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Diversity study of acridian fauna in Senegal

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Abstract

Acridians are among the most destructive insects to agriculture worldwide. In many tropical regions, only a few of the approximately 10,000 locust species represent a major threat to agriculture. In Senegal, crops and even trees are regularly attacked by crickets and grasshoppers. The exact number of locusts remains unclear but is generally estimated to be in the Sahel.

The aim of this study is to determine the locust fauna in Senegal focusing on six administrative regions covering a total area of 62,473 square kilometers. Over six years, from 2019 to 2024, we carried out net captures and light trapping during both the dry and rainy seasons. We carried out 1,800 captures per region, totaling 10,800 samples for the whole country. The captured individuals were identified using classification and identification keys.

The 270,000 individuals captured belong to 156 species, 14 subfamilies and 3 families. Some species are observed year-round, although females enter imaginal diapause, while others are found only during the rainy season and remain in embryonic diapause during the dry season. Our study showed that species previously described are no longer present in Senegal and have consequently decreased their range. To the best of our knowledge, this study is the first of its type in Senegal. Previous surveys of locust fauna have been conducted in the broader context of the Sahel, rather than specifically in Senegal.

Keywords: Diversity; Fauna; Locust; Grasshoppers; Senegal

1. Introduction

Locusts are a group of insects belonging to the order Orthoptera, known for their ability to form devastating swarms that cause considerable agricultural losses [1-2]. These insects are among the most destructive agricultural pests worldwide, damaging all forms of vegetation, such as trees and crops, particularly in regions where they originate or converge [3]. For millennia, humans have had to contend with devastating outbreaks of large migratory locusts, both gregarious and non-gregarious [4-6]. In many tropical regions, only a few of the approximately 10,000 locust species pose a significant threat to agriculture. As a result, more than half of the world's land surface may be subject to swarm attacks, and entire continents may be invaded. Around twenty-five of the estimated 6,700 Acrididae species (Order: Orthoptera) [7-8] are considered major locust pests to varying degrees [9-12]. When populations of these insects increase under favorable ecological conditions, they exhibit gregarious and migratory behavior, leading to the formation of spectacular swarms that can travel vast distances and devastate crops. However, these insects also serve as a food source for various human populations [13], and swarms likely play beneficial but largely unknown ecological roles [14].

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Most crop-destroying insects are species that live permanently in the affected areas and are more or less closely associated with cultivated plants [12; 15-16]. Locusts that cause significant crop damage and require control have highly complex population dynamics, living in vegetation similar to non-crop-damaging species. Some exhibit low migratory capacity during certain life stages, and their transition from solitary to gregarious phases is closely linked to fluctuations in their numbers [17]. The combination of these two phases, observed at high densities, leads to synchronized movements over vast distances, resistance to adverse environmental conditions, and an expansion of their diet [18].

Locust problems can be extremely destructive, with rapid outbreaks resulting from the migration of large concentrations of insects. The most spectacular invasions involve the desert locust *Schistocerca gregaria* (Forskal), with swarms sometimes containing up to 40 million adults per square kilometer, creating "clouds" that can cover more than 100 hectares. Losses can be measured in tens of thousands of tonnes per day, such as the 167,000 tonnes of cereals lost in Ethiopia during the 1958 invasion. Migratory locusts are particularly voracious, consuming the equivalent of their body weight daily, while sedentary species living on savannah grasses only consume about half that amount [19]. Although observed on a smaller scale in Brazil (with hundreds of "clouds" measuring 50 x 2 km and weighing 100 tonnes), these events are still a cause for concern.

The need to prevent this major risk has led to extensive research, with remarkable results. We now know how to prevent most locust invasions, as we have a partial understanding of their origins and patterns. However, in Africa, the situation remains partly uncertain, as the locust complex has not been fully identified, particularly in Senegal. In this context, our goal is to identify as many locust species as possible found in Senegal, with a particular focus on the eastern (Kaffrine, Fatick), central (Thies, Diourbel and Louga), and northern (Saint Louis) regions.

2. Materials and methods

2.1. Study environment

Our study was conducted in Senegal, focusing on the areas most affected by locust invasions. These areas cover six administrative regions, with a total surface area of 62,473 km^2, or 31.75% of the country's total land area (Fig. 1).

