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Entomofauna Associated Tree Plantations in Gezira State, Sudan

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Abstract: Sudan has a diverse ecological zones, ranging from deserts and semi-deserts to low- and high-rainfall savannas, special forest types, montane forests, and coastal regions. Each of these zones supports a unique variety of fauna and flora, contributing to a broad spectrum of biodiversity. Plant-animal relationships play a critical role in preserving this biodiversity by forming intricate, interdependent networks essential for sustaining ecosystems. Plants provide food and habitats for animals, while animals help plants through pollination and seed dispersal. This mutual dependence ensures the balance of ecosystems, where the loss of one species can have significant repercussions on others. These interactions, including food webs and pollination processes, influence species evolution and are vital to maintaining ecological stability. Similarly, plant-insect relationships are fundamental to biodiversity as they drive processes like co-evolution, support interconnected food webs, and enable pollination. Greater plant diversity often promotes higher insect diversity and enhances pollination services. Several studies have assessed how various trees utilized in those systems influence the dynamics and population of insects. This study aimed to investigate the diversity of insects linked to tree plantations within the semi-arid ecosystem of Gezira State. The key objectives were to monitor ecological restoration efforts and emphasize the role of insects in maintaining ecosystem functionality. Additionally, it sought to explore the relationship between the diversity of plant and insect species and assess the different combinations of tree species within a semi-arid ecosystem across three This study aimed to assess the entomofauna assemblages associated with different combinations of tree species within a semi-arid ecosystem in Gezira state. Tree species surveyed were *Capparis decidua*, *Maerua crassifolia*, *Balanites aegyptiaca*, *Acacia seyal* and *Acacia mellifera*. Insect sampling was carried out using the beating sheet method, and the collected specimens were sorted into the lowest feasible taxonomic groups for subsequent analysis. The results obtained indicated collection of 351 insect specimens from *C. decidua,* fall in 8 orders (Orthoptera, *Coleoptera,* Odonata, *Hymenoptera,* Lepidoptera, Hemiptera, Diptera, and Isoptera),14 families, and 16 species. *M.crassifoila* hosted 849 insects assemblages identified into 7 orders (*Diptera, Orthoptera, Hymenoptera, Lepidoptera, Isoptera, Hemiptera and Neuroptera*), 9 families, and 9 species. *B. aegyptiaca* has 724 insects specimens classified into 6 orders(*Hymenoptera,* Hemiptera, *Diptera,* Neuroptera, Lepidoptera and Odonata), 9 families,11 species. *A. mellifera* populated with 102 insects representing 3 orders (Lepidoptera, Diptera and Hymenoptera), 3 families and 3 species whereas, 579 insects including 7 orders(Diptera, *Hymenoptera,* Lepidoptera, Coleoptera, Orthoptera, Odonata and Neuroptera),12 families and 12 species were obtained from *A. seyal*. The overall insects collected from the five surveyed trees amounted to 2605 , where 32.59 % confined to *M. crassifoila,27.79% from B. aegyptiaca,22.23% from A. seyal 13.47% from C. decidua and 3.92 % from A. mellifera.* Pearson's Chi-square test strong significant association between the tree species and the collected insect species (p <0.001). Simpson's Diversity Index values are 0.63 for *Capparis decidua*, 0.656 for *Maerua crassifolia*, 0.6101 for *Balanites aegyptiaca*, 0.47 for *Acacia seyal*, and 0.039 for *Acacia mellifera*. These values showed that *M. crassifolia*, *C. decidua*, and *B. aegyptiaca* host a more diverse insect community than the two *Acacia* species, with *A. mellifera* having the least diverse assemblage among the tested species. These findings could be ascribed to habitat heterogeneity which favored specific insect proliferation and to insect -tree specific relationship. Further studies are needed to clarify more ecological insect - plant interrelationships.

Keywords: *Sudan, Gezira state, biodiversity, ecological zones, Plant-insect relationships, Entomofauna.*

INTRODUCTION

Biodiversity is shaped by a mix of biogeography, regional, and local factors, each working at different levels of space. Biogeography factors, which take place over very long periods, affect how species spread and go extinct, how new species form, and how species are spread across different climates, such as changes in latitude and height (Roger et al. 2021). The variety of land species is also influenced by the variety of environmental conditions, including soil type, land shape, and how local communities are connected through movement (Deák et al. 2021). The way species live together and the types of species present are also affected by different kinds of interactions, like competition, cooperation, and conflict. Insects connected to trees may compete with each other either directly for food or indirectly through the ways trees defend themselves,(Fahey et al 2025). Insects have a big role in many parts of terrestrial ecosystems, such as helping with biological control and pollination, but they can also cause problems like physical and health damage to plants through eating. This study looked at the variety of insects connected to tree plantations in the semi-arid area of Gezira State. The main goals were to check on ecological restoration and highlight the role of insects in keeping the ecosystem healthy. It also looked at the connection between plant and insect diversity and tested different groups of tree species in a semi-arid ecosystem in Gezira State. This study aimed to examine the insect communities linked to various combinations of tree species in a semi-arid ecosystem across Gezira State.

MATERIALS AND METHODS

Study Area

Gezira State, located at 14° 30' 0" N, 33° 30' 0" E, was chosen for the research because it is one of Sudan's semi-arid states. It is situated between the Blue Nile and the White Nile rivers in the east-central part of the country, Sudan. The environment of Gezira State is shaped by the Gezira Scheme, which transforms dry land into areas that support farming and feature a diverse range of plant life, including Acacia woodland and grasslands. The soil is mostly dark and becomes very sticky when wet. The main plant types found there include thickets of *Acacia mellifera*, woodlands of *Acacia seyal* and *Balanites aegyptiaca*, broad-leaved deciduous woodlands, open areas dominated by annual grasses, and grasslands composed of *Brachiaria obtusiflora*. Human actions, especially farming and animal herding, have a significant ecological effect on this area. These activities cause problems like cutting down trees for firewood, changes in the types of weeds that grow, and ecological issues intensified by climate change impacts, such as heavy flooding and drought cycles that get worse because of armed conflict, as noted by Zubair et al. (2020).

Tree Selection for Insect Sampling

Maerua crassifolia, a plant in the Capparaceae family, is native to Africa and tropical Arabia. Its foliage is used as a crucial dry-season fodder for animals like camels and is a common food source in parts of central Africa. It is found across the Sahara from the Atlantic coast to the Arabian Peninsula and Yemen. Its range also extends into countries like Kenya, Sudan, and Pakistan. The plant is also used in traditional medicine and for other purposes, such as making toothbrushes from its shoots and root systems. It can grow in a variety of soil types, including sand, and can survive with low annual rainfall (Oldfield,2020).

