection from the Dakar Niayes area, was conducted at the experimental center of the Plant Protection Head office (PPH) located in the town of Sicap Mbao. It took place from July 18 to October 2, 2022. Seventy-seven collection phases were carried out and 1,008 insects were captured. After identification of the different specimens, the results revealed the presence of 47 species. These species are divided into 08 orders, namely those of the Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Mantoda, Odonata and Orthoptera. Beetles, Hemipterans and Lepidoptera alone account for 73% of the species harvested. The determination of the status of species showed the presence of auxiliaries, fertilizers, pollinators and pests. Pests represent 26 species; auxiliaries, 15 species; pollinators, five species and fertilizers, one species. The study of the distribution of different orders of insects according to status has shown that beetles are made up of both auxiliaries, fertilizers, and pests; dipterans and hemipterans are made up of both auxiliaries and pests; lepidopterans made up of pollinators and pests; orthopterans contain only pests and hymenopterans, mantises, and odonates are made up only of auxiliaries. Among the four developed speculations, okra is the main target of the entomofauna (80% pollinators, 64% helpers and 50% pests). This study made it possible to enrich the reference collection of the DPV of Mbao by the introduction of previously unlisted species and to report for the first time the presence of pollinators in the area.

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INTRODUCTION

In Senegal, horticultural crops have experienced strong growth due to rapid urbanization and the rice crisis in the river valley. Devaluation of the CFA franc also made imported vegetables more expensive, making local production more attractive (Wade, 2003). Thus, within the framework of the policy of intensification of agricultural production, horticulture occupies a privileged place (PAPSEN, 2015).

Vegetable production rose by 12.3% compared to 2018 (1,349,016 tons) and by 18% compared to the average of the last five years (1,142,844 tons) under the effect of the availability of inputs as well as protective measures against imports of certain products during part of the year. Dakar alone accounts for 40% of Senegal's total demand for vegetables, and this region covers more than 60% of its vegetable consumption (Fall *et al.*, 2000). Horticultural production mainly comes from the Niayes area and the Senegal River valley. During a survey conducted by Boinahadji and Kebe (2020) in the Niayes area, seventeen (17) speculations belonging to nine (9) botanical families were cited by market gardeners. These are fruit vegetables: tomato (11%), pepper (11%), eggplant (10%), cucumber (8%), okra (8%), chili pepper (6%), zucchini (4%), watermelon (1%), and melon (1%); leaf vegetables: cabbage (10%), lettuce (5%); bulb: onion (9%), root vegetable: turnip (7%), carrot (3%) and tuber: potato (4%), sweet potato (2%) and cassava (2%).

However, insect pests and mites limit the production and quality of speculation by their damage (Tendeng *et al.*, 2017). The market gardening sector continues to face many challenges, including lack of control over pest damage and insufficient knowledge of integrated pest management techniques (Boinahadji and Kebe, 2020).

Moreover, the pests of vegetable crops and their natural enemies have been little or no studied in the Niayes area. Updates are very rare or even non-existent. The only work carried out is that of Collingwood and Bourdouxhe (1980) and Etienne *et al.*, 1993. Studies by Etienne *et al.*, 1993 showed that for vegetable crops, pest surveys were incomplete and additional data had to be obtained.

Unfortunately, since then, almost no studies on the pests of market gardening crops and their auxiliaries have been carried out. According to Choudourou *et al.*, 2012, the preliminary step for successful crop protection is knowledge of pests. To this must be associated knowledge of the auxiliary fauna that participates in pest regulation (Tendeng, 2017). It is in this context that this work, whose objective is to contribute to the knowledge of the entomological fauna of vegetable crops in a station in the Niayes area, was undertaken.

MATERIALS AND METHODS

Presentation of the study environment

The Plant Protection Head office (PPH), through its center located in Sicap Mbao, housed our experiment (Fig. 1). This area is characterized by physical conditions (mild and humid climate, shallow depth of the water table, etc.) and a socio-ecological context favorable to intense agro-pastoral activities. It is the main market gardening area in Senegal and offers good conditions for arboriculture (Ba, 2008).