2.1.1. Kaffrine zone

In the Kaffrine region, studies are being conducted in the communes of Gniby (latitude 14°25' North, longitude 15°39' West), Boulel (latitude 14°17' North, longitude 15°32' West), and Nganda (latitude 13°83' North, longitude 15°42' West). These communes are located in the Kaffrine department, at distances of 43 km, 22 km, and 35 km, respectively, from Kaffrine, the regional capital. The climate is Sudano-Sahelian, characterized by high average temperatures from April to July, with minimums ranging from 15° to 18 °C and maximums from 35° to 40°C. The year is divided into two main seasons: a dry season from November to May and a rainy season from June to October. The region, between isohyets of 800 and 900 mm, receives moderate rainfall.

The soils are of dior type. The Sudano-Sahelian vegetation is composed of shrub and tree savannahs, pseudo-shrub steppes, and patches of open forest. Agriculture supports 75% of the regional population. The main food crops are millet, sorghum, and maize, while groundnuts and market garden crops are also cultivated in the region [20].

2.1.2. Fatick zone

Experiments in this region are conducted in Gossas commune. Gossas (latitude 14º30' North, longitude 16º05' West) experiences a tropical-Sudanese climate, with annual rainfall ranging from 300 to 900 mm. The average annual temperature is 28.9 °C, with minimum temperatures between 17°C and 20°C, and maximums between 33°C and 40°C. The vegetation is highly varied, and the soils are of the dior or ferruginous tropical types. The dominant plant formations in the area consist of shrubby to combretaceous savannah, with species such as *Faidherbia albida* (Kadd) and *Adansonia digitata* (Gouye). These formations are the most degraded in the region due to increasing demand for arable land, livestock, and human-induced destruction. As a result, there is a progressive ecosystem "sahelization."

The soils in this area are particularly suitable for cultivating millet (*Pennisetum glaucum*) and groundnuts (*Arachis hypogaea*), but due to their progressive depletion, they yield only modest harvests [20].

2.1.3. Thies zone

For the central zone, the study was conducted in the rural commune of Touba Toul (latitude 14°49' North, longitude 16°40' West), located in the Thieneba arrondissement of the Thies department and region.

Like the urban area, this rural zone experiences a Sahelian-type climate (dry and hot), influenced by the north and northeast maritime trade winds as well as the continental or harmattan winds. These winds bring the dry, hot easterly winds typical of the dry season from October to June, while the humid westerly winds are associated with the monsoon or wet season from July to October. Vegetation in the area is highly varied, with several species distributed across three strata: trees, shrubs, and herbaceous plants. Agriculture plays a vital role in the economic life of the rural commune, with 80% of the working population engaged in farming

In the Touba Toul area, soils are predominantly of dior type, with low clay content. These soils are ideal for growing crops such as peanuts, millet, cowpeas, and others. There are also deck soils, which are rich, moist, and fertile [20].

2.1.4. Diourbel zone

Situated between 14°30 and 15° north latitude and 15°40 and 16°40 west longitude, the Diourbel region is located in central Senegal, around 120 km east of Dakar. The climate is tropical and semi-arid, with a long dry season from November to May, and a wet, rainy season from approximately late June to early October. Rainfall totals 525 millimeters per year, making it an intermediate level. All year round, however, warm, dry winds can blow in from the interior. The average temperature of the coldest month (January) is 24.8 °C, that of the hottest month (June) is 30.3 °C.

Soils are essentially sandy or sandy-clay sediments of eolian and alluvial origin. Three (03) types of soil are generally found in the Diourbel region: tropical ferruginous soils with little or no leaching, hydromorphic brown soils or deck soils and tropical ferruginous red soils or lithosols. Most of the woody vegetation is parkland, with a strong presence of *Acacia albida* [20].

2.1.5. Louga zone

The Louga region is located between latitudes 14°70′ and 16°10′ North and longitudes 14°27′ and 16°50′ West. The region features a flat relief, with some dune formations, particularly in the east. Tropical ferruginous soils are washed out and degraded at the surface due to intense rainfall and cultivation without fallowing. Vegetation cover has become very sparse, and sand dunes are reformed by strong winds for much of the year.