Balanites aegyptiaca, also known as the desert date, is a spiny tree native to Africa and the Middle East with numerous uses, including as a food source, for traditional medicine, and for materials. Its fruits are edible, leaves and young shoots are used as animal fodder, and the tree is used for creating live fences, making it a valuable, multipurpose species for local communities. It is a spiny shrub or tree that can grow up to 10 meters tall. It is a semi-evergreen or sometimes deciduous tree with a rounded crown and deeply fissured bark. The leaves are compound, with two leaflets, and the plant has long, stout, and sharp spines. It is widely distributed across dry land areas of Africa, the Arabian Peninsula, and parts of India. It can tolerate various soil types and climatic conditions (Chothani and Vaghasiya,2011; and Hamada et al, 2021).

Acacia seyal **or** ***Vachellia seyal***, the red acacia, is a thorny, 6– to 10-m-high (20 to 30 ft) tree with a pale greenish or reddish bark. At the base of the 3–10 cm (1.2–3.9 in) feathery leaves, two straight, light grey thorns grow to 7–20 cm (2.8–7.9 in) long. The blossoms are displayed in round, bright yellow clusters about 1.5 cm (0.59 in) in diameter. It is more common on heavy clay soils, and some of the thorns are swollen as domatia, housing mutuality ants such as Crematogaster sp. In Africa, it is native to many countries, from Morocco in the north to Mozambique in the south. In the Sahara, it often grows in damp valleys. It is also found in valleys on the Arabian Peninsula (CABI 2024).

Acacia mellifera is a drought-tolerant tree with a spherical crown, black bark, and sharp spines. It thrives in rocky hillsides and forms impenetrable thickets if unchecked. Gum is edible; camels and goats browse its protein-rich leaves. The flowers yield honey, while the wood serves multiple uses, including medicine for various ailments. It is native range Angola, Botswana, Chad, Eritrea, Ethiopia, Kenya, Namibia, Oman, Saudi Arabia, Somalia, Sudan, Tanzania, Uganda, Yemen, the Republic of Zambia, and Zimbabwe. It is a commonly occurring shrub on rangelands throughout the savannah in western, eastern, and southern Africa. Gum collected from injured stems is edible and relished by man and animals. Flowers produce excellent quality honey for bees to forage. The wood is used for fuel and charcoal. and Timber: for building huts, and the branches for fencing. The bark decoction is used for stomachache, sterility, pneumonia, malaria, and syphilis. In Botswana, a decoction of the roots is a medicine for stomach pain (Orwa et al 2009).

Methods

Insect Collection and Preservation

A random survey was conducted to collect insects from five tree species in Gezira State using the beating sheet method. Montgomery et al (2021) explained that a beating sheet, also called a beat sheet, is used to collect insects from trees in the three study areas. It is a simple fabric sheet attached to a frame that helps gather insects from tree branches and other surfaces by shaking or hitting them. The usual design has an 'X' shaped frame covered with white fabric, which makes it easier to see the insects. The sheet is about 90 cm square, with crossbars that are 1.3 meters long. A striking tool, which is around 2.5 cm in diameter and 60 cm long, is used to hit the branches. Once collected, the insects are either stored in ethanol or pinned in an insect box for later identification.

RESULTS AND DISCUSSION

Insects Associated with *Capparis decidua*

In total, 351 insect specimens were gathered and classified into 8 orders, 14 families, and 16 species linked to C. decidua. Odonata made up 54.13 % of the total catch, while Diptera accounted for 32.19 %. The lowest insect dominance observed is Hymenoptera and Isoptera, 0.85 % each, and Hemiptera, 0.29 (Table 1).

Table (1): Insect Community Dynamics on Capparis decidua

Order	Family	Scientific name	Frequency	%dominance/order
Orthoptera	Acrididae	*Achurum* Sp.	2	5.70
	Pyrgomorphidae	*Adesmia antiqua*	18	
Coleoptera	Tenebrionidae	Anax sp.	5	4.84
	Scarabaeidae	*Aphodius sp*	4	
	Buprestidae	*Apis millefera*	3	
		Belenois aurota	5	
Odonata	Aeshnidae,	*Camponotus sp*	184	54.13
	Libellulidae	*Chrotogenus* spp.	6	
Hymenoptera	Apidae	*Diplacodes luminans*	2	0.85
	Formicidae	*Dysdercus fasciatus*	1	
Lepidoptera	Pieridae	*Eristalinus* sp	4	1.15
Hemiptera	Pyrrhocoridae	*Lampetis catenulata*	1	0.29
Diptera	Syrphidae	*Microtermes* sp.	*100*	32.19
	Muscidae	*Musca domestica*	4	
		Steraspis squamosa	9	
Isoptera	Termitidae	Stomoxys sp.	3	0.85

8	**14**	16	351	100

C. decidua seems to favor insects proliferation by providing them with food and shelter. Saeed Ahmad et al. (2016) noted that the flowers of C. decidua are mainly pollinated by insects, as they are very appealing to insects that look for nectar and pollen. The plant has a low fruit production rate because it has strong self-incompatibility, so it depends a lot on insects for pollination to produce fruits successfully. Sharma and Imran (2022) noted that Odonata was the predominant insect order linked with *C. decidua*. They explained their outcome by the interdependent connection between the insect and the tree. The gathered insects exhibited different functional categories, such as *Apis mellifera* as a pollinator, *Adesmia antiqua* as a decomposer, and *Anax* sp. as a predator. Table 1 also showed that species of insects identified include *Musca domestica*, *Chrotogenus* spp., *Camponotus* sp., and *Microtermes* sp. Saeed Ahmad et al. (2016) noted that the flowers of *C. decidua* are mainly pollinated by insects, as they are very appealing to insects that look for nectar and pollen. The plant has a low fruit production rate because it has strong self-incompatibility, so it depends a lot on insects for pollination to produce fruits successfully.

