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Species inventory and morphological traits of spiders (Arachnida, Araneae) and ants (Insecta, Hymenoptera, Formicidae) in northern Ghana

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Abstract

Background

Agricultural expansion, a leading driver of biodiversity loss, has widespread effects on ecosystem services, particularly in tropical regions. In West Africa, the impact of intensified agriculture on local biodiversity – especially predator and decomposer species like spiders and ants – is understudied. This study in northern Ghana examines the species diversity and functional traits of spiders and ants in human-transformed mango orchards and pristine savanna, aiming to compare the biodiversity of intensively managed agroecosystems and the extensively managed natural habitats. Insights will aid in estimating the effort needed to promote diversity through agroecological practices in mango orchards.

New information

In this data paper, we publish the baseline checklist and morphological traits of spiders (Araneae) and ants (Hymenoptera: Formicidae) associated with mango orchards and forest savannas located in northern Ghana. In total, we collected 64 species (including 29 unidentified morphospecies) of spiders and 64 species (including 24 unidentified

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morphospecies) of ants. Of these, almost all spider species and nine ant species were new records for Ghana, while many of the morphospecies could potentially be undescribed new species to science. In addition, we collected six morphological traits for spiders: total body length, prosoma length, prosoma width, prosoma height, tibia I (leg) length, and fang length; and four traits for ants: total body length, head length, scape length, and eye distance.

Keywords

agriculture, biodiversity, checklist, mango orchard, morpholometrics, standardized sampling, West Africa, West Sudanian savanna.

Introduction

Biodiversity loss – including decreases of genetic variability, population abundances, and species richness – lowers an ecosystem's capacity to maintain natural processes and its ability to provide goods and services to satisfy human needs. Despite our deep dependency on biodiversity (Cardinale et al. 2012), we are losing it alarmingly fast. One of the main drivers of biodiversity loss is agriculture (Dudley and Alexander 2017), as it leads to the conversion of natural habitats to managed systems, which, in addition to habitat loss, increases pollution, such as greenhouse gases and pesticide use. These factors are among the most important threats to spiders (Branco and Cardoso 2020) and insects (Mauda et al. 2018,Miličić et al. 2021) worldwide. By industrializing agriculture, we become even more dependent on a few crop and livestock species while contributing to the mass extinction of others. For instance, richness and abundance of predator and decomposer arthropods have been shown to decline because of increased intensive agricultural practices (Attwood et al. 2008, Prieto-Benítez and Méndez 2011, Potapov et al. 2020,Melo et al. 2021). While most of the biodiversity-ecosystem functioning studies come from Europe, North America, and Australia (Carrick and Forsythe 2020), similar studies need to be extended to all agricultural regions of the world.

The project "Sustainable intensification of food production through resilient farming systems in West and North Africa (SustInAfrica)" is a Horizon 2020 EU-funded capacity-building project targeting West and North African smallholder farmers to facilitate sustainable intensification of African farming systems. One of its objectives is to test and assess sustainable and resilient farming methods for mango (*Mangifera indica* L.), among other economical and environmental challenges, losing significant yields to pest insects, such as the mango seed weevil (Coleoptera: *Sternochetus mangiferae* (Fabricius, 1775)) and mango fruit flies (Diptera: *Bactrocera* spp., *Ceratitis* spp.). In Ghana, farmers still mostly rely on the use of synthetic pesticides (Akotsen-Mensah et al. 2017), which may have both direct and indirect negative effects on non-target organisms, and more sustainable agroecological practices promoting biodiversity and ecosystem services are needed. As a consequence, local biodiversity and its service

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providers (e.g., biological control agents) must be surveyed and monitored in order to evaluate the loss of ecosystem functioning due to farming.

We collected, quantified, and identified spiders (Araneae) and ants (Hymenoptera: Formicidae) from two human-transformed mango orchards and one pristine savanna habitat near Tamale, northern Ghana. The savanna sampling serves as a reference condition needed to quantify ecosystem integrity, i.e., to answer the question of how much different communities in agricultural areas compare with the original landscape dominated by savanna. Only with a baseline is it possible to know how much we lose in terms of taxonomic and functional diversity when relying on adverse agricultural practices. Spiders and ants were chosen as study taxa because **1)** they are abundant and common in various ecosystems, providing many ecosystem services and disservices (Del Toro et al. 2012, Michalko et al. 2018, Cardoso et al. 2024), and **2)** they have potential as bioindicators of ecosystem service provision (e.g. Gerlach et al. 2013).