Fig. 1. Location of the study area (Plant Protection Head office of Diamaguène Sicap Mbao)

Subsampling

Inventory of pest arthropods was carried out from the main market garden crops. Samples were taken from the stems, leaves, fruits, and flowers of plants. Insects found on the different parts (mentioned above) of the plants as well as on the soil, were captured. Some individuals, encountered in the larval stage, were bred at the PPH Entomology Laboratory up to the adult stage. Three major steps were identified and each required the implementation of a protocol. These steps are: selection of plots, collection of insects in the fields and monitoring of individuals in the laboratory.

Plots choice

Plots Choice was carried out during the month of July 2022. The study takes place in four plots at least 10 m apart. In order to better carry out the study, the plots selected for the study have not undergone any chemical treatment and are far from the treated fields.

Insects catching

Seventy-seven one-day collection phases were conducted from July 18 to October 2, 2022. Two methods were used:

The passive method

This method consists in setting insect traps. During our work, two types of traps were used: buried traps to capture night predators in large part (Fig. 2) and coloured traps to capture diurnal flying arthropods (Fig. 3). The device consists of a yellow pot, half filled with water and formalin to preserve the captured insects. The whole system is suspended on a stake between two cultivation plans.

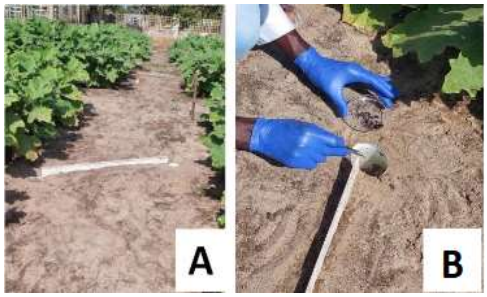

Fig. 2. Buried trap (A: Trap buried between two cultivation plans, B: Extraction of insects captured by the buried trap)

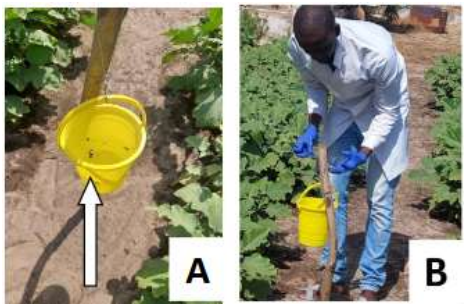

Fig. 3. Color trap (A: Color trap, suspended on a stake between two planes, B: Extraction of insects captured by the color trap)

The active method

This method does not require traps, it is to chase certain insects in the field to capture them. Some large and docile arthropods were captured with gloved hands (manual capture). Others fly and are very mobile; a mowing net allowed us to capture them. The very small insects were captured using a vacuum cleaner, a tool consisting of a sampling pot that can receive collected specimens and two tubes that are connected to the pot. A first tube connected to the inspector's mouth allows air to be drawn from the pot, and the second tube, equipped with a fitting placed on the insect, allows the insect to be sucked into the pot.

Laboratory monitoring of larval stages

Caterpillar monitoring

The collected caterpillars are put individually in plastic boxes. Infested fruits of Cucurbitaceae and Solanaceae are deposited in pots. Each pot contains sand and is covered with a mosquito net cloth (Fig. 4). Pupae obtained from attacked fruits were monitored until the emergence of adults or parasitoids.

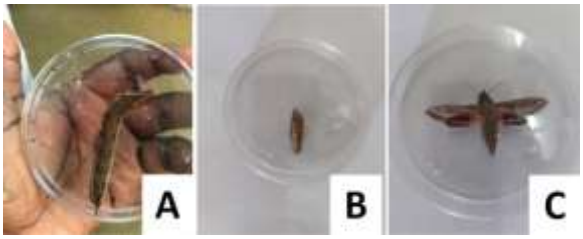

Fig. 4. The different stages of development of the butterfly caterpillar

A= Caterpillar captured and bred in laboratory, B= Chrysalis resulting from the transformation of the caterpillar, and C= Butterfly emerged from the Chrysalis.

Locust larva monitoring

Collected locust larvae were brought back to the laboratory and fed with fresh leaves from their host plants until adults were obtained (Fig. 5).