It lies within the Sahelian zone, between isohyets of 300 and 500 mm, characterized by low and highly variable rainfall. Extensive farming in the region depends largely on rainfall. The Louga region is primarily an agro-pastoral zone, with the regional economy heavily reliant on agriculture and livestock farming, and to a lesser extent, on fishing, due to the scarcity of fish resources [20].

2.1.6. Saint Louis zone

Saint-Louis is located in the Sahelian zone, situated between 16°02′ North and 16°30′ West (Fig. 1). The region's climate is Sahelian, characterized by hot, dry continental trade winds, known as Harmattan, as well as maritime trade winds from the west. Average annual temperatures are relatively high, with the continental zone experiencing high temperatures nearly year-round, sometimes exceeding 40 °C in the Podor department. Rainfall has been low in recent years but can reach up to 346 mm per year. However, the moderating influence of the sea to the west benefits agricultural activities.

The sandy soil is often windswept, creating sandstorms that can last for several days. These storms typically occur during the Harmattan period (December to May), which originates in the Sahara Desert. During the rainy season, a light layer of grass covers the ground, and bushes regain their foliage [20].

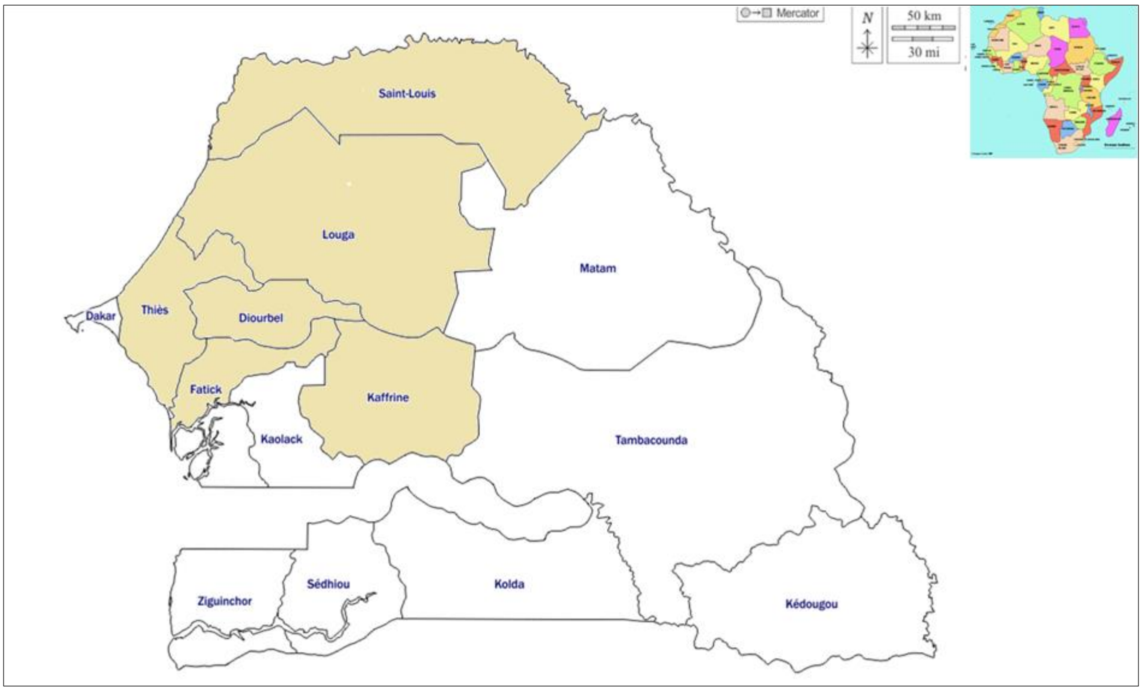

Figure 1 Regions of the study zone in Senegal

2.2. Experimental studies

The experiments will be conducted over six years, during the rainy seasons of 2019, 2021, and 2023, and the dry seasons of 2020, 2022, and 2024. The methodology will primarily rely on net sampling and light trap captures.