Numerous studies have been published on West African spiders since the late 19th century. The earliest were pioneer expedition reports (such as Karsch 1879 or Marx 1893 , to cite a few), but eventually more focused and specialised works appeared, such as those by Millot in the 1940s (Berland and Millot 1941, Berland and Millot 1940, Millot 1941, Millot 1942, Millot 1946) or those by Jézéquel in the 1960s (Jézéquel 1964a, Jézéquel 1964b, Jézéquel 1964c, Jézéquel 1965, Jézéquel 1966). As a result of the interest of taxonomists and the availability of large collections that allow for comprehensive taxonomic and systematic studies, the studies published for each family have been largely biased towards certain groups. For example, the current knowledge of West African Ctenidae is significantly enriched after the works coordinated by Rudy Jocqué (Jocqué et al. 2006, Steyn et al. 2003, Jocqué and Steyn 1997, Henrard and Jocqué 2017), but other groups, such as the genus *Oxyopes* Latreille, 1804, an ubiquitous presence at African grasslands and shrublands, still lack a comprehensive revision of the African species that could allow proper identification.

In myrmecology, early notable authors include Gustav Mayr, Filippo Silvestri, Felix Santschi, Henri Stitz, Carlo Emery, and William Morton Wheeler, who contributed to early ant taxonomy, including African species. Later, Barry Bolton became known for extensive taxonomic work on African ants, publishing identification keys and descriptions still used today. More recent studies of ant diversity in West Africa were predominantly focused on ant assemblages in tropical forest-savanna (Belshaw and Bolton 1994, Yeo et al. 2011, Yeo et al. 2017, Kaiser et al. 2015), cocoa (Room 1971, Majer 1972, Kone et al. 2014), and mango orchards (Diamé et al. 2017, Taylor et al. 2018), to name a few. The most recent study from northwestern Ghana (Sosiak et al. 2024) recorded regionally unique ant assemblages across three habitats (41, 54, and 43 species in floodplain, Guinea savanna, and riparian forest habitats, respectively), protected within the Wechiau Community Hippo Sanctuary (WCHS). The authors found that the WCHS ant assemblage was relatively unique, sharing only about 35% of species found in similar Côte d'Ivoire habitats and 25% of other Ghanaian assemblages. As of 2024, there are 428 native ant

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species recorded from Ghana (antsmaps.org). Nevertheless, the surveys in Ghana and West Africa in general remain scattered, and a thorough region-wide revision is needed.

In order to study the biodiversity of mango agroecosystems, it is essential to have comparable and reliable metrics. Metrics such as species richness and evenness, being widely used, measure the composition and structure of communities (Gaston and Spicer 2013). In addition to taxonomic identities, a functional dimension can be applied by collecting species traits (Wong et al. 2018). In this data paper, we publish the checklist and morphological traits of spiders and ants associated with mango orchards and forest savannas in northern Ghana. Further taxa will be identified in the future and used for cross-taxa analyses of functional diversity and ecosystem service provision in the region.

General description

Purpose: "SustInAfrica" is a research project targeting West and North African smallholder farmers to facilitate sustainable intensification of African farming systems. Its overall objective is to develop and deploy a reference framework on best agricultural practices and technologies, based on a systems approach, and successfully verify their efficacy to intensify primary production in a self-sufficient, sustainable, and resilient manner. With this work, we intend to present a comprehensive database for species and traits of both spiders and ants sampled in the region of Tamale, northern Ghana. This work contributes to the objectives of SustInAfrica as a baseline for future monitoring of spider and ant taxonomic and functional diversity as providers of important ecosystem services and disservices, such as pest control and herbivory.

Project description

Title: Sustainable intensification of food production through resilient farming systems in West and North Africa (SustInAfrica)

Funding: SustInAfrica is funded by the EU Horizon 2020 Research and Innovation Programme under Grant Agreement 861924.

