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Nest building, food storage and foraging behaviours of the African weaver ant, *Oecophylla longinoda* (Hymenoptera: Formicidae), in relation to host plant and land-use types in a typical Guinea savannah area of North-central Nigeria

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Abstract

This study investigated the nesting architecture, dietary composition, and foraging dynamics of the African weaver ant (*Oecophylla longinoda*) across diverse ecological settings in North Central Nigeria. Ant colonies were sampled from four conventional host plants (HPs)—mahogany (*Khaya senegalensis*), shea butter (*Vitellaria paradoxa*), mango (*Mangifera indica*), and cashew (*Anacardium occidentale*)—within five distinct land-use (LU) types: farmland (FL), natural vegetation (NV), school environment (SE), office business (OB), and residential area (RA). Collections were conducted between March and May 2022. Nest architecture exhibited marked variability, with irregularly shaped nests predominating, while circular nests were least frequent. Notably, circular nests required the greatest investment of resources, averaging 20.09 leaves per nest, whereas triangular nests represented the most economical design, constructed with an average of 4.75 leaves. Dietary analysis revealed significant differences ($p < 0.05$) in food material composition across host plants and land-use types. The primary food components recovered included insects, floral vegetative parts, and cereal grains. Foraging behaviour varied substantially among host plants. Internest movement ranged from 71.46% on cashew trees to 86.56% on shea butter trees. Trail utilisation was highest on mango trees (92.20%) and lowest on cashew (58.30%). Foraging success peaked on mahogany (85.60%) but was lowest on cashew (61.70%). These findings highlight the ecological plasticity of *O. longinoda* and its capacity to adapt foraging strategies to host plant characteristics. The findings of this study

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provide critical insights into the behavioural ecology of African weaver ants, reinforcing their potential as biological control agents in integrated pest management programmes.

Keywords Dietary composition, Fruit trees, Farm land, Habitat, Niche, Nest-types, Trails

Introduction

Weaver ants (*Oecophylla* spp.) are eusocial insects comprising two closely related species: *O. longinoda* and *O. smaragdina*. Although morphologically and behaviourally similar, they differ in distribution and colouration; *O. longinoda* is widespread across sub-Saharan Africa (Wetterer, 2017), whereas *O. smaragdina* is predominantly found in Asia (Rahman et al., 2021). Both species are obligately arboreal and polydomous, establishing multiple nests on host plants (Wargui et al., 2015). Their hallmark is an intricate nest-building behaviour in which workers weave host plant leaves into enclosed structures using silk secreted by larvae (Langthasa et al., 2017; Stewardson et al., 2025; Patel & Bhatt, 2020). Nest construction is strongly influenced by host tree architecture, leaf morphology, and environmental conditions (Devarajan, 2016; Coulibaly et al., 2024).

Weaver ants form large monogynous colonies, often comprising up to half a million workers distributed across hundreds of nests spanning several trees (Rahim & Ohkawara, 2018). Despite their expansive colony sizes, they maintain strict territorial boundaries through continuous patrolling and aggressive defence (D'Ettorre & Lenoir, 2010). Colonies exhibit worker polymorphism: minor workers tend brood chambers, while major workers defend territories and forage (Badejo et al., 2011). Foraging is diurnal, driven by light intensity and temperature, and involves exploration followed by food retrieval to specific nests, reflecting strong nest fidelity (Panait & Luke, 2004; Patel & Bhatt, 2020). Foraging activity is central to colony survival, with aggressiveness modulated by brood and worker hunger levels (Crozier et al., 2010; Kolay et al., 2020). Although omnivorous, weaver ants preferentially consume protein-rich foods and act as generalist predators of diverse arthropods.

Ecologically, *Oecophylla* ants are dominant in tropical forests, savannahs (Andersen, 2019), and agricultural landscapes (Rahim & Ohkawara, 2018). They play a pivotal role in suppressing insect pests across multiple fruit tree species, including *Mangifera indica*, *Nerium odorum*, *Cocos nucifera*, *Tamarindus indica*, *Anacardium occidentale*, and *Vitellaria paradoxa* (Rajagopal et al., 2019). Consequently, their use in biological control programmes has been widely advocated in tropical plantations (Van Mele, 2008; Thuman et al., 2019).

However, current knowledge is disproportionately skewed toward the Asian species, *O. smaragdina*, with extensive studies on colony structure (Marcela et al., 2012; Offenberger et al., 2012), ecology (Offenberger et al.,

2004), predation behaviour (Gathalkar & Barsagade, 2016), and biological control potential (Peng et al., 2012, 2013; Offenberger et al., 2013; Rodríguez-Gironés et al., 2013). In contrast, research on the African species, *O. longinoda*, remains limited. Notable exceptions include studies on population structure (Badejo et al., 2011), mating behaviour (Nene et al., 2015), seasonal abundance (Olotu, 2016), biological control (Danjuma et al., 2020), and host plant associations (Vayssières et al., 2021). Yet, critical gaps persist in understanding its bioecology and behavioural dynamics, particularly in northern Nigeria. This paucity of knowledge constrains the effective deployment of *O. longinoda* as a biological control agent, despite its proven efficiency in pest suppression.

To address these gaps, a broad-based research programme was initiated to elucidate the bioecology of *O. longinoda*. The present study specifically investigates nest-building strategies, food storage, and foraging behaviours of African weaver ants in the Nigerian savannah—the country's largest ecological zone—under varying anthropogenic land-use systems. By advancing knowledge of these behavioural traits, this work aims to strengthen the integration of *O. longinoda* into sustainable pest management strategies for enhanced fruit tree productivity.