Maggots monitoring

Attacked fruits of Cucurbitaceae and Solanaceae were deposited on a dish and incubated in a basin containing sand and covered with a mosquito net until pupae were obtained and then the emergence of adults (Fig. 6).

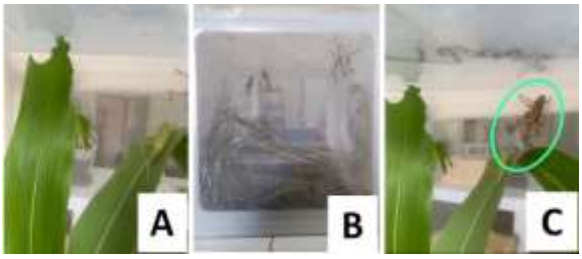

Fig. 5. Breeding of locust larvae

A= Locust larva captured in plots, B= Breeding of larvae in a cage, containing leaves from their host plants, and C= Emergence of adult locusts.

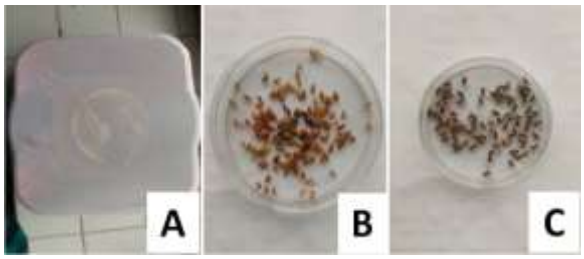

Fig. 6. Different stages of development of maggots

A= Infested fruit, B= Box containing hatching pupae, and C= Box containing flies emerged from the pupae.

Preparation of insects for collection

Insects killing

Adults of collected pests were immediately introduced into a potassium cyanide box in order to kill them and facilitate conservation and identification. Under normal conditions of use, this method does not present any handling hazard and is very practical in the field; it is only necessary to avoid breathing cyanide fumes when opening the bottle.

Insects display

Insects were spread on polystyrene and dried under shade for 72 hours. They were fixed by an entomological pin in the right part of the thorax. This pin should protrude one-third from the side of the back and two-thirds from the side of the stomach. With other pins, the appendages were well spread out in standard position.

In the case of Lepidoptera, the anterior wings were well opened to highlight the color of the posterior wings. Once the arthropods had dried up, the spreading pins were carefully removed because all the appendages had become rigid and brittle. An entomological label of modest size (25 × 10 mm maximum) has been fixed under each specimen with indication of the date, place of capture and the name of the collector.

Observation of insects

The recognition of specimens was carried out by observation with a stereo microscope with screen. To better visualize the captured specimens, hand-held magnifiers were used. After identification at the family level, the recognition key of DELVARE and ABERLENC (1989) was used.

Identification of specimens

The catalogue of "Arthropods of vegetable crops from West Africa, Central Africa, Mayotte and Réunion" (Bordat and Arvanitakis, 2004), the key to recognition of the families of Delvare and Aberlenc (1989) and the reference collection of the Plant Protection Head office were used for species identification.

Statistical analyses

Obtained data after species identification were recorded in an Excel 2013 table (version 15.0). Results had guided us to make circular diagrams and vertical bar diagrams in order to see the distribution of species in the different orders and in speculation, as well as their status in the different orders.

RESULTS

Inventory of pests

A total of 1,008 insects were captured. After identification, 5 orders, 18 families and 26 species were identified as pests (Table 1). The Order Hemiptera is the most representative with 7 families and 9 species, followed by the Order Coleoptera with 4 families and 6 species, the order Lepidoptera with 3 families and 5 species, the Order Orthoptera with 2 families and 4 species and the Order Diptera with 2 families and 2 species.

Inventory of auxiliaries

Auxiliaries represent 8 families and 16 species (Table 2). The Order of Coleoptera contains more auxiliaries, the family Carabidae is the most represented as well as that of the Reduviidae.