Sampling methods

Description: The West Sudanian savanna, situated in West Africa, is a tropical savanna ecoregion. In the northern part of Ghana (Fig. 1), it encompasses a hot and dry wooded savanna, characterized by large tree species and extensive "elephant" grass. This habitat has faced significant reduction, degradation, and fragmentation due to agricultural activities, fire, and clearance for wood and charcoal (One Earth 2024). Additionally, overhunting has led to a drastic decline in the populations of many larger mammal species. The ecoregion, predominantly flat and ranging between 200 and 400 meters in elevation, lacks prominent topographical features. Its climate is tropical, with mean monthly maximum temperatures fluctuating between 30 °C and 33 °C and mean

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minimum temperatures ranging from 18 °C to 21 °C. Annual rainfall reaches up to 1,000 mm in the southern region but decreases towards the north, with only 600 mm along the border with the Sahelian Acacia Savanna ecoregion. Rainfall is highly seasonal, and the dry season can persist for several months.

Sampling description: Sampling took place in three localities near the town of Tamale, northern Ghana (Fig. 2). In Kumbungu, a small town 20 km NW of Tamale (9.545, −0.934), five 30 × 30 m plots were each sampled with 32 pitfall traps and four Malaise traps. These plots were further divided into four approx. 10 × 10 m subplots with eight pitfall traps and one Malaise trap. In Dallung, a small town 30 km NW of Tamale (9.632, −1.007), a smaller 10 × 10 m plot was sampled with eight pitfall traps and one Malaise trap. In addition to these two mango orchards, a partly forested savanna in the Sinsablegbinni Forest Reserve, located 25 km E of Tamale (9.389, −0.601), was sampled with four 50 × 50 m plots, each with 48 pitfall traps and one Malaise trap.

One pitfall trap consisted of a 350-ml plastic cup (80 mm diameter) with propylene glycol up to half depth and a paper sheet to cover circa 2 cm above the ground. The traps were situated at least five meters apart from each other along the plot borders. Malaise traps were 120 × 100 × 150 cm, Townes style, in white color (Ento Sphynx, ref: 26.61). The Malaise traps were situated in the middle of each plot, usually in between two trees. The trapping interval lasted for fourteen days during October and November 2022. Because of flooding, some of the fieldwork was postponed in Kumbungu for two weeks (see Temporal Coverage for details). After sampling, the material was stored in 80% ethanol and transported to the Finnish Museum of Natural History (Luomus), University of Helsinki, Finland, for further processing.

Step description: Spiders and ants were sorted from the bulk material. All of the spider specimens were first sorted into adults and juveniles, and the adult specimens were identified into species and morphospecies depending on the available literature. Next, a maximum of five males and five females of each (morpho)species were measured for morphological traits. These same specimens were incorporated in the Luomus collections, the remaining specimens were shipped back to Ghana and are available at the collection of the University of Development Studies, Tamale, Ghana.

For ants, similar methods were used except that not all identified specimens were separated from the samples after counting to save time and space. Due to the heavily female-biased sex ratio and high size variation, five to ten workers of each (morpho)species were measured for morphological traits, and a maximum of ten individuals were stored in the Luomus collections, while the remaining specimens were shipped back to Ghana and are available at the collections of the University of Development Studies, Tamale, Ghana.

Leica S8AP0 and Leica M165C microscopes with Leica CLS 100 LED light sources were used for identification and morphometrics. Identification of higher taxonomy (families, subfamilies, and genera) followed the literature of African spiders: an identification manual (Dippenaar-Schoeman and Jocqué 1997) and Ants of Africa and Madagascar: a

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guide to genera (Fisher and Bolton 2016). Identification to species was made by searching taxonomic descriptions and keys from online databases (spiders: World Spider Catalog; ants: Antwiki and Ants of Africa).

Geographic coverage

Description: Northern region, Ghana, West Africa

Coordinates: 9.3793 and 9.6289 Latitude; −1.0077 and −0.5958 Longitude.

Taxonomic coverage

Description: The following taxa of the phylum Arthropoda are covered

Taxa included:

Rank	Scientific Name
phylum	Arthropoda
class	Arachnida
order	Araneae
class	Insecta
order	Hymenoptera
family	Formicidae

Traits coverage

Spiders: Total body length (mm), Prosoma length (mm), Prosoma width (mm), Prosoma height (mm), Tibia I (leg) length (mm), Fang length (mm).

Ants: Total body length (mm), Head length (mm), Scape length (mm), Eye distance (mm).

Temporal coverage

Data range: 2022-10-06 - 2022-11-14.