Materials and methods

Study area and sampling sites

The study was conducted in Lapai, the administrative headquarters of Lapai Local Government Area (LGA), Niger State, North-central Nigeria. Lapai lies between 9° 04' – 9° 05' N and 6° 34' – 6° 35' E, covering approximately 3,730 km² with a population of 200,700 (2022 estimate) (Fig. 1). The climate is tropical, with a wet season (May–October) and a dry season (November–April). Mean annual conditions include a temperature of 34.87 °C, relative humidity of 55.72%, and rainfall of 1,136 mm. Vegetation is dominated by Guinea savanna, characterised by tall grasses and scattered shrubs and trees such as neem (*Azadirachta indica*), cashew (*Anacardium occidentale*), mahogany (*Swietenia macrophylla*), mango (*Mangifera indica*), shea butter (*Vitellaria paradoxa*), and locust bean (*Parkia biglobosa*). Many of these species serve as host plants for the African weaver ant (*Oecophylla longinoda*). The area is largely agrarian, inhabited predominantly by the Nupe ethnic group, alongside Gbagyi and Hausa minorities (Danjuma et al., 2020). The soils in Lapai are generally sandy (Ibrahim, 2018). The soil texture includes sand, silt, clay, and sandy loam. Particle size

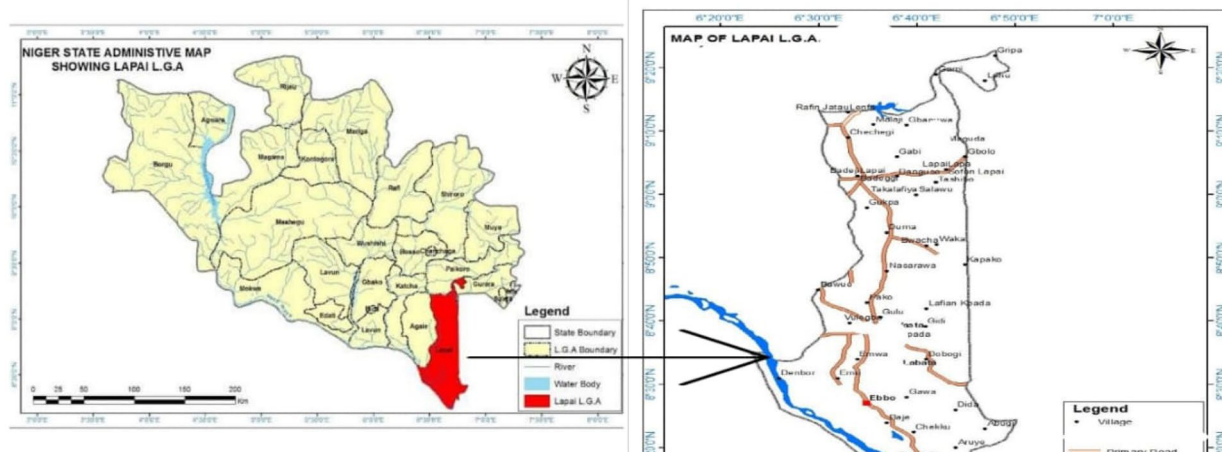


Fig. 1 The study area. (Source: ArcGIS Pro Version 3.7)

ranges from 93.90 to 137.70 g. The soil bulk density value ranged from 1.85 to 1.98 mg/m³. The moisture content and soil porosity of the soil in Lapai are generally low, ranging, respectively, from 0.049 to 11.659 mg/m³, and 25 to 39% (Ibrahim, 2018).

Selection of host plant types

Four host plant species—mahogany (*Swietenia macrophylla*), shea butter (*Vitellaria paradoxa*), mango (*Mangifera indica*), and cashew (*Anacardium occidentale*)—were selected. Five replicates of each host plant type were randomly chosen across sampling stations.

Sampling sites

Five land-use types were selected: school environment (SE), office-business areas (OB), residential areas (RA), farmland (FL), and natural vegetation (NV). Two replicates of each land-use type were randomly chosen, resulting in ten sampling sites within the study area. The SE is characterised by high anthropogenic activity, academic buildings, and adjacent busy roads. Vegetation was sparse, limited to ornamental and shade trees such as cashew, mango, and neem. The OB areas are located near highways with moderate human activity and built-up spaces. Tree cover included host plants that moderated microclimatic conditions. The RA is the staff quarters of Ibrahim Badamasi Babangida University, Lapai. Host plants included cashew, mango, locust bean, and shea butter. Anthropogenic interference was high, with altered vegetation for farming and waste disposal, while the FL were dominated by crop cultivation (legumes, cereals, tubers) with occasional patches of natural vegetation. Human and vehicular traffic was minimal, though cattle grazing was common. Host plants occurred in both cultivated and uncultivated plots. The NV are rich in species diversity and climax vegetation with minimal human disturbance. Trees grew in proximity, forming contiguous

canopies. Wildlife activity was evident, and bush burning was absent.

Measurements of microclimatic conditions

Temperature and relative humidity within nests were measured during each sampling using a plastic mini-probe thermo-hygrometer (Model MPH-01). The probe was inserted into each nest for at least five minutes before readings were recorded.

Behavioural observations

Weaver ant nests were sampled weekly for 12 weeks, from March to May 2022. Sampling was performed between 0800 and 1200 h, corresponding to the time of day when the ants were least aggressive (Marcela et al., 2012) and most common in the nests, as revealed in a preliminary study. On every sampling day, four nests were selected for monitoring from six individuals of each host plant type (mango, cashew, mahogany and shea butter trees) in each land-use type (namely, natural vegetation, office-business area, farm land, residential and school environment). Each nest was monitored by three trained observers standing slightly apart, each assigned to monitor one of the three ant behavior parameters considered: internest movements (number of times an ant could be traced from one nest to another, per 3-minute observation period), consistency of use (proportion of worker ants following established trails to and from the nests) and foraging success (proportion of worker ants returning to the nests with food items). Internest movement was measured as the number of times an ant could be traced from one nest to another; consistency of use of trails was determined as the proportion of worker ants following established trails to and from the nests; and foraging success was recorded as the proportion of worker ants returning to the nests with food items. Each of the three parameters was measured for 3-minute observation

periods, with five such observations made at 10-minute intervals per nest.