Insects on *Maerua crassifoila:*

A total of 849 insect samples were gathered and categorized into 7 orders, 9 families, and 9 species associated with *M. crassifoila*. The greatest dominance was observed in Hymenoptera at 51.12, followed by Orthoptera 24.03 %. The lowest dominance was seen in Hemiptera and Neuroptera each of 0.12 (Table 2). Hamidou et al (2022) reported that *M. crassifolia* as a perennial fodder tree whose leaves, flowers, and particularly its fruits serve to attract insects for feeding. They indicated that insect fauna linked to it were identified into four orders: Lepidoptera, Coleoptera, Orthoptera, Isoptera, 22 families, and 24 species.

Table 2:Abundance of insects associated with *Maerua crassifoila*

Order	Family	Scientific name	Frequency	Abundance/order
Diptera	*Muscidae*	*Musca domestica*	7	0.84
Orthoptera	Pyrgomorphidae	*Chrotogenus spp*	4	24.03
	Acrididae,	*Schistocerca gregaria*	100	
	Pyrgomorphidae	*Poekilocerus bufonius*	100	
Hymenoptera	*Formacidae*	*Camponotus sp*	434	51.12
Lepidoptera	Pieridae	*Belenois sp*	2	0.23
Isoptera	Termitidae	*Microtermes* sp.	200	23.54
Hemiptera	Coreidae	*Acanthocephala curvipes* (Fabricius)	1	0.12
Neuroptera	Myrmeleontidae	*Palpares* sp	1	0.12
7	**9**	***9***	**849**	

Table (2) also, indicated that key insect species associated with *M. crassifoila* such as defoliator *Schistocerca gregaria and Belenois sp* the predators *Palpares* sp. and the plant pest *Acanthocephala curvipes*. The defoliators species specifically *Belenois sp* which are identified as the main defoliating pests of *M. crassifolia* leaves in some regions like Niger as given by Hamidou et al (2022). The predator species are thought to be found around the tree to find prey host. Chrotogenus spp.; *Camponotus* sp. *Belenois* sp. *Microtermes* sp., *Schistocerca gregaria* and *Poekilocerus bufonius* are examples of insect species reported on *M. crassifolia* which is an important desert plant that creates small habitats that change local wind flow, temperature, and moisture, which helps certain insects species to thrive more than others. It is a long-lived tree that provides food and shelter for insects through its fruits, flowers, and especially its leaves. Similar observation were reported by Amadou et al. (2023). and Weschler and Tronstad (2024)

Insects Gathered from *Balanites aegyptiaca*

A total of 724 insects assemblages were collected in relation to *B. aegyptiaca* and identified into 6 orders, 9 families and 11 species as shown in Table 3.

Table 3: insects associated with Balanites aegyptiaca

Order	**Family**	**Scientific Name**	**Frequency**	
Hymenoptera	*Formacidae*	*Camponotus sp*	135	20.03
		Pogonomyrmex Sp.	8	
	Apidae	*Xylocopa* sp.	2	
Hemiptera	Pyrrhocoridae	*Dysdercus fasciatus* F	3	0.43
Diptera	*Muscidae*	*Musca domestica*	4	0.55
Neuroptera	Myrmeleontidae	*Palpares* sp.	4	0.55
Lepidoptera	Nymphalidae	*Danaus chrysippus* L.	4	2.90
	Pieridae	Catopsilia florella	1	
		Belenois aurota	16	
Odonata	Aeshnidae	Anax sp.	139	19.19
	Libellulidae	*Diplacodes luminans*	408	56.35
6	**9**	***11***	**724**	

The Odonata order demonstrated the highest relative abundance at 56.35 %, followed by Hymenoptera at 20.03 %. The least abundant orders identified were Hemiptera (0.43%) and Diptera (0.55 %). This mode of dominance highlights a significant disparity in the populations of these insects in relation to *B. aegyptiaca* tree; where this tree significantly supports insect diversity by providing food and shelter, thus hosting diverse groups of insects and improving ecosystem resilience. Medina-Serrano et al. (2025) studied insect abundance, diversity, and species composition associated with *B. aegyptiaca*. Their results showed that the order Hymenoptera is the most abundant, followed by Diptera. They attributed their findings to the floral food resources of *B. aegyptiaca* throughout the year, which ensure the persistence of numerous insect species. *Diplacodes luminans revealed highest number among the total encountered species. D. luminans* adults and nymphs frequent still waters near vegetation like *B. aegyptiaca*, and some moths use the tree as a host for their young, showing how different organisms interact within shared ecosystems, as noted by Yougouda et al (2018). The Least species dominance was noticed in *Catopsilia florella*. This could be due to the fact that *B. aegyptiaca is not recorded among the host plants of this insect species. Similar observations were given by* Koren et al (2019).

Dynamic of Insects Associated with *Acacia mellifera*

A total of 102 insect specimens were caught associated with *A. mellifera* and classified into 3 orders, 3 families and 3 species (Table 4). Member of the Order Lepidoptera dominated the total catch by 98.04% whereas, Diptera and Hymenoptera showed least % dominance by 0.98 each. The relationship between insects and the *A. mellifera* tree involves a mix of mutualism e.g. pollination by bees and protection by ants and herbivory insects feeding on the plant. *Auchmophila kordofensis* detected could be due to **suitability of the tree for insect feeding and proliferation** (Johnson, et al 2022). Detection of *Musca domestica and Camponotus sp* might be due to enhanced activity for ***M. domestica*** (house flies) and improved foraging conditions for ***Camponotus* sp**. Zahn, and Gerry (2020) indicated that the housefly distribution is governed by environmental factors.

Table (4): Insect associated with *Acacia mellifera*

Order	Family	Scientific Name	Frequency	% Dominance/Order
Lepidoptera	Psychidae	*Auchmophila kordofensis*	100	98.04
Diptera	Muscidae	*Musca domestica*	1	0.98
Hymenoptera	Formacidae	*Camponotus sp*	1	0.98
3	3	*3*	102	100

Insects associated with *Acacia seyal*

A total of 579 insect specimens were collected on *A. seyal* identified into 6 Order s 9 families and nine species as indicated in table (5). Lepidoptera dominated the total catch 53.35,followed by Hymenoptera 43.00%. Least insect dominance was noticed in Diptera, Orthoptera, Odonata and Neuroptera 0.35 each. *Acacia seyal* tree provides forage and a food source where certain insects feed on different parts of it, including the leaves, pods, and gum. The tree also provides shelter supporting a community of insect orders such as Coleoptera, Hymenoptera, Lepidoptera, and Neuroptera, and habitat for various insects, but is primarily known for being highly susceptible to damage from different insect species rather than being a general beneficial resource for a wide variety of insects. On the other hand, the tree is susceptible to insect damage, causing significant damage and impacting gum production. Insect pests include termites (Isoptera), grasshoppers, borers, and several species of long horned beetles (Cerambycidae). Inducing seed damage upon attack by certain insects, e.g., Bruchid beetles, is known to damage a high proportion of Acacia seeds,(Bhatnagar, et al 2022). *Adesmia* sp. (specifically *Adesmia cancellata*) activity through its influence on thermoregulation and overall activity patterns, with beetles showing a preference for specific wind conditions to manage body temperature in hot desert environment,(Abushama and Al-Salameen,1989). Alanazi et al 2022 detected Buprestidae associated with Acacia sp. trees in Saudi Arabia.