Notes:

6.-19. Oct 2022 (Kumbungu plots 1-3)

7.-21. Oct 2022 (Sinsablegbinni plots 3-4)

8.-22. Oct 2022 (Sinsablegbinni plots 1-2)

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13-27. Oct 2022 (Dallung)

31. Oct - 14. Nov 2022 (Kumbungu plots 4-5)

Collection data

Collection name: Finnish Museum of Natural History (MZH): Hymenoptera World (Luomus), Arachnida and Myriapoda (Luomus)

Collection identifier: http://tun.fi/HR.23, http://tun.fi/HR.46

Specimen preservation method: Ethanol 80 %

Curatorial unit: The Finnish Museum of Natural History (MZH), University of Helsinki, Finland

Usage licence

Usage licence: Open Data Commons Attribution License

IP rights notes: CC-BY 4.0

Data resources

Data package title: Occurrences and traits of spiders and ants collected in Ghana, West Africa

Resource link: https://doi.org/10.15468/h9vtau https://doi.org/10.5061/dryad.h18931zwc

Number of data sets: 3

Data set name: Occurrence data of spiders (Araneae) and ants (Hymenoptera: Formicidae) collected from northern Ghanaian mango orchards and forest savanna

Download URL: https://ipt.laji.fi/archive.do?r=osang

Description: The dataset contains occurrence data of 36 species and 29 morphospecies of spiders (Araneae) and 41 species and 22 morphospecies of ants (Formicidae) collected from ten sampling points in northern Ghana during Oct-Nov 2022. The total sample size is 288 samples of spiders with 438 mature individuals and 782 samples of ants with 7859 individuals. The dataset contains collection information (locality, habitat, collecting method, time, coordinates, collectors, etc.) and sample information (count, sex, remarks, etc.).

Column label	Column description
occurrenceID	An identifier for the dwc:Occurrence (e.g. Dallung-Plot-1-Sample-1-Spider-1).

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locationID	An identifier for the set of dcterms:Location information (e.g. Dallung-Plot-1).
eventDate	The date-time or interval during which a dwc:Event occurred (e.g. 2022-10-13/2022-10-27).
samplingProtocol	The names of, references to, or descriptions of the methods or protocols used during a dwc:Event (e.g. Pitfall traps).
family	The full scientific name of the family in which the dwc:Taxon is classified (e.g. Lycosidae).
subfamily	The full scientific name of the subfamily in which the dwc:Taxon is classified (e.g. Formicinae).
genus	The full scientific name of the genus in which the dwc:Taxon is classified (e.g. Trochosa).
scientificName	The full scientific name, with authorship and date information if known (e.g. *Myrmarachne kiboschensis* Lessert, 1925).
taxonRank	The taxonomic rank of the most specific name in the dwc:scientificName (e.g. genus).
identificationID	An identifier for the set of dwc:Taxon information (e.g Thomisidae008_GHA).
identificationRemarks	Comments or notes about the dwc:Identification (e.g. "Could be A. wilsoni which occurs in South Africa.").
identifiedBy	A list (concatenated and separated) of names of people, groups, or organizations who assigned the dwc:Taxon to the subject (e.g. Luís Crespo).
dateIdentified	The date on which the subject was determined as representing the dwc:Taxon (e.g. 2023-03-17).
sex	The sex of the biological individual(s) represented in the dwc:Occurrence (e.g. female).
caste	Categorisation of individuals for eusocial species (e.g. worker).
individualCount	The number of individuals present at the time of the dwc:Occurrence (e.g. 1).
basisOfRecord	The specific nature of the data record (e.g. HumanObservation).
occurrenceStatus	A statement about the presence or absence of a dwc:Taxon at a dcterms:Location (e.g. present).
organismRemarks	Comments or notes about the dwc:Organism instance (e.g. "Missing two legs").
dynamicProperties	A list of additional measurements, facts, characteristics, or assertions about the record. Meant to provide a mechanism for structured content (e.g.{"HW": 0.4875,"HL":0.625,"CI":78,"SIL":52}; abbreviations were retrieved from "antwiki Mophological Measurements")
occurrenceRemarks	Comments or notes about the dwc:Occurrence (e.g. a new species).
continent	The name of the continent in which the dcterms:Location occurs (e.g. Africa).