Collection and examination of ant nest samples

The four nests selected and monitored for ant behaviour per host plant were eventually removed from the tree by cutting the twig at the base of the nest using a long cutter (Sharpex). The nests were immediately transferred, separately, into thick transparent polythene bags (30 cm × 40 cm) containing cotton pads soaked in chloroform to make the ants dormant. The polythene bags were then taken to the laboratory, where processing and examination of the nests were performed within 24 h of collection. The nest examination included determining the shape, number of leaves used for construction, total weight of all the food materials in a nest, and type and frequency of occurrence of the dietary components.

Statistical analysis

Data collected were curated, organised, and cleaned in Microsoft® Excel 2019 (Microsoft®, Redmond, WA, USA), and analysed using the Statistical Package for Social Scientists expressed as means. Nest shape and dietary components were calculated as percentages. Descriptive statistics (mean, standard deviation, and range) were used to analyse the number of leaves per nest, food material weight, and behavioural indices (e.g. internest movements, consistency of use and foraging success. Differences in mean number of leaves per nest, food material weight, and behavioural parameters across host plants and land-use types were tested using compared using Welch's Analysis of Variance (ANOVA) (since there were uneven variances after the Levene's Test) at a significance level of $p=0.05$. Post-hoc analyses were done using Tukey's post hoc test.

Results

Shapes and distribution of the nest of Odorous Ants

The analysis of nest architecture revealed distinct variations in the shapes of nests constructed by the African weaver ant (*Oecophylla longinoda*) across different host plant species. As illustrated in Fig. 2, the ants exhibited a remarkable diversity in nest morphology, ranging from irregular and oval to triangular and circular forms. Among these, irregularly shaped nests were the most prevalent, representing an aggregate mean of 41.09% of all nests recorded during the study. On mango and mahogany trees, irregular nests were particularly common, accounting for 39.51% and 50.58% of the total nests, respectively. These were followed by oval-shaped nests, which constituted 27.78% on mango and 29.41% on mahogany. Interestingly, the least frequent nest shapes differed between the two host plants: circular nests were rare on mango trees (10.49%), whereas triangular nests were least represented on mahogany (7.06%).

In contrast, the pattern observed on cashew and shea butter trees diverged from that of mango and mahogany. On cashew trees, triangular nests were predominant (50.67%), while on shea butter trees, oval nests were most common (41.28%). Circular nests were consistently scarce across both host plants, comprising only 1.33% on cashew and 4.59% on shea butter.

Complexity (number of leaves per nest) of nests of Odorous Ants

The number of unit leaves used by *Oecophylla longinoda* to construct different nest shapes, serving as a proxy for nest complexity, is shown in Figs. 3 and 4. Circle-shaped nests required the greatest investment of host plant leaves, averaging 20.09 leaves per nest, followed by irregular nests with 16.15 leaves per nest. In contrast, triangular nests represented the simplest structures, requiring only 4.75 leaves per nest on average. Considerable

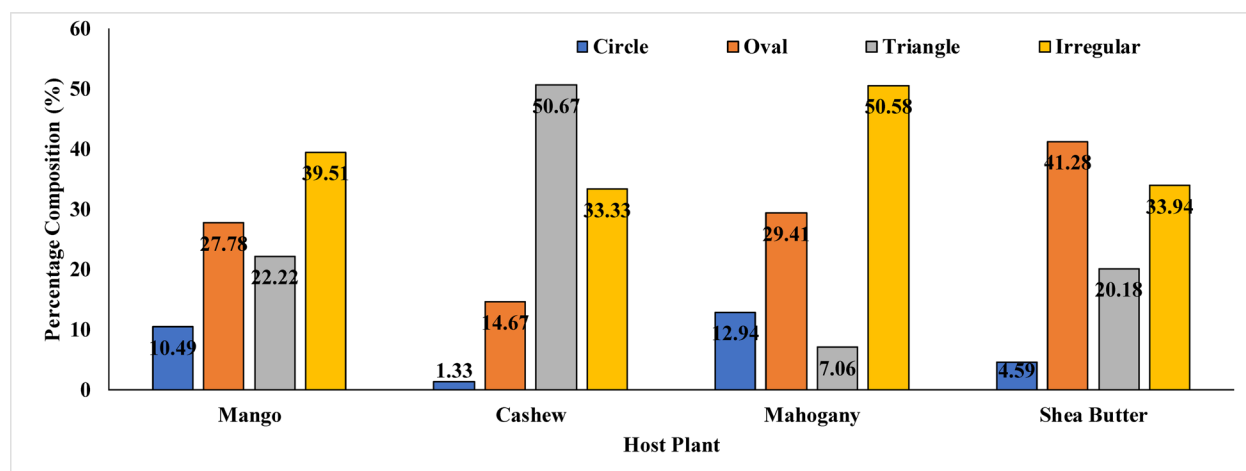


Fig. 2 Distribution of nest-shape types of weaver Odorous Ant populations, *Oecophylla longinoda*, in relation to host plants in Northcentral Nigeria