Table (5): Association between insects and *Acacia seyal*

Order	Family	Scientific Name	Frequency	Dominance /Order
Diptera	*Muscidae*	*Musca domestica*	1	0.35
	Syrphidae	*Eristalinus* sp	1	
Hymenoptera	*Formacidae*	*Camponotussp*	247	43.00
	Apidae	*Apis millefera*	2	
Lepidoptera	Psychidae	*Auchmophila kordofensis*	308	53.35
	Pieridae	Belenois aurota	1	
Coleoptera	*Tenebrionidae*	*Adesmia* sp.	5	2.25
	Buprestidae	*Psiloptera (Damarsila) bioculata*	5	
	Scarabaeidae	*Onitis alexis* Klug	3	
Orthoptera	Pyrgomorphidae	*Chrotogenus* spp.	2	0.35
Odonata	Aeshnidae	Anax sp.	2	0.35
Neuroptera	Myrmeleontidae	*Palpares* sp.	2	0.35
7	12	*12*	579	

Insect Diversity across Five Different Tree Species

A total of 2605 individuals were collected from the five trees surveyed. Results given in table (6) showed that 32.59% of the total insects were obtained from *M. crassifoila*. This tree provides benefits to insects as a food source (leaves, flowers, fruits) for herbivores and pollinators. Hamidou et al (2022) studied insect dynamics in the foliage of M. crassifolia in Niger. Their results indicated that the insects associated with M. crassifolia revealed the presence of 24 species; were collected and identified as the main pests of the tree leaves. Insects collected from *B. aegyptiaca* showed 27.79 % of the total catch. *B. aegyptiaca* generally offers negative benefits to many insect pests, acting as a natural insecticide due to compounds in its roots, bark, seeds, and leaves, which deter, repel, and kill pests like mosquitoes, weevils, and beetles by reducing egg-laying and larval survival. However, its flowers provide positive benefits, offering nectar and pollen, attracting diverse pollinators like bees and other insects, supporting ecosystem health. Thus it could suits certain insects proliferations and suppress others. Medina-Serrano et al (2025) reported insecticidal effects of *B. aegyptiaca*.

Table (6) also, illustrate that 22.23% of the total insect population collected were found to be related to *Acacia seyal*. This tree could provides **food sources** for certain insects and can also host symbiotic relationships, while simultaneously possessing **natural insecticidal properties** that repel or harm others. Fierke, et al (2007) formerly reported that insects population associated with *A. seyal* were affected by explained by microclimatic conditions in connection with tree morphology and the respective requirements of the specific insect species.

Table (6) showed that 13.47 % of insects assemblages were caught from *C. decidua*. This tree is believed to offer significant benefits to certain insects, primarily by providing a vital source of nectar and pollen during a time of food scarcity in arid regions, thereby supporting diverse **pollinator communities.** Shiwani et al (2022) claimed that *C. decidua* support wide range of insects which visits the tree as pollinators and feeders. *A. mellifera* surveyed resulted in collection of 3.92 % of the total catch,(Table 6). *A. mellifera* benefits insects by providing essential food sources like nectar and pollen for pollinators and protein-rich bodies for ants, while its chemical compounds, like alkaloids in bark, can also act as natural insecticides or repellents against pest species, offering a dual role as both sustenance and protection for beneficial insects. Christine, et al (2025) reported that *A. mellifera* perform different effects to insects either positively as food source and shelter or negatively as insecticidal producer.

Figure (1), highlighted that the order of herierchial insects abundance in relation to the surveyed tree species is *M. crassifolia* > *.B aegyptiaca* >*A. seyal* > *C. decidua* > *A. mellifera*. This hierarchy mode suggests *M. crassifolia* supports the most diverse/abundant insect communities, followed by *B. aegyptiaca*, *A. seyal*, *C. decidua*, and *A. mellifera* . This pattern likely reflects plant traits such as leaf chemistry e.g. nutritional value, defenses, physical structure such as canopy, and bark structures , flowering phenology including nectar and pollen availability, and host-plant specificity, where generalists thrive on diverse resources while specialists prefer certain host trees, all influenced by the local environment. Moreover, *M. crassifolia* can provide superior habitat, food e.g. leaves, flowers, fruits, or shelter, attracting a wide array of insects. *B. aegyptiaca* could offer substantial resources, whereas *A. seyal* represents a key acacia species with distinct insect associations. Furthermore, *C. decidua* might be a more specialized or seasonal resource provider, and .*A. mellifera* has the lowest abundance/diversity, suggesting fewer resources or harsher conditions for insects on this species. Similar observations were attained by **Medina-Serrano et al (2025).**

Table (6): Insect Diversity across Five Different Tree Species

Tree Species	***Maerua crassifoila***	***Balanites aegyptiaca***	***Acacia seyal***	***Capparis decidua***	***Acacia mellifera***	**Grand Total**
Total catch	849	724	579	351	102	2605
%/total	32.59	27.79	22.23	13.47	3.92	100