2.2.1. Net sampling

During the rainy season, three capture missions were carried out, each lasting 10 days, at intervals of 15, 45, and 70 days after the first rain. These correspond to the beginning, middle, and end of the rainy season. Each day, five prospectors conducted captures at 7:00 a.m. and 5:30 p.m., with each session lasting 1 hour and 30 minutes. The captures were made in both cultivated and fallow fields using a swath net. The net consists of a one-meter-long metal handle, with a 0.4-meter-diameter circular frame at one end. A cloth bag, 0.6 meters deep, is attached to this metal frame.

Repeated sampling over time ensures that all locusts present in the study area are captured. If a locust is in the hypogeous (egg) stage during one mission, it will be captured in the epigeous (larva or adult) stage in subsequent missions.

During the dry season, the same capture experiments are carried out at the beginning, middle, and end of the season.

For each mission, one hundred captures are made, with an average of 150 locusts obtained per capture. Over the six years of the study (2019-2024), 18 missions were carried out in each region, resulting in 1,800 captures and over 270,000 locust individuals.

Each population sample from every capture is thoroughly analyzed. The individuals are meticulously examined using identification keys and classified by species.

2.2.2. Light trap captures

Daytime net sampling was combined with nighttime light sampling. Light traps were set up in the survey areas, consisting of a metal circle supported by four 2-meter-high legs. A tube connected to the circle holds a 120 W white-light lamp above a tub containing soapy water. At the bottom, another vat with the same liquid is placed on the ground.

The light traps are placed on the ground in the evening, after the last net capture. Early the next morning, at 6:30 a.m., the traps are removed, and the samples are collected (Fig. 2).

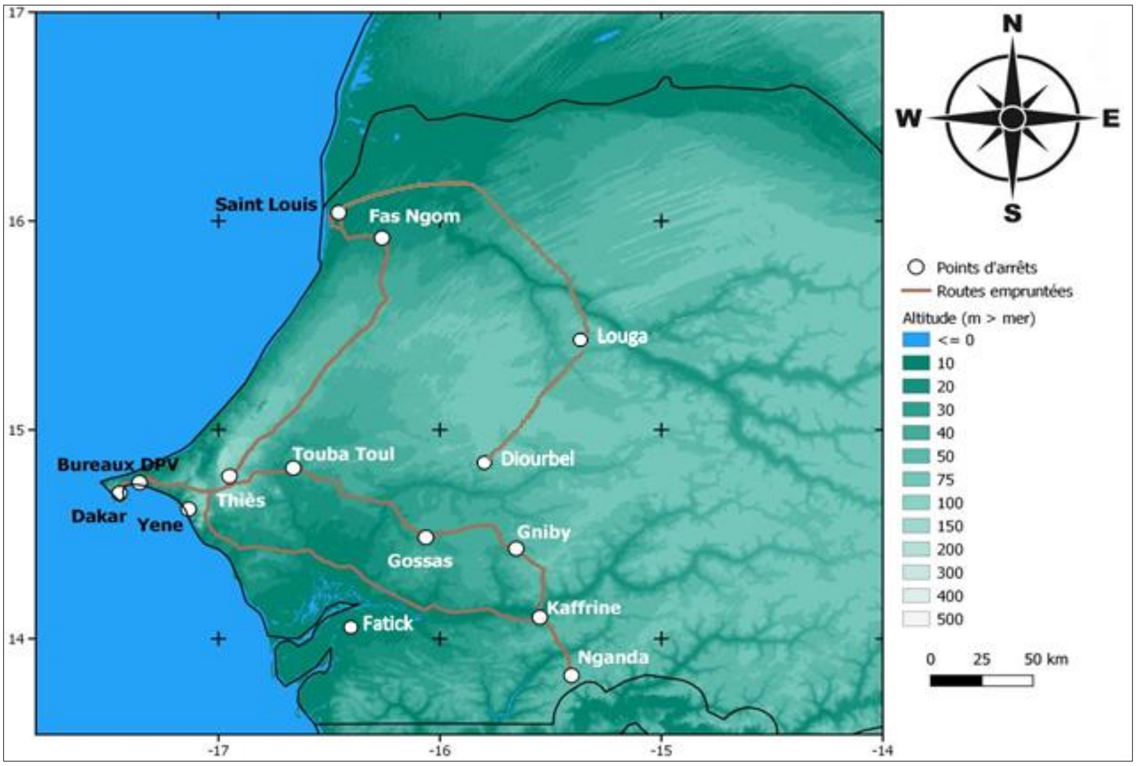

Figure 2 Map of light trap installation zones

2.2.3. Identification of captured species

Captured insects are brought back to our base for identification. All identified individuals are discarded, and the corresponding information is recorded. Those that are unknown are photographed, preserved in alcohol, and transported to the laboratory for precise identification using keys and reference books [21, 22, 23]. The number of individuals captured during the study period is sufficiently large to properly characterize and identify the locust fauna of Senegal.