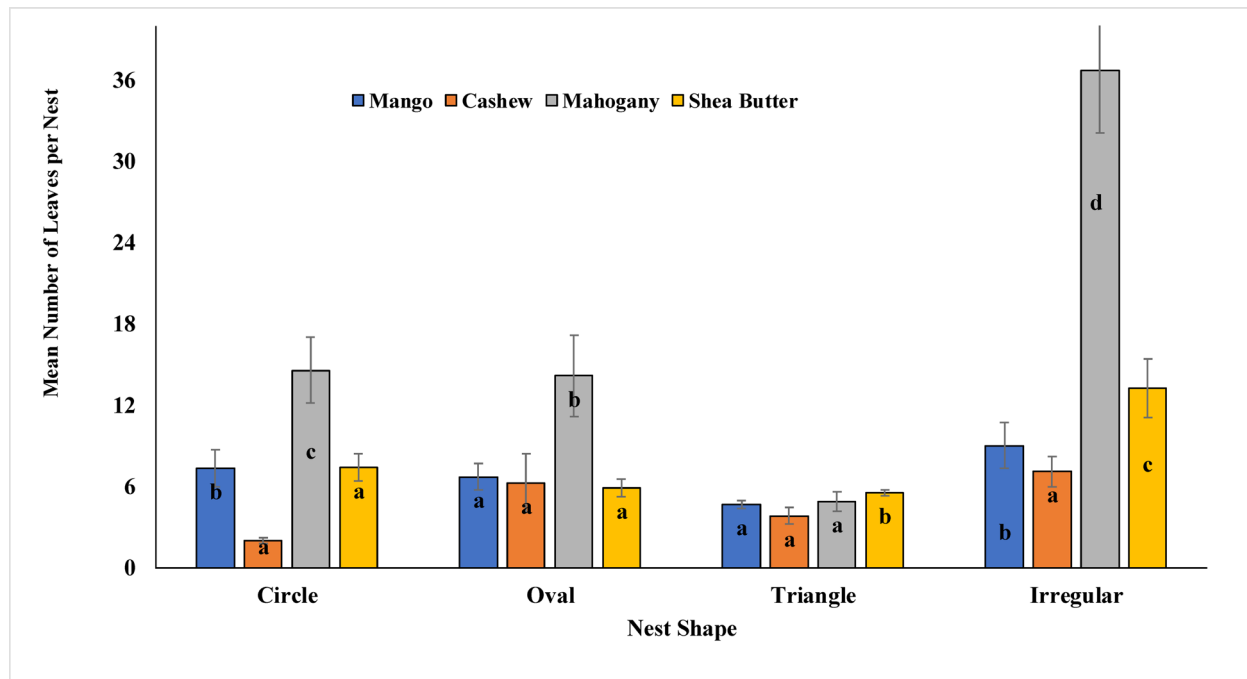


Fig. 3 Complexity (mean number of leaves per nest) of nests of the Odorous Weaver Ant Populations, *Oecophylla longinoda*, in relation to host plants, in North-central Nigeria. Bar graphs with the same alphabet for a nest shape are not significantly ($p > 0.05$) different

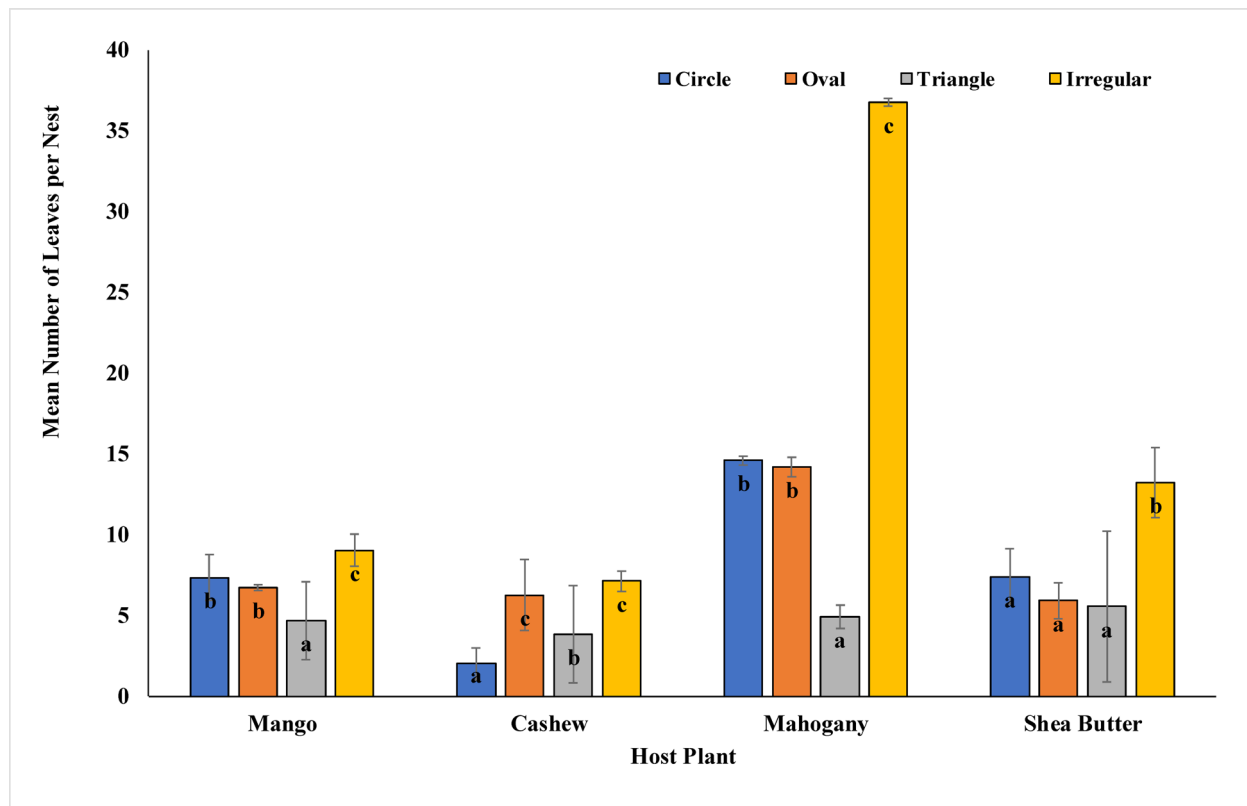


Fig. 4 Complexity (mean number of leaves per nest) of nests of the Odorous Weaver Ant Populations, *Oecophylla longinoda*, in relation to the shape of nests, in North-central Nigeria. Bar graphs with the same alphabet for a host plant are not significantly ($p > 0.05$) different

variability was observed in the mean number of leaves required for nest construction across host plants. Irregular nests consistently involved the highest number of leaves on all four host plants, ranging from 7.12 leaves on cashew to 35.76 leaves on mahogany. The triangle-shaped nests required the fewest leaves on mango (4.69), mahogany (4.91), and shea butter (5.55). Notably, circle-shaped nests on cashew trees were established with only two leaves, representing the lowest recorded value across all host plants.