Table 1. Inventory of pests caught on market garden crops in the station of the EPH

Orders	Families	Species	Host plants
Coleoptera	Scarabaeidae	*Pachnoda marginata*	Okra
		Pachnoda interrupta	Okra
		Pseudoprotaetia stolata	Okra
	Chrysomelidae	*Aulacophora quinquefasciata*	Eggplant
	Curculionidae	*Lixus pulverulentus*	Cucumber
	Celoritidae	*Rhipidosia mirifica*	Okra
Diptera	Diopsidae	*Diopsis macrophthalma*	Okra
	Tephritidae	*Zeugodacus cucurbitae*	Cucumber
Hemiptera	Aphididae	*Aphis gossypii Glover*	Cucumber
	Coreidae	*Clerus* sp.	Eggplant
		Anoplocnemis curvipes	Cucumber
	Pentatomidae	*Aspavia armigera*	Cucumber
		Nezara viridula	Cucumber
	Pseudococcidae	*Cochonille*	Cucumber
	Pyrrhocoridae	*Dysdercus cingulatus*	Okra
	Lygaeidae	*Spilostethus pandurus*	Okra
	Scutelleridae	*Chrysocoris stolli*	Eggplant
Lepidoptera	Noctuidae	*Spodoptera* sp.	Tomato
	Macroglossinae	*Hippotion celerio*	Cucumber
		Hyles livornica	Cucumber
	Pyralidae	*Diaphania hyalinata*	Cucumber
		Udea recurvalis	Cucumber
Orthoptera	Acrididae	*Kraussaria angulifera*	Okra
		Catantops stramineus	Okra
		Acrida bicolor	Okra
	Gryllotalpidae	*Gryllotalpa africana*	Cucumber

Table 2. Inventory of auxiliaries and fertilizers obtained

Orders	Families	Species	Status
Coleoptera	Carabidae	*Lophyra senegalensis*	Predator
		Phaeoxantha sp.	Predator
		Aptinus displosor	Predator
	Coccinellidae	*Cheilomenes sulphurea*	Predator
	Scarabaeidae	*Oryctes nasicornis*	Fertilizer
		Cheilomenes vicina	Predator
Mantoda	Mantidae	*Mantis religiosa*	Predator
Diptera	Syrphidae	*Ichiodon aegyptius*	Predator
Hemiptera	Reduviidae	*Reduvius personatus*	Predator
		X1	
		X2	
Hymenoptera	Sphecidae	*Sphex pensylvanicus*	Parasitoid
		Isodontia mexicana	Parasitoid
		Sceliphron spirifex	Parasitoid

Table 3. Inventory of pollinizers

Orders	Families	Species	Status
Lepidoptera	Nymphalidae	*Hypolimna misippus*	Pollinizer
		Danaus chrysippus	Pollinizer
	Pieridae	*Eurema hecabe*	Pollinizer
	Papilionidae	*Graphium pylades*	Pollinizer
	Pieridae	*Catopsilia florella*	Pollinizer

Inventory of pollinators

Five (5) pollinating species have been identified, belonging to the order Lepidoptera. They are divided into 4 families (Table 3).

Distribution of species according to orders

Fig. 7 shows the distribution of species in the different orders encountered. Of the 47 species identified, Coleoptera and Hemiptera were the majority with

26% for each order. Then come the orders of Lepidoptera, Orthoptera, Hymenoptera, Diptera, Odonates, and Mantis with 22%, 9%, 7%, 6%, 4%, and 2% respectively.

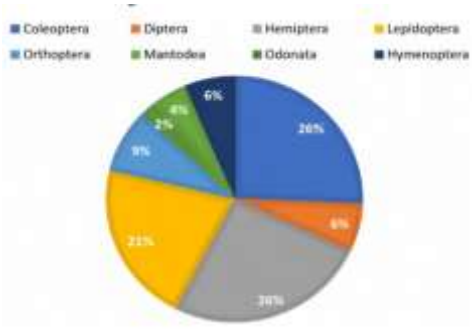

Fig. 7. Distribution of collected species in the different orders

Distribution of species in orders according to their status

Results obtained (Fig. 8) show an unequal distribution of species in the different orders. The orders Coleoptera, Dipteron and Hemipteron contain pests and auxiliaries. Apart from pests and auxiliaries, the Order Coleoptera contains fertilizers. These orders have no pollinators. The order of mantises, odonates and hymenopterans contains only auxiliaries. Lepidoptera's contains pests and all the pollinators encountered. The Order of orthopterans only contains pests.