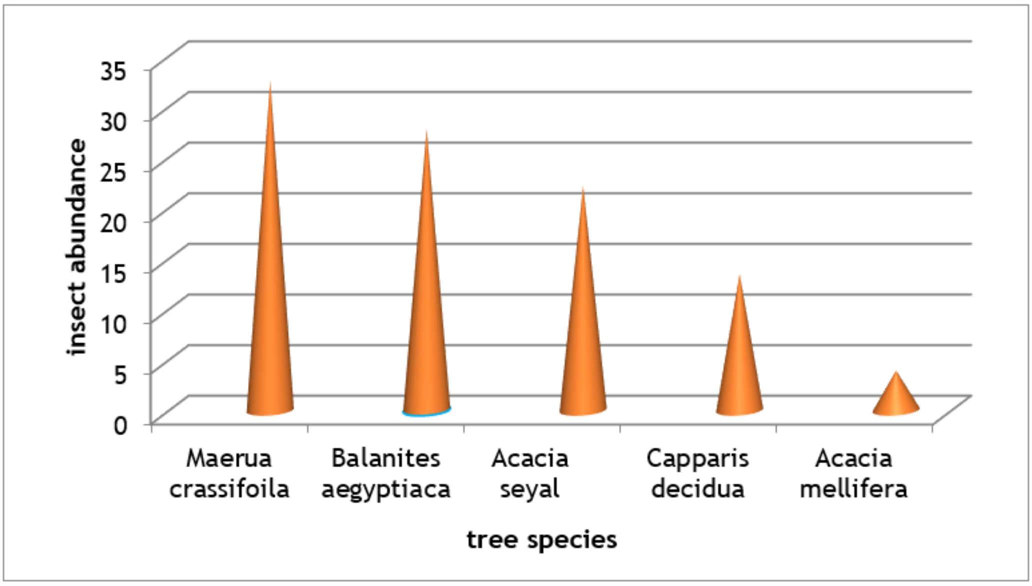

Figure (1): Abundance of insects associated with the five sampled trees

Investigating the Relationship Between Trees and Insect Species

Table (7) Pearson's Chi-square test resulted in a p-value of <0.001, providing strong evidence of a statistically significant association between the tree species and the observed insect species. This low probability value ($p < 0.001$) suggests that the distribution of insect types varies significantly based on the tree species. This significant association between tree species and collected insect species might be due to insect host tree presence, insect dynamic in relation to habitat heterogeneity and ecosystem resilience, similar observations were made by (Gely et al 2020 and Stazione et al 2025). In contrast, the Cramer's is was 0.579, which is considered in the moderate-to-strong range for association strength. This suggests that the tree species accounts for a meaningful amount of the variation observed in the insect species. Tree species significantly affect insect diversity and activity through various mechanisms, including habitat structure, food web dynamics, and host-specific defenses. The specific insect diversity depends on the tree species present and climatic factors such as wind, temperature and relative humidity. Jactel et al (2021) explained that tree species significantly affect insect diversity and activity through various mechanisms, including habitat structure, food web dynamics, and host-specific defenses. The specific insect diversity depends on the tree species present and climatic factors such as wind, temperature, and relative humidity.

Table (7): Assessing the Association between Insect Presence and Tree Condition using Chi-Square Analysis and Cramer's V test

Statistics Test	Resultant Value
χ^2	334.01
Df	112
p-value	< 0.001
Cramer's V	0.579

Simpson Diversity Index for The Five Trees

Table (8) indicated notable variations in insect diversity across the five tree species, as measured by the Simpson's Diversity Index and highlights instances of exclusive insect-plant associations. Simpson's Diversity Index values for insects collected from various tree species are as follows: 0.63 for *C. decidua*, 0.656 for *M. crassifolia*, 0.6101 for *B. aegyptiaca*, 0.47 for *A. seyal*, and 0.039 for *A. mellifera*. These values showed that *M. crassifolia*, *C. decidua*, and *B. aegyptiaca* host a more diverse insect community than the two *Acacia* species, with *A. mellifera* having the least diverse assemblage among the tested species. These values, which are close to 1, suggest high diversity for most species, except for *A. mellifera*, which has a remarkably low index. These findings suggest that habitat type, potentially related to tree species-specific characteristics (e.g., foliage type, chemical composition, presence of nectar/sap, bark texture), plays a significant role in structuring the local insect communities and their associated biodiversity. *M. crassifoila* appears to be a much more crucial host for diverse insect life than *A. mellifera*, which might host a specialized or generalist pest species in very high numbers, (Tobisch et al 2023). Table (9) also points to high host specificity for several insect species, which were exclusively found on a single type of tree. *Lampetis catenulata* and *Aphodius* sp. were found only on Capparis decidua. Similarly, *Schistocerca gregaria*, *Poekilocerus bufonius*, and *Acanthocephala curvipes* were restricted to *Maerua crassifolia*. On the other hand, Pogonomyrmex sp., *Xylocopa* sp., *Danaus chrysippus*, *Catopsilia florella*, and *Onitis alexis* were solely associated with Acacia seyal, as detailed in Table 8. These exclusive relationships suggest strong ecological dependencies, potentially due to specific nutritional requirements, defensive compounds unique to the host plant, or specialized life cycle needs. The data presented in the Table likely provides further detail on the specific abundances that contribute to these diversity indices and host specificities,(Kemp and Ellis 2017).

Table (8): Assessment of Insect Assemblages in Trees using the Simpson Diversity Index

Capparis decidua	
Insect species	**Individual number**
Achurum Sp.	2
Adesmia antiqua	18
Anax sp.	5
Aphodius sp	4
Apis millefera	3
Belenois aurota	5
Camponotus sp	184
Chrotogenus spp.	6
Diplacodes luminans	2
Dysdercus fasciatus	1
Eristalinus sp	4

Lampetis catenulata	1
Microtermes sp.	100
Musca domestica	4
Steraspis squamosa	9
Stomoxys sp.	3
Simpson diversity index	**0.63**
Maerua crassifoila	
Insect species	**Individual number**
Musca domestica	**7**
Chrotogenus spp	**4**
Camponotussp	**434**
Belenois sp	**2**
Microtermes sp.	**200**
Schistocerca gregaria	**100**
Poekilocerus bufonius	**100**
Acanthocephala curvipes (Fabricius)	**1**
Palpares sp	**1**
Simpson diversity index	**0.656**
Balanites aegyptiaca	
Insect species	**Individual number**
Camponotus sp	135
Pogonomyrmex Sp.	8
Xylocopa sp.	2
Dysdercus fasciatus F	3
Musca domestica	4
Palpares sp.	2
Danaus chrysippus L.	4
Catopsilia florella	1
Palpares sp.	2
Anax sp.	139
Diplacodes luminans	408
Belenois aurota	16
Simpson diversity index	**0.6101**
Acacia seyal	
Insect species	**Individual number**

Musca domestica	1
Eristalinus sp	1
Camponotussp	247
Auchmophila kordofensis	308
Belenois aurota	1
Adesmia sp.	5
Psiloptera (Damarsila) bioculata	5
Chrotogenus spp.	2
Apis millefera	2
Anax sp.	2
Onitis alexis Klug	3
Palpares sp.	2
Simpson diversity index	**0.47**
Acacia mellifera	
Insect species	**Individual number**
Auchmophila kordofensis	*100*
Musca domestica	1
Camponotussp	1
Simpson diversity index	**0.039**