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higherGeography	A list (concatenated and separated) of geographic names less specific than the information captured in the dwc:locality term (e.g. West Africa).
country	The name of the country or major administrative unit in which the dcterms:Location occurs (e.g. Ghana).
stateProvince	The name of the next smaller administrative region than country (state, province, canton, department, region, etc.) in which the dcterms:Location occurs (e.g. Northern region).
locality	The specific description of the place (e.g. 30 km NW of Tamale).
habitat	A category or description of the habitat in which the dwc:Event occurred (e.g. West Sudanian savanna).
decimalLatitude	The geographic latitude (in decimal degrees, using the spatial reference system given in dwc:geodeticDatum) of the geographic center of a dcterms:Location. Positive values are north of the Equator, negative values are south of it (e.g. 9.544).
decimalLongitude	The geographic longitude (in decimal degrees, using the spatial reference system given in dwc:geodeticDatum) of the geographic center of a dcterms:Location. Positive values are east of the Greenwich Meridian, negative values are west of it (e.g. −0.936).
geodeticDatum	The ellipsoid, geodetic datum, or spatial reference system (SRS) upon which the geographic coordinates given in dwc:decimalLatitude and dwc:decimalLongitude are based (e.g. WGS84).
georeferenceSources	A list (concatenated and separated) of maps, gazetteers, or other resources used to georeference the dcterms:Location, described specifically enough to allow anyone in the future to use the same resources (e.g. Google maps).
coordinateUncertaintyInMeters	The horizontal distance (in meters) from the given dwc:decimalLatitude and dwc:decimalLongitude describing the smallest circle containing the whole of the dcterms:Location (e.g. 300).
recordedBy	A list (concatenated and separated) of names of people, groups, or organizations responsible for recording the original dwc:Occurrence (e.g. Francis Asamoah | Pedro Cardoso | Stéphanie Saussure | Arttu Soukainen | Fuseini Wumdei).
associatedOccurrences	A list (concatenated and separated) of identifiers of other dwc:Occurrence records and their associations to this dwc:Occurrence (e.g. id.luomus.fi/HV.25869).
countryCode	The standard code for the country in which the dcterms:Location occurs (e.g. GH).
kingdom	The full scientific name of the kingdom in which the dwc:Taxon is classified (e.g. Animalia).
id	ID of the data row added by the IPT (here same as occurrenceID).

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Data set name: Morphological traits of spiders (Araneae) collected from northern Ghanaian mango orchards and forest savanna

Download URL: https://datadryad.org/stash/dataset/doi:10.5061/dryad.h18931zwc

Description: This dataset contains the values of morphological traits measured from mature spiders collected in northern Ghana October/November 2022. The six measured morphological traits for spiders are Total body length (mm), Prosoma length (mm), Prosoma width (mm), Prosoma height (mm), Tibia I length (mm) and Fang length (mm).

Column label	Column description
organismID	An identifier for the dwc:Organism instance.
family	The full scientific name of the family in which the dwc:Taxon is classified (e.g. Lycosidae).
genus	The full scientific name of the genus in which the dwc:Taxon is classified (e.g. Trochosa).
scientificName	The full scientific name, with authorship and date information if known (e.g. *Myrmarachne kiboschensis* Lessert, 1925).
taxonRank	The taxonomic rank of the most specific name in the dwc:scientificName (e.g. species).
identificationID	An identifier for the set of dwc:Taxon information (e.g Lycosidae034_GHA).
sex	The sex of the biological individual (e.g. female).
measurementRemarks	Comments or notes accompanying the measurements (e.g. "detached opisthosoma").
Total body length mm	Maximum Opisthosoma length + Maximum Prosoma length in millimeters (excl. chelicerae and spinnerets).
Prosoma length mm	Maximum length of the prosoma antero-posteriorly from clypeus to pedicel in millimeters.
Prosoma width mm	Maximum length of the prosoma meso-laterally in millimeters.
Prosoma height mm	Maximum length of the prosoma dorso-ventrally in millimeters.
Tibia I length mm	Maximum length of the outer tibia I (leg) in millimeters.
Fang length mm	Maximum length of the fang from outer base to tip in millimeters.
measurementMethod	A description of the method used to determine the measurement (e.g. microscopy).