Some unidentified individuals are currently being studied using molecular biology techniques.

The classification system used is based on that of de Dirsh [24] and Uvarov [25], with modifications.

3. Results

The methods employed and the number of repetitions in the study of Senegal's locust fauna have enabled us to determine all the species present. We have accurately identified 156 species, belonging to three families: Euschmidtiidae (1 species), Pyrgomorphidae (15 species), and Acrididae (140 species).

The species from the Euschmidtiidae family belong to the Pseudoschmidtiinae subfamily. In the Pyrgomorphidae family, all 15 identified species belong to the Pyrgomorphinae subfamily. The 140 species in the Acrididae family are distributed across 12 subfamilies: Hemiacridinae (7 species), Spathosterninae (2 species), Tropidopolinae (7 species), Oxyinae (2 species), Coptacrinae (4 species), Calopteninae (7 species), Eyprepocnemidinae (13 species), Catantopinae (17 species), Cyrtacanthacridinae (12 species), Acridinae (30 species), Oedipodinae (28 species), and Gomphocerinae (11 species) (Table 1).

For some species, epigeal stages are observed only during the rainy season, while for others, they are present throughout the year. However, larvae are only found during the rainy season. During the dry season, adults with blocked reproductive functions are captured.

Nine (9) individuals are still unidentified and are undergoing molecular analysis. They will be sent to the reference center for identification. If these individuals do not belong to any previously identified species, they will constitute a new species and will be named following the scientific process.

Table 1 Species found in Senegal

Family Euschmidtiidae	
Species	**Sub Family**
1- *Eudirshia koba* (Roy, 1962)	Pseudoschmidtiinae
Family Pyrgomorphidae	
Species	Sub Family
2- *Atractomorpha acutipennis gerstaeckeri* (I. Bolívar, 1884)	Pyrgomorphinae
3- *Chrotogonus homalodemus homalodemus* (Blanchard, 1836)	
4- *Chrotogonus senegalensis* (Krauss, 1877)	
5- *Phymateus cinctus* (Fabricius, 1793)	
6- *Poekilocerus bufonius hieroglyphicus* (Klug, 1832)	
7- *Pyrgomorpha bispinosa incognita* (Walker, 1870)	
8- Pyrgomorpha cognata cognata (Krauss, 1877)	
9- *Pyrgomorpha cognata maculifemur* (Kevan, 1968)	
10- *Pyrgomorpha conica* (Olivier, 1791)	
11- *Pyrgomorpha vignaudii* (Guérin-Méneville, 1849)	
12- *Rutidoderes squarrosus* (Linné, 1771)	
13- *Tanita parva violacea* (Kevan, 1962)	
14- *Taphronota calliparea dimidiata* (I. Bolívar, 1904)	
15- *Tenuitarsus sudanicus* (Kevan, 1953)	
16- *Zonocerus variegatus* (Linné, 1758)	
Family Acrididae	
Species	Sub Family
17- *Acanthoxia gladiator* (Westwood, 1841)	Hemiacridinae
18- *Hemiacris uvarovi* (Ramme, 1929)	
19- *Hieroglyphodes occidentalis* (Roy, 1962)	
20- *Hieroglyphus africanus* (Uvarov, 1922)	
21- *Hieroglyphus daganensis* (Krauss, 1877)	
22- *Leptacris kraussii* (I. Bolívar, 1890)	
23- *Sudanacris pallida* (Burmeister, 1838)	
24- *Spathosternum nigrotaeniatum* (Stål, 1876)	Spathosterninae
25- *Spathosternum pygmaeum* (Karsch, 1893)	
26- *Chloroxyrrhepes virescens* (Stål, 1873)	Tropidopolinae
27- Homoxyrrhepes punctipennis (Walker, 1870)	
28- *Petamella prosternalis* (Karny, 1907)	
29- *Tristria conops* (Karsch, 1896)	
30- *Tristria marginicosta* (Karsch, 1896)	