Food storage in the nests of Odorous Ants

The mean total amounts of food materials recovered from ant nests varied significantly ($p < 0.05$) across host plant species and land-use types (Figs. 5 and 6). Among the host plants, nests on shea butter trees contained the largest quantity of food, averaging 101.99 g per nest, followed by mahogany (73.09 g/nest) and mango (60.68 g/nest). Cashew nests were the least resourceful, with only 35.95 g/nest.

Variation was also evident across land-use types. Nests located in residential areas (90.85 g/nest) and farmland (71.13 g/nest) yielded the highest food quantities, with no significant difference between them ($p > 0.05$). In contrast, nests from natural vegetation (57.84 g/nest) and

office-business areas (45.60 g/nest) contained the least food, though natural vegetation supported significantly greater amounts than office-business sites ($p < 0.05$).

When host plant and land-use interactions were considered, residential areas consistently supported the most productive nests for all host plants except mango. Food quantities ranged from 46.52 g/nest in cashew to 176.77 g/nest in shea butter. Mango nests, however, were most productive in natural vegetation and school environments, averaging ~74.0 g/nest. The least productive nests were observed in office-business areas for mango (45.79 g/nest) and shea butter (28.38 g/nest), in natural vegetation for mahogany (62.11 g/nest), and in farmland and school environments for cashew (~29.0 g/nest).

Composition and frequency of occurrence of dietary components in the nests of Odorous Ants

The composition and frequency of dietary components stored in the nests of *Oecophylla longinoda* varied across host plant types (Fig. 7). Ant food materials consisted of three major categories—insects, floral vegetative parts, and cereal grains—with unidentifiable items classified as “Others.”

Insects dominated the food items in nests from mahogany (75.76%) and shea butter (55.40%) trees, and were

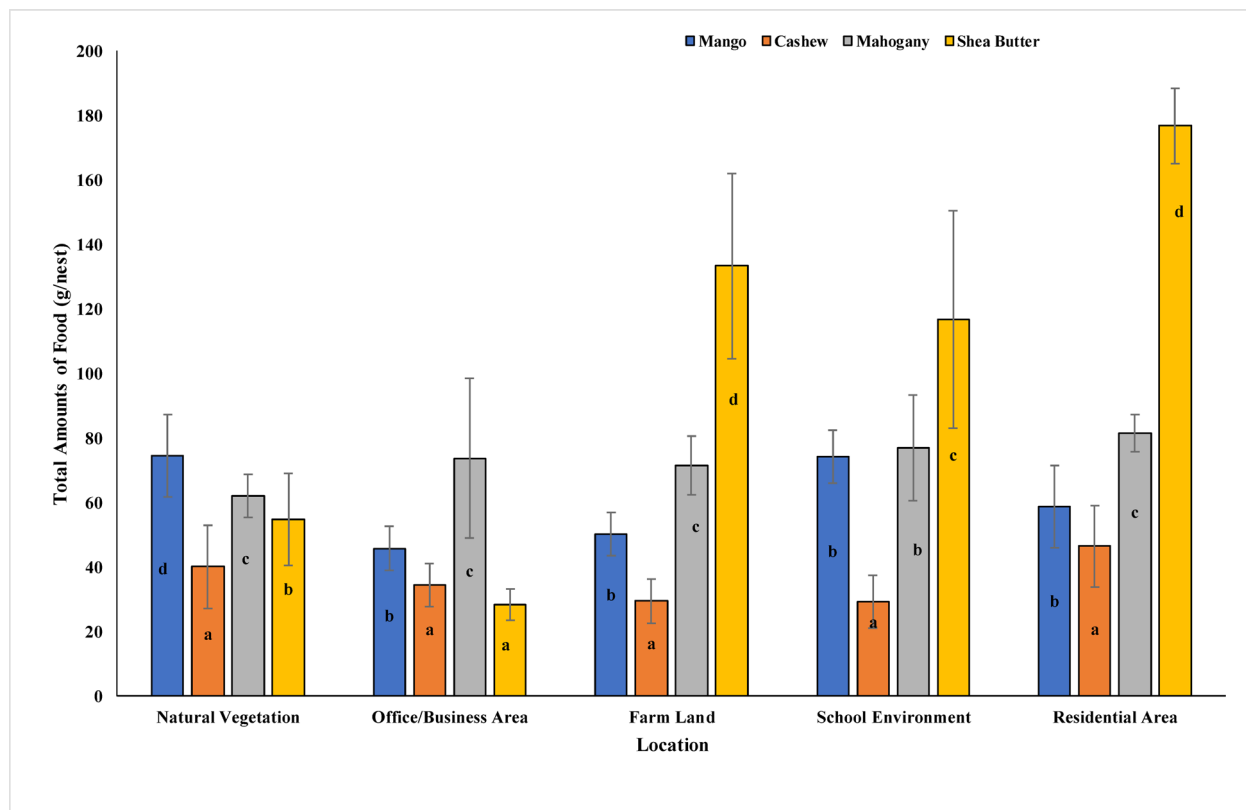


Fig. 5 Total amounts of food (g/nest) recovered from the nests of the Odorous Weaver Ant, *Oecophylla longinoda*, in relation to land-use type, in North-central Nigeria. Bar graphs with the same alphabet for a host plant are not significantly ($p > 0.05$) different