Data set name: Morphological traits of ants (Hymenoptera: Formicidae) collected from northern Ghanaian mango orchards and forest savanna

Download URL: https://datadryad.org/stash/dataset/doi:10.5061/dryad.h18931zwc

Description: This dataset contains the values of morphological traits measured from ants collected in northern Ghana October/November 2022. The four measured

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morphological traits for ants are Total body length (mm), Head length (mm), Scape length (mm) and Eye Distance (mm).

Column label	Column description
organismID	An identifier for the dwc:Organism instance.
subfamily	The full scientific name of the subfamily in which the dwc:Taxon is classified (e.g. Formicinae).
genus	The full scientific name of the genus in which the dwc:Taxon is classified (e.g. Camponotus).
scientificName	The full scientific name, with authorship and date information if known (e.g. *Camponotus sericeus* (Fabricius, 1798)).
taxonRank	The taxonomic rank of the most specific name in the dwc:scientificName (e.g. subspecies).
identificationID	An identifier for the set of dwc:Taxon information (e.g Pheidole002_GHA).
caste	Categorisation of individuals for eusocial species (e.g. worker).
measurementRemarks	Comments or notes accompanying the measurements (e.g. "head dented").
Total body length mm	Maximum Head length + Maximum Mesosomal (Weber's) length + Maximum Metasomal length in millimeters.
Head length mm	Maximum length of the head excluding mandibles in millimeters.
Scape length mm	Maximum length of the 1st antennal segment.
Eye distance mm	Minimum length of the distance between compound eye and mandibular base in millimeters.
measurementMethod	A description of the method used to determine the measurement (e.g. microscopy).

Additional information

Our survey revealed 64 (morpho)species of spiders from 47 genera and 22 families (Table 1). The total sample size was 438 individuals, with 291 males and 147 females (juveniles were not counted). In total, 35 taxa (55%) were identified to species level and 29 (45%) to morphospecies. Approximately 40 % of the observed taxa were singletons (only one occurrence), while the most abundant (morpho)species with 64 individuals was *Dusmadiores* sp. (Zodariidae009_GHA).

Our survey revealed 64 (morpho)species of ants from 27 genera and five subfamilies (Table 2). The total sample size was 7,849 individuals, of which four were males. In total, 40 taxa (62.5%) were identified to species level and 24 (37.5%) to morphospecies. Approximately 17% of the observed taxa were singletons (only one occurence), while the most abundant (morpho)species with over 2,700 individuals was *Pheidole* sp. (Pheidole002_GHA).

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In Kumbungu mango orchards, species richness (mean 8.4 ± sd 2.19), hill number 1 (6.5 ± 2.52), and evenness (0.907 ± 0.054) of spiders were rather low and variable (Table 3). The single plot in the Dallung mango orchard also revealed low values for species richness (8.0), hill number 1 (6.5), and evenness (0.901), which was expected due to lower sampling intensity in the area. Finally, in Sinsablegbinni Forest Reserve, species richness (10.0 ± 2.15), hill number 1 (8.6 ± 2.47), and evenness (0.947 ± 0.015) of spiders were higher on average.

In Kumbungu mango orchards, species richness (mean 14.7 ± sd 3.62), hill number 1 (6.6 ± 2.37), and evenness (0.918 ± 0.023) of ants were surprisingly high but had high variance between plots (Table 3). As with spiders, the single plot at Dallung mango orchard showed low values for species richness (10.7), hill number 1 (6.1) and evenness (0.894) of ants. Finally, in Sinsablegbinni Forest Reserve, species richness (14.7 ± 2.13), hill number 1 (5.57 ± 1.45), and evenness (0.935 ± 0.015) of ants were more or less the same as in Kumbungu.

In addition to alpha diversity, we calculated the community weighted means of each spider (Table 4) and ant trait (Table 5). For instance, the largest spiders and ants (by total body size), on average, occurred in Kumbungu mango orchards (4.710 and 5.349 mm, respectively), while the smallest spiders and ants occurred in Sinsablegbinni Forest Reserve (2.942 and 4.353 mm, respectively).