31- *Tristria pallida* (Karny, 1907)	
32- *Tropidopola nigerica* (Uvarov, 1937)	
33- *Oxya cyanoptera* (Stål, 1873)	Oxyinae
34- *Oxya hyla hyla* (Audinet-Serville, 1831)	
35- *Epistaurus bolivari* (Karny, 1907)	Coptacrinae
36- *Epistaurus succineus* (Krauss, 1877)	
37- *Eucoptacra anguliflava* (Karsch, 1893)	
38- *Eucoptacra spathulacauda* (Jago, 1966)	
39- *Acorypha clara* (Walker,1870)	Calopteninae
40- *Acorypha dipelecia* (Jago, 1966)	
41- *Acorypha glaucopsis* (Walker, 1870)	
42- *Acorypha picta* (Krauss, 1877)	
43- *Acorypha unicarinata* (Krauss, 1877)	
44- *Stobbea riggenbachi* (Ramme, 1929)	
45- *Stobbea togoensis* (Ramme, 1929)	
46- *Cataloipus cymbiferus* (Krauss, 1877)	Eyprepocnemidinae
47- *Cataloipus fuscocoeruleipes* (Sjöstedt, 1923)	
48- *Eyprepocnemis plorans ornatipes* (Walker, 1870)	
49- *Eyprepocnemis plorans ssp.*	
50- *Heteracris adspersa* (Redtenbacher, 1889)	
51- *Heteracris annulosa* (Walker, 1870)	
52- *Heteracris coerulescens* (Stål, 1876)	
53- *Heteracris guineensis* (Krauss, 1890)	
54- *Heteracris harterti* (I. Bolívar, 1913)	
55- *Heteracris leani* (Uvarov, 1941)	
56- *Heteracris littoralis* (Rambur, 1838)	
57- *Jagoa gwynni* (Uvarov, 1941)	
58- *Metaxymecus gracilipes* (Brancsik, 1895)	
59- *Catantops stramineus* (Walker, 1870)	Catantopinae
60- *Catantopsilus elongatus* (Ramme, 1929)	
61- *Catantopsilus taeniolatus* (Karsch, 1893)	
62- *Catantopsis asthmaticus* (Karsch, 1893)	
63- *Catantopsis basalis* (Walker, 1870)	
64- *Criotocatantops pulchripes* (Karny, 1915)	
65- *Cryptocatantops haemorrhoidalis* (Krauss, 1877)	
66- *Diabolocatantops axillaris axillaris* (Thunberg, 1815)	
67- *Exopropacris mellita* (Karsch, 1893)	
68- *Exopropacris modica* (Karsch, 1893)	

69- *Hadrolecocatantops royi* (Jago, 1994)	
70- *Harpezocatantops stylifer* (Krauss, 1877)	
71- *Oxycatantops exsul exsul* (Karny, 1907)	
72- *Oxycatantops spissus spissus* (Walker, 1870)	
73- *Parapropacris notata* (Karsch, 1891)	
74- *Stenocrobylus cinnabarinus* (Ramme, 1929)	
75- *Trichocatantops villosus* (Karsch, 1893)	
76- *Acanthacris ruficornis citrina* (Audinet-Serville, 1838)	Cyrtacanthacridinae
77- *Acridoderes strenuus* (Walker, 1870)	
78- *Anacridium melanorhodon melanorhodon* (Walker, 1870)	
79- *Anacridium wernerellum* (Karny, 1907)	
80- *Cyrtacanthacris aeruginosa flavescens* (Walker, 1870)	
81- *Cyrtacanthacris aeruginosa goldingi* (Uvarov, 1941)	
82- *Cyrtacanthacris aeruginosa ssp.* (Stoll, 1813)	
83- *Kraussaria angulifera* (Krauss, 1877)	
84- *Ornithacris cavroisi* (Finot, 1907)	
85- *Orthacanthacris humilicrus* (Karsch, 1896)	
86- *Ritchiella baumanni* (Karsch, 1896)	
87- *Leptoscirtus unguiculatus* (Saussure, 1888)	
88- *Acrida bicolor* (Thunberg, 1815)	Acridinae
89- *Acrida sulphuripennis* (Gerstäcker, 1869)	
90- *Acrida turrita* (Linné, 1758)	
91- *Acridarachnea ophthalmica* (I. Bolívar, 1908)	
92- *Cannula gracilis* (Burmeister, 1838)	
93- *Chirista compta* (Walker, 1870)	
94- *Coryphosima stenoptera* (Schaum, 1853)	
95- *Duronia chloronota* (Stål, 1876)	
96- *Gelastorhinus africanus* (Uvarov, 1941)	
97- *Glyphoclonus miripennis* (Karsch, 1896)	
98- *Gonista occidentalis* (Descamps, 1965)	
99- *Gymnobothrus longicornis* (Ramme, 1931)	
100- *Gymnobothrus temporalis* (Stål, 1876)	
101- *Machaeridia bilineata* (Stål, 1873)	
102- *Ocnocerus diabolicus* (Karsch, 1893)	
103- *Odontomelus scalatus scalatus* (Karsch, 1896)	
104- *Orthochtha ampla* (Sjöstedt, 1931)	
105- Orthochtha brachycnemis brachycnemis (Karsch, 1893)	
106- *Orthochtha dasycnemis bisulcata*	