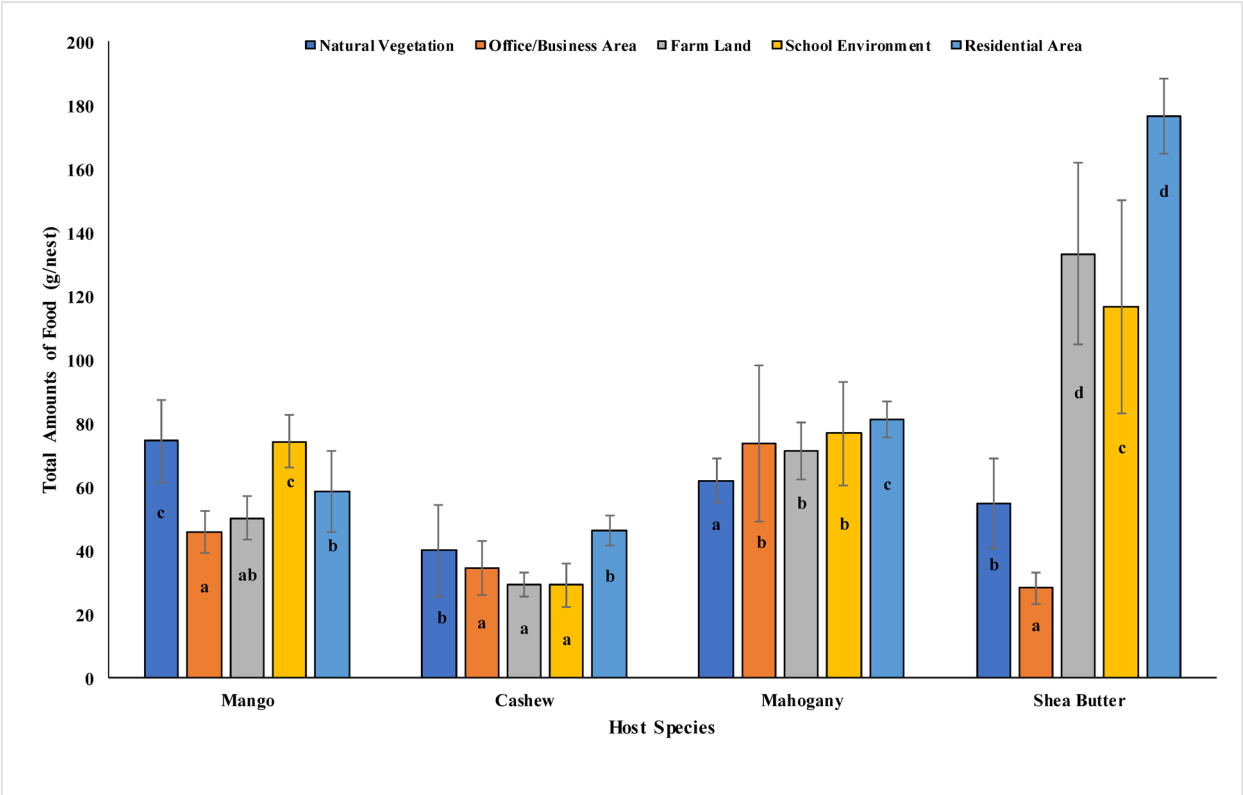


Fig. 6 Total amounts of food (g/nest) recovered from the nests of the Odorous Weaver Ant, *Oecophylla longinoda*, in Relation to host plant type, in Northcentral Nigeria

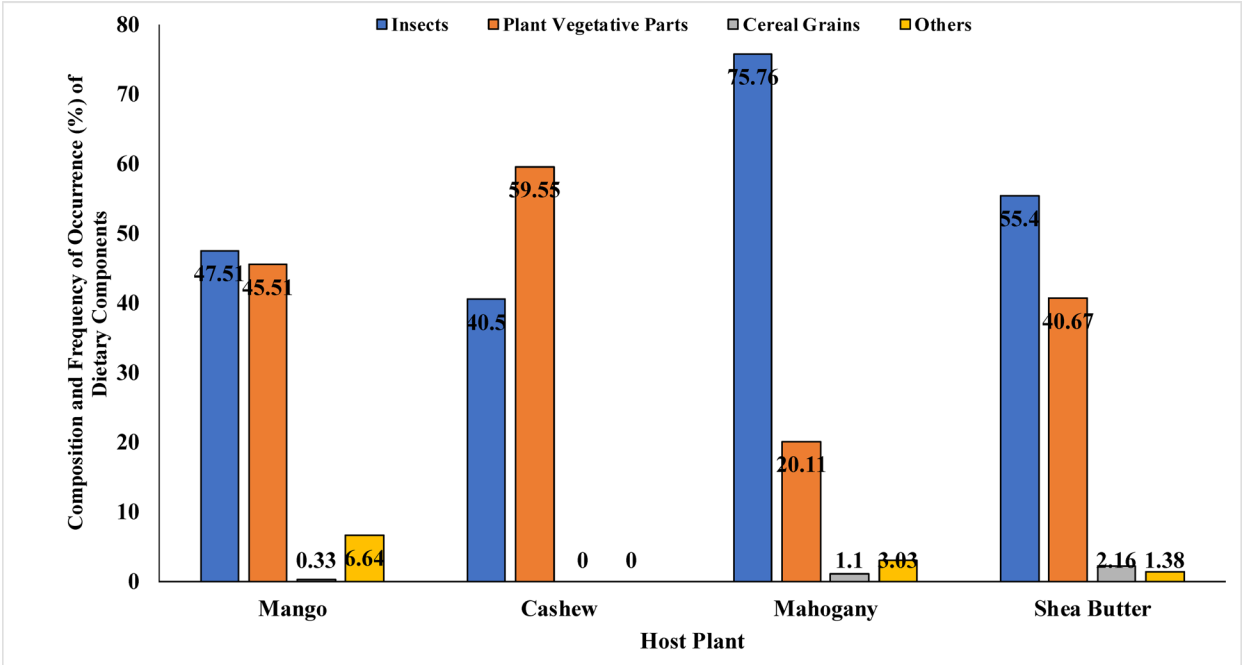


Fig. 7 Composition and frequency of occurrence (%) of dietary components retrieved from the nests of the Odorous Weaver Ant, *Oecophylla longinoda*, in relation to host plants in Northcentral Nigeria