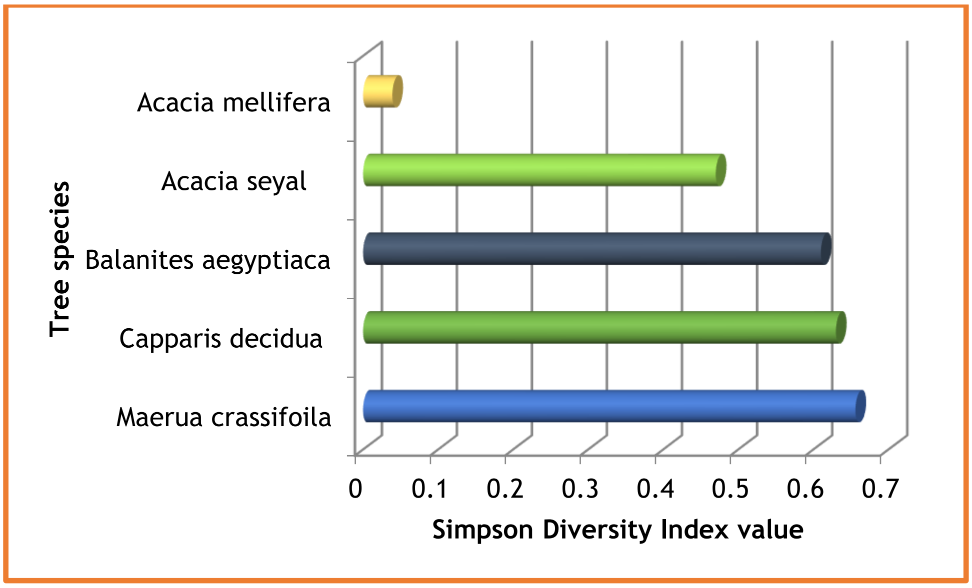

Figure (2): Simpson Diversity of Tree-Associated Insects

Figure (2) shows that ranking the Simpson diversity index values for insects collected from the five tree species establishes a clear hierarchy where *M. crassifolia*, *C. decidua*, and *B. aegyptiaca* occupy the highest positions (most diverse communities), while the two *Acacia* species fall into the lower ranks, with *A. mellifera* having the least diverse assemblage among those tested. Furthermore, Figure (3) give examples of insects' photos as collected from Gezira state. These results highlight significant differences in how various plant species support local insect biodiversity. They also indicated variation in wood properties of the first three species may provide a wider range of ecological niches or food sources that support a more varied insect population than those offered by *A. seyal* or *A. mellifera*. Southwood et al (1982) formerly correlated insect species diversity to plant host species. Similar observations were reported later by **Maron, et al (2025)**.

colitis sp | *Belenois aurota* | *Danaus chrysippus*

<u>Figure (3)</u>**: examples of insects collected from Gezira state**

Host Plant Effects on Insect Species Composition

Table 9 showed that certain insect species were collected solely from one tree but not from the others. The table indicated that insect species *Achurum* Sp., *Adesmia antiqua, Aphodius* sp, *Dysdercus fasciatus*, *Steraspis squamosa*, and *Stomoxys* sp. were collected from *C. decidua*. Bhakare and Kawthankar (2026) reported that *C. decidua* is a host plant for different insect species, thus they could be associated with it. *Schistocerca gregaria, Poekilocerus bufonius, Belenois* sp, and *Acanthocephala curvipes* were collected from *M. crassifoila. M. crassifolia* serves as a critical resource for these four diverse insect species primarily because it is a hardy, evergreen desert plant that provides nutrition, chemical protection, and stable roosting habitat in arid environments. Maeno , and Ebbe (2018) explained that *S. gregaria* (Desert Locust): While highly polyphagous, they use *M. crassifolia* as both a food source and a preferred night-roosting site. Its status as a larger tree or bush in desert landscapes makes it an ideal platform for swarms to gather safely during the night. Belenois sp. (Caper Whites): Many species in this butterfly genus are specialized to feed on plants in the Capparaceae family, which includes *M. crassifolia*. The larvae of *Belenois* sp. depend on these plants for specific chemical compounds that they often sequester for their own defense. *Poekilocerus bufonius* (Toxic Grasshopper): This grasshopper is famously associated with toxic desert plants. It often feeds on *Capparaceae* and *Asclepiadaceae* to sequester cardiac glycosides or other toxins, which it then uses in a defensive spray to deter predators. *Acanthocephala curvipes* (Leaf-footed Bug). This insect typically feeds on the juices of fruits and stems. Inari zones, M. crassifolia provides a reliable year-round source of moisture and nutrients through its evergreen leaves and berries. Pogonomyrmex Sp. Pogonomyrmex Sp. Xylocopa sp. Danaus chrysippus and Catopsilia florella were collected from Balanites aegyptiaca. Xylocopa sp. (Carpenter Bees): These large bees are major pollinators of B. aegyptiaca. They visit the tree's "open-access" flowers to gather nectar and pollen, which are vital for adult energy and larval provisioning. In desert environments, the tree's wood can also serve as a sturdy nesting substrate for their tunnels. Pogonomyrmex sp. (Harvester Ants): Although primarily known for harvesting seeds on the ground, these ants are frequently found on B. aegyptiaca to collect fallen seeds or to forage for other organic matter. Recent 2025/2026 research indicates that the tree's floral resources support a high diversity of Hymenoptera, including ants, which act as decomposers or predators within the tree's canopy. Catopsilia florella (African Migrant): B. aegyptiaca serves as a primary larval host plant for this butterfly. The larvae feed on the leaves, while adults rely on the tree's frequent flowering events for nectar, especially during migrations across arid regions like the Sahel. Danaus chrysippus (Plain Tiger): While its larvae typically specialize on milkweeds (Apocynaceae) to sequester toxins, the adults are highly opportunistic nectar-feeders. They are collected from B. aegyptiaca because its flowers provide a stable nectar source during the long dry seasons when other nectar-producing plants are unavailable (Medina-Serrano et al 2025). Table 9 also showed that Psiloptera (Damarsila) bioculata and Adesmia sp. were collected on Acacia seyal. Psiloptera (Damarsila) bioculata and Adesmia sp. are collected from Acacia seyal because it is a primary host for wood-boring pests and a critical habitat for desert-dwelling beetles in the "gum belt" regions of Sudan and Saudi Arabia. Psiloptera (Damarsila) bioculata (Jewel Beetle)is associated with this tree because its larvae tunnel into the wood and complete their life cycle. It also feeds on the Phloem. The Adesmia sp. related to A. seyal because this tree provides a stable microclimate and refuge from extreme surface temperatures, (Jamal,1994)