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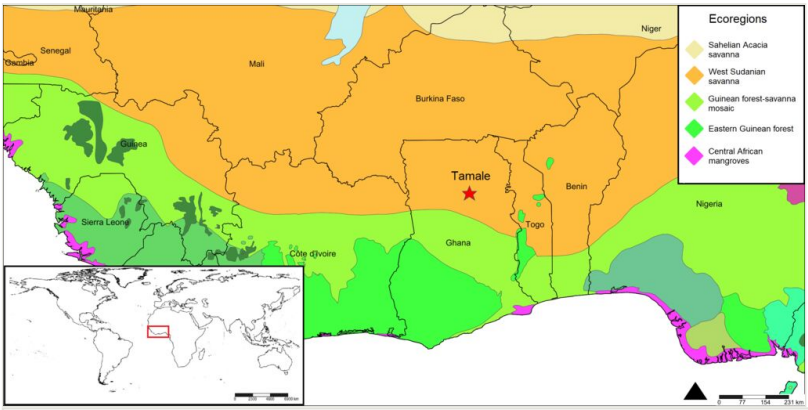

Figure 1.

The research took place in the vicinity of Tamale (red star), a northern Ghanaian town that is located in the southern part of the West Sudanian savanna ecoregion (in orange colour). Map made with SimpleMappr.

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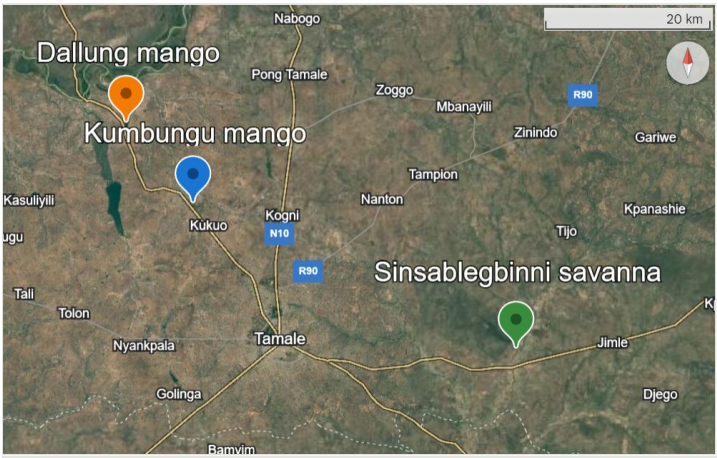

Figure 2.

Localities of the study sites on a base map from Google Earth.

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Table 1.

List of all spider (morpho)species in taxonomic and alphabetical order by their family, the first records from Ghana, presence/absence within habitats, and the total number of observed individuals.

Species/morphospecies	**Family**	**First record from Ghana**	**Mango**	**Savanna**	**Count**
Larinia sp. Araneidae027_GHA	Araneidae			X	1
Neoscona blondeli (Simon, 1886)	Araneidae	no	X		1
Neoscona cereolella (Strand, 1907)	Araneidae	yes	X		1
Clubiona sp. Clubionidae037_GHA	Clubionidae		X		1
Cambalida compressa Haddad, 2012	Corinnidae	yes		X	1
Cambalida fulvipes (Simon, 1896)	Corinnidae	yes	X		1
Anahita aculeata (Simon, 1897)	Ctenidae	yes	X	X	4
Acontius sp. Cyrtaucheniidae024_GHA	Cyrtaucheniidae		X	X	2
Hongkongia sp. Gnaphosidae006_GHA	Gnaphosidae		X	X	5
Minosia clypeolaria (Simon, 1907)	Gnaphosidae	yes	X		28
Minosia eburneensis Jézéquel, 1965	Gnaphosidae	yes	X		2
Synaphosus yatenga Ovtsharenko, Levy & Platnick, 1994	Gnaphosidae	yes		X	1
Zelotes cassinensis FitzPatrick, 2007	Gnaphosidae	yes	X		7
Zelotes scrutatus (O.Pickard-Cambridge, 1872)	Gnaphosidae	yes		X	2
Agyneta prosectes (Locket, 1968)	Linyphiidae	yes		X	1
Ceratinopsis idanrensis Locket & Russell-Smith, 1980	Linyphiidae	yes	X		5
Ceratinopsis machadoi (Miller, 1970)	Linyphiidae	yes		X	7
Erigone prominens Bösenberg & Strand, 1906	Linyphiidae	yes	X		19
Metaleptyphantes perexiguus (Simon & Fage, 1922)	Linyphiidae	yes	X	X	3
Amblyothele hamatula Russell-Smith, Jocqué & Alderweireldt, 2009	Lycosidae	yes		X	1
Amblyothele sp. Lycosidae023_GHA	Lycosidae			X	22
Arctosa sp. Lycosidae034_GHA	Lycosidae		X		2
Foveosa albicapillis Russell-Smith, Alderweireldt & Jocqué, 2007	Lycosidae	yes	X	X	7