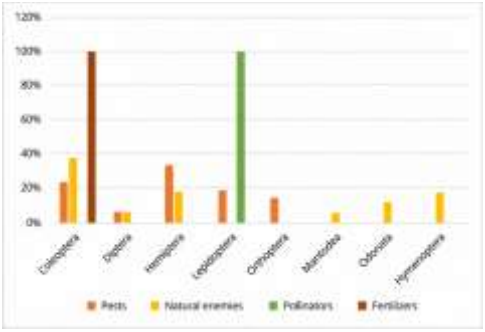

Fig. 8. Distribution of pests, auxiliaries, pollinators and fertilizers in each order

Distribution of species based on speculation

Okra is the most targeted speculation by insects (Fig. 9). It is visited by 50% of pests, 64% of auxiliaries and 80% of pollinators, i.e. 40.43% of all species collected. As for the entomofauna of cucumber, it is dominated by auxiliaries (36%) and pests (35%). Eggplant is home to 12% of pests and 20% of pollinators. The tomato was not well developed after transplanting (4% of pests).

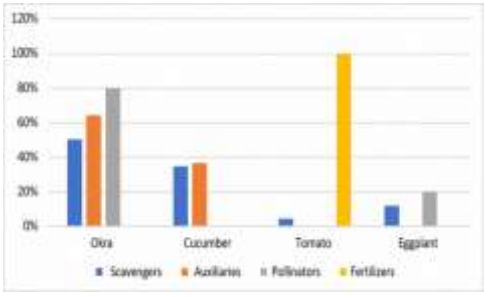

Fig. 9. Abundance of pests, auxiliaries, pollinators and fertilizers based on speculations

Establishment of a collection of insects encountered

A total of five collection boxes were made. Boxes A, B, and C contain beetles, lepidopterans, and hemipterans, respectively. Orthoptera, mantids and odonates are stored in box D. Hymenoptera and Diptera are stored in box E (Fig. 10).

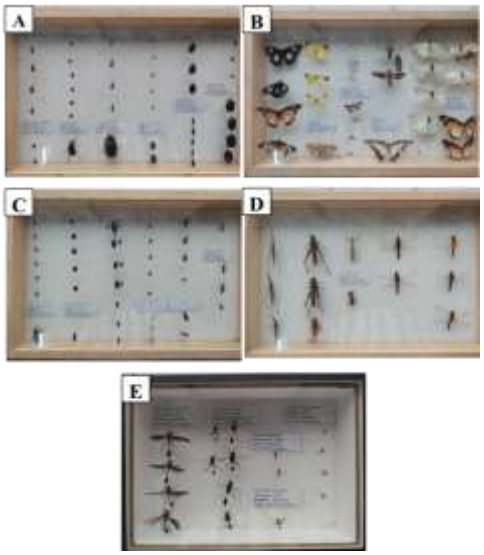

Fig. 10. Collection boxes

DISCUSSION

Results obtained during this study highlight a significant entomological diversity in the vegetable crops of the experimental station of the Plant Protection Head office (PPH) of Sicap Mbao. The inventory carried out made it possible to update

knowledge about the insects associated with the main market gardening activities in the Niayes area, to highlight new species, but also to identify new functional groups hitherto not reported in this area. These results demonstrate the richness of local entomofauna and highlight the value of regular monitoring of insect communities in order to improve knowledge about their diversity and their role in the functioning of market garden agroecosystems. The comparison of these results with previous work allows to assess the evolution of the entomofauna in the area and to better situate the contributions of this study.

Since Ndiaye work (2017), five new pest species have been found. These are *Anoplocnemis curvipes* (Coreidae), *Cletus* sp. (Coreidae), *Chrysocoris stolli* (Scutelleridae), *Diopsis macrophtalma* (Diopsidae) and *Spilostethus pandurus* (Lygaeidae). The appearance of these species reflects a change in the specific composition of pests in the DPV station. This evolution could be related to changes in cultural practices, variations in environmental conditions or even an improvement in prospecting and identification techniques implemented during this study.