Table (9): **Insect species composition as compared between the five surveyed trees**

Capparis decidua	***Maerua crassifoila***	***Balanites aegyptiaca***	***Acacia mellifera***	***Acacia seyal***
Achurum Sp.	Musca domestica	Camponotus sp	*Auchmophila kordofensis*	*Musca domestica*
Adesmia antiqua	Chrotogenus spp	*Pogonomyrmex Sp.*	*Musca domestica*	*Eristalinus sp*
Anax sp.	Schistocerca gregaria	*Xylocopa sp.*	Camponotus sp	Camponotus sp
Aphodius sp	Poekilocerus bufonius	*Dysdercus fasciatus F*		Apis millefera
Apis millefera	Camponotus sp	Musca domestica		*Auchmophila kordofensis*
Belenois aurota	*Belenois sp*	*Palpares sp.*		Belenois aurota
Camponotus sp	*Microtermes sp.*	*Danaus chrysippus L.*		*Adesmia sp.*
Chrotogenus spp.	*Acanthocephala curvipes (Fabricius)*	Catopsilia florella		*Psiloptera (Damarsila) bioculata*

Diplacodes luminans	*Palpares sp*	Belenois aurota		*Onitis alexis Klug*
Dysdercus fasciatus		Anax sp.		*Chrotogenus spp.*
Eristalinus sp		Diplacodes luminans		Anax sp.
Lampetis catenulata				*Palpares sp.*
Microtermes sp.				
Musca domestica				
Steraspis squamosa				
Stomoxys sp.				

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REFERENCES

Abushama, F.T., and Al-Salameen, M. A.(1989)Temperature reactions of desert tenebrionid beetles from Kuwait, Journal of Arid Environments,16(3): 293-303, Available at: https://doi.org/10.1016/S0140-1963(18)30945-5.

Alanazi, N.A.; Ghorbel, M.; Brini, F.; Mseddi, K. The Life Cycle of the Xylophagous Beetle, Steraspis speciosa (Coleoptera, Buprestidae), Feeding on Acacia Trees in Saudi Arabia. Life 2022, 12, 2015. https://doi.org/10.3390/life12122015

Amadou, H.A., Kadri,D.,I., and Aissetou,D.Y., (2023)Biodiversity of entomofauna and the dynamics of leaf insect pests of the woody forage plant, Maerua crassifolia Forssk. (Capparidaceae) in the Niamey region (Niger). international journal of innovation and applied studies,36(1): 194-204. Available at: https://ijias.issr-journals.org/abstract.php?article

Bhakare, M. and N. Kawthankar 2026. Capparis decidua Edgew. – Karira, Bare Caper. In Kunte, K., S. Sondhi, and P. Roy (Chief Editors). Butterflies of India, v. 4.12. Published by the Indian Foundation for Butterflies. URL: https://www.ifoundbutterflies.org/capparis-decidua

Bhatnagar, Sh. Ullah Khan,A., Rathore,L., Kumar,B., and . Imran (2022) “Diversity of Insect Visitor’s on Blossom of Capparis decidua (Forssk.) Edgew (Kair) in Northwest Rajasthan”, International Journal of Environment and Climate Change, 12(11), pp. 616–621. doi: 10.9734/ijecc/2022/v12i1131013.

Bhatnagar, Sh., Singh,S., Khan,A., Rathore,L., Sharma,N., and Khan,I.,(2022) Insect Visitor's Diversity on Blossom of Acacia senegal (L.) Wild (Kumat) in Rajasthan, India. Available at: https://www.researchgate.net/publication/377081851_Insect_

CABI (2024) Acacia seyal (whistling thorn) Available at: https://doi.org/10.1079/cabicompendium.2404

Chothani, D. L., & Vaghasiya, H. U. (2011). A review on Balanites aegyptiaca Del (desert date). Pharmacognosy Reviews, 5(9), 55–63.

Christine Joy Cano, Princes Angel Cantuangco, Ethiane Mark Iraula, Cristine Villaflor, Jo Angeli Ong. "The Insecticidal Activity of Acacia Bark Extract on the Mortality Rate of Rice Earhead Bug (Leptocorisa Oratorius)" International Journal of Research and Innovation in Social Science (IJRISS), vol. 9, no. 03, 1001-1011, 2025, https://doi.org/https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0072.

Deák, B., Kovács,B., Rádai,Z., Apostolova,I., Kelemen,A., Kiss, R., Lukács,K., Palpurina,S., Sopotlieva, D., Báthori, F., and Valkó,O. (2021). Linking environmental heterogeneity and plant diversity: The ecological role of small natural features in homogeneous landscapes. Science of The Total Environment,763: 144199. Available at: https //www.sciencedirect.com/science/article/pii/S0048969720377305)

Fahey,C., Burghardt ,K. Griffin,E., Komatsu,K., McCormick,K. Pullen,J., Sedio,., Parker,J.(2025) Chemically mediated plant-enemy interactions promote positive biodiversity effects on young tree growth. Journal of Ecology 113(7):1606-1621 DOI: 10.1111/1365-2745.70062

Fierke, M. K., Kelley, M. B. and Stephen, F. M. (2007): Site and stand variables influencing red oak borer, (Coleoptera: Cerambycidae), population densities and tree mortality. Forest Ecology and Management 247: 227–236.

Gely C, Laurance SGW, Stork NE. How do herbivorous insects respond to drought stress in trees? Biol Rev Camb Philos Soc. 2020 Apr;95(2):434-448. doi: 10.1111/brv.12571. Epub 2019 Nov 21. PMID: 31750622.

Gull, A., Hussain, M. A., Khan, A., Muhammad, G., & Tahir, M. N. (2018). Capparis decidua* Edgew (Forssk.): A comprehensive review of its traditional uses, phytochemistry, pharmacology, and nutrapharmaceutical potential. Arabian Journal of Chemistry, 13(3), 1901-1916.