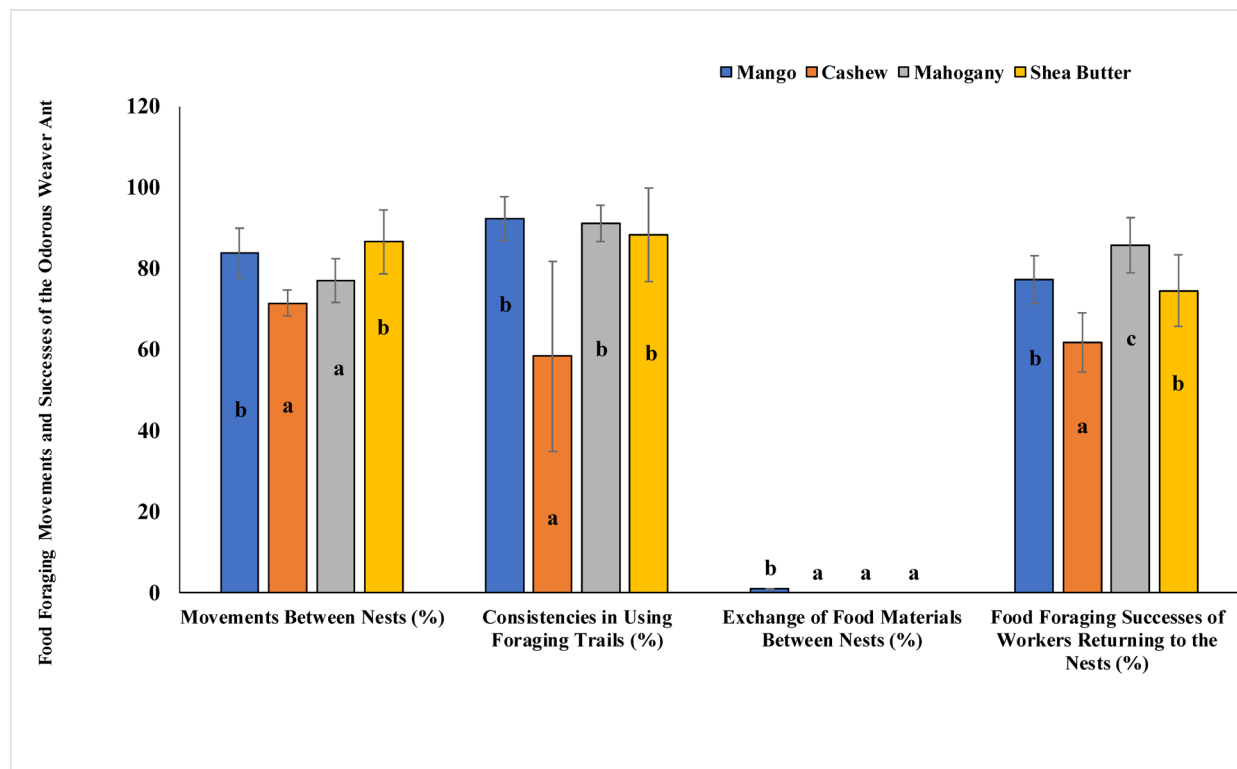


Fig. 8 Food foraging movements and successes of the Odorous Weaver Ant, *Oecophylla longinoda*, in relation to host plants, in Northcentral Nigeria. Bar graphs with the same alphabet for a behaviour are not significantly ($p > 0.05$) different

only slightly more common than vegetative parts in mango nests (47.51%). Plant vegetative parts represented the second most frequent category in these three host plants, ranging from 20.11% in mahogany to 45.51% in mango. A reverse trend was observed in cashew nests, where vegetative parts were most abundant (59.55%) compared to insects (40.50%).

Cereal grains occurred in very low proportions, ranging from 0.33% in mango to 2.16% in shea butter nests. Similarly, “Others” accounted for minor fractions, from 1.38% in shea butter to 6.64% in mango. Both cereal grains and “Others” were completely absent from cashew nests.

Foraging behaviour and success of the Odorous Ants

The foraging behaviour of *Oecophylla longinoda*, measured as internest movements, trail consistency, and foraging success, varied significantly across host plant types (Fig. 8). Internest movements were frequent, with an overall mean of 79.71%, ranging from 71.46% on cashew trees to 86.56% on shea butter trees.

Trail consistency, defined as the proportion of ants following established foraging paths, was lowest on cashew trees (58.30%) but reached very high values on shea butter (88.30%) and mango (92.20%) trees. Exchange of food materials between nests was virtually absent, recorded only occasionally (1.10%) in mango populations.

Foraging success, expressed as the proportion of ants returning to nests with food items, also differed significantly ($p < 0.05$) among host plants. The lowest success was observed on cashew trees (61.70%), while intermediate values were recorded on shea butter (74.50%) and mango (77.20%) trees. The highest success rate was associated with mahogany trees, where ants achieved a mean of 85.60%.