107- *Orthochtha sudanica* (Popov & Fishpool, 1988)	
108- *Orthochtha venosa* (Ramme, 1929)	
109- *Parga cyanoptera* (Uvarov, 1926)	
110- *Rhabdoplea munda* (Karsch, 1893)	
111- *Sherifuria haningtoni* (Uvarov, 1926)	
112- *Truxalis johnstoni* (Dirsh, 1951)	
113- *Truxalis nasuta* (Linné, 1758)	
114- *Truxalis procera* (Klug, 1830)	
115- *Truxaloides braziliensis braziliensis* (Drury, 1773)	
116- *Truxaloides braziliensis ssp*. (Drury, 1773)	
117- *Zacompsa festa* (Karsch, 1893)	
118- *Acrotylus blondeli* (Saussure, 1884)	Oedipodinae
119- *Acrotylus daveyi* (Mason, 1959)	
120- *Acrotylus insubricus* (Scopoli, 1786)	
121- *Acrotylus longipes* (Charpentier, 1843)	
122- *Acrotylus patruelis* (Herrich-Schäffer, 1838)	
123- *Aiolopus simulatrix simulatrix* (Walker, 1870)	
124- *Aiolopus thalassinus thalassinus* (Fabricius, 1781)	
125- *Calephorus compressicornis* (Latreille, 1804)	
126- *Conipoda pallida* (Walker, 1870)	
127- *Eurysternacris brevipes* (Chopard, 1947)	
128- *Gastrimargus determinatus procerus* (Gerstäcker, 1889)	
129- *Heteropternis couloniana* (Saussure, 1884)	
130- *Heteropternis descampsi* (Roy, 1969)	
131- *Heteropternis thoracica* (Walker, 1870)	
132- *Hilethera nigerica* (Uvarov, 1926)	
133- *Humbe tenuicornis* (Schaum, 1853)	
134- *Locusta migratoria migratorioides* (Reiche & Fairmaire, 1850)	
135- *Morphacris fasciata* (Thunberg, 1815)	
136- *Oedaleus nigeriensis* (Uvarov, 1926)	
137- *Oedaleus senegalensis* (Krauss, 1877)	
138- *Paracinema tricolor* (Thunberg, 1815)	
139- *Pycnodictya diluta* (Ramme, 1929)	
140- *Sphingonotus canariensis canariensis* (Saussure, 1884)	
141- *Sphingonotus rubescens rubescens* (Walker, 1870)	
142- *Sphingonotus rubescens ssp.* (Walker, 1870)	
143- *Sphingonotus savignyi savignyi* (Saussure, 1884)	
144- *Trilophidia conturbata* (Walker, 1870)	