Hamada, F., El-Banhawy,A., Ellmouni,F., AL-Juhani,W., Makharita,R., and Nour,I., , (2021) Comparative Taxonomic Study of Balanites aegyptiaca (L.). Biology, environmental science. Available at: https://api.semanticscholar.org

Hamidou A. Amadou, Djibrilla I., Abdou K., and Drame Y.(2022) Biodiversity of entomofauna and the dynamics of leaf insect pests of the woody forage plant, Maerua crassifolia Forssk. (Capparidaceae) in the Niamey region (Niger). International Journal of Innovation and Applied Studies, 36(1):. 194–204.

Jactel, H., Moreira, X., and Castagneyrol, B. (2021). "Tree Diversity and Forest Resistance to Insect Pests: Patterns, Mechanisms, and Prospects." Annual Review of Entomology, 66: 277-296.

Jamal, A. (1994). Major insect pests of gum arabic trees Acacia Senegal Willd. And Acacia seyal L. In Western Sudan. Journal of Applied Entomology, 117(1-5), 10-20. https://doi.org/10.1111/j.1439-0418.1994.tb00702.x

Johnson,T., Elgar, M and Symonds, M (2022).Movement and olfactory signals: Sexually dimorphic antennae and female lightlessness in moths. Frontiers in Ecology and Evolution . DOI: 10.3389/fevo.2022.919093.

Kemp, JE, Ellis AG (2017) Significant Local-Scale Plant-Insect Species Richness Relationship Independent of A biotic Effects in the Temperate Cape Floristic Region Biodiversity Hotspot. PLoS ONE 12(1): e0168033. https://doi.org/10.1371/journal.pone.0168033

Koren T., Dender D., Ilić B. and Martinović M. (2019). On the distribution and status of the African monarch (Danaus chrysippus (Linnaeus,1758); Lepidoptera: Nymphalidae) in Croatia. — Nachrichten des entomologischen Vereins Apollo, Neue Folgen 39(3/4): 140–144

Maeno ,K., O. and Ebbe ,M.A.(2018) Aggregation Site Choice by Gregarious Nymphs of the Desert Locust, Schistocerca gregaria, in the Sahara Desert of Mauritania. Insects, 9, 99; doi:10.3390/insects9030099.

Maron, M., et al. (2025). "Deadwood as a surrogate for forest biodiversity: Meta-analysis of correlations between deadwood volume and species richness of saproxylic organisms." Ecological Indicators, 167, 108170.

Medina-Serrano, N., Bagnères,A., Ndiaye,M., Vrecko, V., McKey, D., and Hossaert-McKey.M.(2025). Seasonal variation in insect assemblages at flowers of Balanites aegyptiaca, an ecologically and socially important tree species in the Ferlo region of Senegal's Great Green Wall corridor. bioRxiv,1-71. Doi.org/10.1101/2025.03.26.645493

Montgomery, G. A., Belitz, M. W., Guralnick, R. P., & Tingley, M. W. (2021). Standards and Best Practices for Monitoring and Benchmarking Insects. Frontiers in Ecology and Evolution, 8, 579193. Doi.org/10.3389/fevo.2020.579193

Oldfield, S. (2020). "Maerua crassifolia". IUCN Red List of Threatened Species. e.T137749048A165379886..doi:10.2305/IUCN.UK.2020-2.RLTS.T137749048A165379886.en.

Roger B.J. Benson, Richard Butler, Roger A. Close, Erin Saupe, Daniel L. Rabosky (2021). Biodiversity across space and time in the fossil record. Current Biology, 31, (19): R1225-R1236. Available at : (https://www.sciencedirect.com/science/article/pii/S0960982221010617)

Saeed Ahmad, A. M, Alvi,A., Saeed, Q., Saeed,Sh., Shuja,M., Ejaz,M., and Iqbal,N., (2016). Pollinators'community of Capparis aphylla at Dera Ghazi Khan, Punjab, Pakistan. Journal of entomology and zoology Studies; 5(1): 967-969. Available at: https://www.entomoljournal.com

Sharma and Imran (2022). Insect Visitor's Diversity on Blossom of Acacia senegal (L.)Willd (Kumat) in Rajasthan, India 14(2): 896-904(2022)

Shiwani Bhatnagar, Sangeeta Singh, Ameen Ullah Khan, Lokendra Singh Rathore, Neha Sharma and Imran (2022). Insect Visitor's Diversity on Blossom of Acacia senegal (L.) Willd (Kumat) in Rajasthan, India 14(2): 896-904(2022)

Southwood, T. R. E., Moran, V. C. and Kennedy, C. E. J. (1982), The richness, abundance and biomass of the arthropod communities on trees. Ecological Entomology, 7: 71-80.

Stazione, L. Corley J., Allison J., Hurley B., Lawson S. and, Lantschner M.(2025) Novel associations among insect herbivores and trees: Patterns of occurrence and damage on pines and eucalypts. Ecol Appl. 35(2):e70018. Doi: 10.1002/eap.70018. PMID: 40071637.

Tobisch, C. Rojas-Botero S, Uhler J, Müller J, Kollmann J, Moning C, Brändle M, Gossner MM, Redlich S, Zhang J, Steffan-Dewenter I, Benjamin C, Englmeier J, Fricke U, Ganuza C, Haensel M, Riebl R, Uphus L, Ewald J. (2023)Plant species composition and local habitat conditions as primary determinants of terrestrial arthropod assemblages. Oecologia, 201(3):813-825. doi: 10.1007/s00442-023-05345-6.

Weschler M, Tronstad L. (2024) Wind energy and insects: reviewing the state of knowledge and identifying potential interactions. Peer J. 14;12:e18153. Doi: https://pmc.ncbi.nlm.nih.gov/articles/PMC11485068/.

Wikipedia (2025) Forest trees. Available at: https://en.wikipedia.org/wiki/Tree

Yougouda ,H., Tchatchoua ,T. Arbonnier ,M. and Mapongmetsem,P. (2018) Ethnobotany and population structure of Balanites aegyptiaca (L.) Delile in Sahelian zone of Cameroon International Journal of Biodiversity and Conservation 10(2):92-99 DOI: 10.5897/IJBC2017.1153

Zahn, LK, Gerry AC. (2020) Diurnal Flight Activity of House Flies (Musca domestica) is Influenced by Sex, Time of Day, and Environmental Conditions. Insects. 11(6):391. Doi: 10.3390/insects11060391.

Zubair, M. A. H. A., Alkhair, S., & Hamdan, M. M. (2020). Deterioration of Blue Nile forests and its ecological effects in the Gezira State- Sudan. MOJ Eco Environ Sci, 5(1), 34–40