Species *Reduvius personatus* (Reduviidae), *Isodontia mexicana* (Sphecidae) and *Sphex pensilvanicus* (Sphecidae) are reported for the first time in this area. This first mention constitutes an important contribution to the knowledge of the distribution of these species in the agroecosystems of the Niayes and enriches the available data on the entomofauna of this region.

In this area, no studies have been carried out on pollinating insects. Work on entomological fauna is generally based on pests and crop auxiliaries. This list of pollinators thus fills an important gap in the study of the entomofauna of market gardening crops and highlights the diversity of insects playing a vital role in pollination and maintaining agricultural production.

The PPH station is heavily populated by species belonging to the orders Coleoptera and Hemiptera. This predominance is consistent with previous observations reported by Ndiaye (2017) and Ondo *et al.* (2014), which also showed the abundance of these two orders in crops. Their high representativeness can be explained by their high specific diversity, their ability to adapt to cultivated environments and the permanent availability of food resources in market garden systems. These results are unusual compared to those obtained by Ndiaye (2017).

Two functional statuses are reported for the first time in this area: pollinators and fertilizers. Taking into account these two groups broadens knowledge on the functional biodiversity of insects associated with market gardening and shows that local entomofauna is not limited to the only pests and auxiliaries traditionally studied.

Pests of okra are mainly represented by Coleoptera and Heteroptera. These results are consistent with those of Ndiaye (2017), who also reported the abundance and high voracity of Coleoptera and Hemiptera on okra, making the production of this speculation low and unfit for consumption.

However, the presence of certain bugs belonging to the family Pentatomidae (*Aspavia armigera* and *Nezara viridula*) had not been reported by Ndiaye (2017), although his work was carried out at the same experimental station in the PPH. This difference may reflect recent changes in the insect population composition or result from variations in ecological conditions between study periods.

Cocumber is attacked by Lepidoptera of Pyralidae families (*Diaphania hyalinata* and *Hymenia recurvalis*) and Macroglossinae (*Hippotion celerio* and *Hyles livornica*). These insects have not been reported in the work of Ndiaye (2017). Their presence could result from the evolution of cropping systems, the availability of new host plants or even changes in climatic conditions favorable to their establishment.

Some species encountered are absent from the reference collection of the PPH laboratory. It is the case for the Hemiptera *Chrysocoris stolli* (Scutelleridae), *Anoplocnemis curvipes* (Coreidae) and *Dysdercus cingulatus* (Pyrrhocoridae), the coleoptera *Pheropsophus* sp. (Carabidae) as well as Hymenoptera

Sphex pensilvanicus and *Sceliphron spirifex* (Sphecidae). The integration of these species into the reference collection will enrich the entomological heritage of the PPH and provide useful reference material for future taxonomic studies, phytosanitary monitoring programmes and work on insect biodiversity in Senegal.

CONCLUSION

This study, which aimed to participate in the inventory and establishment of a collection of entomofauna from the Niayes area of Dakar, covered a sample of 47 species divided into 08 orders, namely those of Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Mantoda, Odonata and Orthoptera. Beetles, Hemipterans and Lepidoptera alone account for 73% of the species harvested. The species inventoried are classified as auxiliary, fertilizer, pollinator or pest.

Pests represent 26 species divided into 05 orders: Hemiptera (09 species), Coleoptera (06 species), Lepidoptera (05 species), Orthoptera (04 species) and Diptera (02 species); auxiliaries, 15 species divided into the orders of Coleoptera (05 species), Hemiptera and Hymenoptera (03 species each), Odonata (02 species) and Diptera and Mantoda (01 species each); pollinators, 05 species of the Order Lepidoptera and fertilizers, one species of the Order Coleoptera. It is a first step in setting up a database that would provide useful information before the choice of a pest control strategy. The inventory of natural enemies of insect pests in market gardening is still very partial and requires more surveys to better understand the species that can regulate pest populations, as well as their functioning in agrosystems.

RECOMMENDATION(S)

It is therefore important to widen the intervention area in order to have a better knowledge of all market gardening crops throughout the Niayes area.

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