Discussion

Nest construction in *Oecophylla longinoda* is fundamental to colony survival, serving not only as shelter for adult workers but also as storage for food, brood-rearing chambers, and protection against adverse weather. In this study, irregular nest shapes were the most common, suggesting that nest architecture may not follow a rigid blueprint but instead reflects opportunistic folding of host plant leaves. Such irregularity could result from the ease and speed of manipulating leaves into random configurations with fewer workers, compared to the effort required to impose a specific geometric shape. The predominance of triangular nests on cashew and oval nests on shea butter trees likely reflects the inherent flexibility and curvature of leaves on these host plants, consistent with earlier findings that tree and leaf morphology strongly influence nest arrangement (Castelino & Roopavathy, 2018; Trocki et al., 2026).

Nest complexity, measured by the number of leaves used, varied significantly among shapes. Circle-shaped nests required the greatest investment (20.09 leaves/nest), followed by irregular nests, while triangular nests were the simplest (4.75 leaves/nest). This pattern aligns with geometric principles, as circular structures have larger surface areas than triangular ones, necessitating more leaves for construction.

Food storage also varied across host plants and land-use types. Shea butter trees supported the most resourceful nests, while cashew trees had the least. Residential and farmland sites yielded significantly higher food quantities than natural vegetation and office-business areas, likely due to greater availability of peri-domestic insect prey and anthropogenic food resources such as cereal grains and plant debris. These findings support earlier reports that host plants attracting pollinators or producing sugary secretions provide richer foraging opportunities (Bochynek & Robson, 2014; Thuman et al., 2019).

Dietary composition confirmed the omnivorous habits of *O. longinoda*. Insects dominated the food items in nests from mango, mahogany, and shea butter trees, while vegetative parts (e.g. leaves) were most abundant in cashew nests. The preference for protein-rich insect prey is consistent with previous studies (Pimid et al., 2019), yet the concurrent presence of plant materials highlights dietary flexibility. Similar observations were reported by Vayssières et al. (2018), who documented seasonal shifts in diet, with insect prey dominating during rainy periods and seeds or plant debris collected during the dry season.

Behavioural observations revealed high internest movements, reflecting colony cohesion and the absence of aggression among workers from different nests of the same colony (Newey et al., 2009). Colonies of *Oecophylla* are known to contain hundreds of thousands of individuals dispersed across multiple nests (Devarajan, 2016), and such movements likely facilitate coordination and resource distribution. Trail consistency was also high, particularly on mango and shea butter trees, underscoring the importance of pheromone-marked trails in guiding foraging activity (Ribeiro et al., 2009; Exélis et al., 2024). These trails are typically established along routes of least resistance, leading to reliable resource sites (Burchill et al., 2022).

Interestingly, food exchange between nests was rare, despite frequent internest movements. This contrasts with reports of food sharing among nests linked by trails (Heller et al., 2008; Pohl et al., 2016), suggesting that in this population, internest movements may serve purposes other than resource redistribution, such as colony surveillance or cooperative defence.

Foraging success was consistently high (>60%) but varied among host plants, peaking on mahogany trees (85.60%). The efficiency of foraging can be attributed to

the aggressiveness of major workers, which are equipped with potent venom and high agility for prey capture (Gathalkar & Sen, 2018; Patel & Bhatt, 2020; Exélis et al., 2022). Variability among host plants likely reflects differences in resource availability and attractiveness to insect prey.

Finally, environmental conditions such as temperature and humidity play critical roles in shaping ant behaviour. Optimal foraging occurs between 20 and 30 °C, with high humidity enhancing pheromone communication, while extreme cold or heavy rainfall suppresses activity (Langthasa et al., 2017; Thuman et al., 2019). These factors, combined with host plant traits and land-use influences, collectively determine the nesting, foraging, and dietary dynamics of *O. longinoda*.

Conclusion

This study demonstrated that *Oecophylla longinoda* exhibits remarkable adaptability in nest construction, food storage, diet, and foraging behaviour across different host plants and land-use types in the Nigerian savanna. Irregular and oval nests were most common, with complexity shaped by leaf morphology and nest surface area. Food storage was greatest in shea butter trees and in residential/farmland environments, while dietary analysis confirmed omnivory, with insects dominating most host plants but vegetative parts prevailing in cashew nests. Behavioural observations revealed high internest movements, strong trail consistency, and consistently high foraging success, particularly on mahogany trees. The findings highlight the ecological plasticity of *O. longinoda* and reinforce its potential as a sustainable biological control agent in agroecosystems, especially for fruit tree pest management in the Nigerian savanna.

Limitation of the study

While this study provides valuable insights into the nesting behaviour, dietary composition, and foraging dynamics of *Oecophylla longinoda* across different host plants and land-use types, several limitations should be acknowledged. First, the research was conducted within a single ecological zone of the Nigerian savanna, which may restrict the generalizability of the findings to other regions with different climatic or vegetation profiles. Second, observations were limited to specific seasons, and potential seasonal variations in nest architecture, food storage, and foraging success were not fully captured. Third, dietary analyses relied on food materials recovered from nests, which may not represent the complete spectrum of resources exploited by the ants in the field. Finally, behavioural observations were constrained by the sampling design and did not include long-term monitoring of colony dynamics, which could provide

deeper insights into resource allocation and inter-nest interactions.

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Author contributions

The submitted work was performed in collaboration with all authors. The experiment was designed by I.K.O., I.M.S., A.C.C., S.O.A., and M.T.S. The laboratory experiment was carried out by A.C.U., J.O.J., M.T.S., O.M.M., and C.S.J. under the supervision of I.K.O., K.A.O., K.O.S., O.M.M., and M.O.A. while I.K.O., A.C.U., and S.O.A. conducted the detailed literature review. Statistical analyses were done by I.K.O., A.C.U., and I.M.S. Critical revision of the article was done by I.K.O., A.C.U., I.M.S., S.O.A. and O.M.M. and All authors read and approved the final manuscript.

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Data availability

All data supporting the findings of this study are available within the paper.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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