145- *Trilophidia repleta* (Walker, 1870)	
146- *Aulacobothrus invenustus* (Karsch, 1893)	Gomphocerinae
147- *Azarea lloydi* (Uvarov, 1926)	
148- *Azarea verticula* (Jago, 1966)	
149- *Berengueria bifoveolata* (Karsch, 1893)	
150- *Berengueria cryptica* (Jago, 1996)	
151- *Brachycrotaphus steindachneri* (Krauss, 1877)	
152- *Crucinotacris werneriana* (Karny, 1907)	
153- *Dnopherula phippsi* (Llorente, 1963)	
154- *Dnopherula punctata* (Uvarov, 1926)	
155- *Eleutherotheca concolor* (Karny, 1907)	
156- *Kraussella amabile* (Krauss, 1877)	

4. Discussion

This study, the first of its kind in Senegal since the 1970s, has provided an opportunity to reassess the locust fauna. Locust inventories had not been conducted for over half a century, making this work a significant contribution to understanding the species present in Senegal. The study accurately identified 156 species, all of which were encountered at least once during the six-year period.

Some species are only caught during the rainy season, passing through the egg stage during the dry season. During this period, they pause their development for varying lengths of time to ensure survival. For instance, species like the Senegalese grasshopper *Oedaleus senegalensis*, as described by Launois [26] and Touré [27], undergo embryonic diapause (a pause in development), while others, like *Tristria pallida*, enter imaginal diapause, where the adults are unable to reproduce for a certain period, typically during the off-season. Species that reproduce continuously are found in epigeal stages year-round. Lecoq [28] identified one-generation and two-generation species within this category. Regardless of the number of generations, breeding must occur during the appropriate season, typically at the end of the rainy season. It is the adults that survive through the dry season. Females of species with obligatory embryonic diapause lay their eggs at the end of the rainy season, allowing them to remain in the hypogeous stage during the harsh dry season. Some species may also undergo optional diapause, which can occur at any time during their life cycle.

Regarding locust faunal diversity, the 156 species recorded in our study surpasses the number reported by Lecoq [23], but is slightly lower than the 168 species identified by Mestre and Chiffaud [29] in 15 subfamilies. Mestre and Chiffaud found one species in the Egnatiinae subfamily, which we did not encounter. The absence of certain species may be related to climatic changes. Rainfall patterns have shifted, becoming more abundant but shorter in duration. The dry season now starts later and ends later, lasting approximately 2 to 2.5 months, compared to the previous duration of 3 months or more. These changes in rainfall, which are linked to insect biology directly through egg hatching and indirectly through vegetation availability as a food source can cause locusts to migrate to ecological zones that are more compatible with their life cycle.

The population dynamics of some locust species are not always predictable based on climate alone [30], as biotic factors such as natural enemies may play a significant role [31]. Understanding the impacts of climate change on locust fauna is complex, as it involves both direct and indirect interactions affecting locust populations [32-34]. Zhang et al. [35] emphasize the importance of understanding these dynamics for locust and grasshopper control. Our study indicates that species described in the past are no longer present in Senegal and have decreased in range, in contrast to the findings of Cullen et al. [36], who showed that several locust species are extending their range and increasing the number of annual generations, possibly due to climate change. Climate remains a determining factor in the population dynamics of many locust species [37], and while the observed changes are affecting locusts, there is still no consensus on how they influence outbreaks [38-41]. Some locust species adapt to these changes without significant effects, while others experience shifts in their life cycle and range. The earliest season species may be able to take advantage of warmer conditions accelerating growth during early spring development, whereas warm temperatures may adversely impact later season species via mechanisms such as increased rates of energy use or thermal stress [42]. It's important to recognize that environmental exposure and sensitivity can differ significantly depending on factors such as altitude and the specific characteristics of the organisms involved.

5. Conclusion

The diversity of locusts in Senegal can now be considered well-established. The methodology employed and the number of replicates has provided clear and reliable data. The locust fauna consists of 156 species, distributed across three families and 15 subfamilies. This number is higher than some previous reports but lower than others, and these differences may be attributed to evolutionary factors or shifts in distribution areas due to climate change. To the best of our knowledge, this study is the first of its kind in Senegal. Previous surveys on locust fauna have been conducted in the broader Sahel region, rather than specifically in Senegal. Our analysis further reinforces the need to move beyond expectations of universal responses to climate change to consider how environmental exposure and sensitivity vary across elevations and life histories.

Compliance with ethical standards

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No conflict of interest to be disclosed.

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