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Lycosidae030_GHA	Lycosidae		X		1
Pardosa sp. Lycosidae033_GHA	Lycosidae		X		1
Trochosa mundamea Roewer, 1960	Lycosidae	yes	X	X	6
Trochosa sp. Lycosidae010_GHA	Lycosidae			X	5
Trochosa sp. Lycosidae029_GHA	Lycosidae		X		34
Speocera sp. Ochyroceratidae014_GHA	Ochyroceratidae			X	6
Oecobius sp. Oecobiidae005_GHA	Oecobiidae		X	X	27
Antoonops kamieli Fannes, 2013	Oonopidae	yes	X	X	3
Oonopidae020_GHA	Oonopidae		X	X	21
Oonopidae026_GHA	Oonopidae			X	1
Opopaea sp. Oonopidae036_GHA	Oonopidae		X		3
Oxyopes dumonti (Vinson, 1863)	Oxyopidae	yes		X	3
Oxyopes sp. Oxyopidae021_GHA	Oxyopidae			X	1
Oxyopes sp. Oxyopidae028_GHA	Oxyopidae		X		1
Oxyopes sp. Oxyopidae032_GHA	Oxyopidae		X		1
Scelidocteus sp. Palpimanidae015_GHA	Palpimanidae			X	1
Thanatus sp. Philodromidae038_GHA	Philodromidae		X		8
Tibellus minor Lessert, 1919	Philodromidae	yes	X		4
Perenethis simoni (Lessert, 1916)	Pisauridae	yes	X		1
Evarcha idanrensis Wesołowska & Russell-Smith, 2011	Salticidae	yes		X	2
Hyllus dotatus (G.W.Peckham & E.G.Peckham, 1903)	Salticidae	yes	X		1
Langelurillus sp. Salticidae004_GHA	Salticidae		X	X	9
Langona bristowei Berland & Millot, 1941	Salticidae	yes	X		1
Manzuma jocquei (Azarkina, Wesołowska & Russell-Smith, 2011)	Salticidae	yes	X		1
Menemerus eburnensis Berland & Millot, 1941	Salticidae	yes		X	1
Myrmarachne kiboschensis Lessert, 1925	Salticidae	yes	X		2
Phlegra pusilla Wesołowska & van Harten, 1994	Salticidae	yes	X	X	2
Phlegra touba Logunov & Azarkina, 2006	Salticidae	yes	X	X	15
Stenaelurillus sp. Salticidae007_GHA	Salticidae			X	6

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Scytodes reticulata Jézéquel, 1964	Scytodidae	yes		X	1
Cepheia longiseta (Simon, 1881)	Synaphridae	yes	X		1
Tetragnatha jaculator Tullgren, 1910	Tetragnathidae	yes	X		1
Argyrodes argyrodes (Walckenaer, 1841)	Theridiidae	yes	X		1
Theridiidae013_GHA	Theridiidae			X	1
Bassaniodes sp. Thomisidae035_GHA	Thomisidae		X		12
Ozyptila sp. Thomisidae008_GHA	Thomisidae			X	2
Acanthinozodium sahelense Jocqué & Henrard, 2015	Zodariidae	yes		X	7
Dusmadiores sp. Zodariidae009_GHA	Zodariidae		X	X	64
Mallinella sp. Zodariidae022_GHA	Zodariidae		X	X	9
Mallinella sp. Zodariidae031_GHA	Zodariidae		X		4
Zodariidae012_GHA	Zodariidae			X	42

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Table 2.

List of all ant (morpho)species in taxonomic and alphabetical order by their subfamily, the first records from Ghana, presence/absence within habitats, and the total number of observed individuals.

Species/morphospecies	**Subfamily**	**First record from Gh**
Tapinoma carininotum Weber, 1943	Dolichoderinae	yes
Aenictus boltoni Gomez, 2022	Dorylinae	no
Aenictus guineensis Santschi, 1924	Dorylinae	no
Dorylus braunsi Emery, 1895	Dorylinae	yes
Dorylus spininodis Emery, 1901	Dorylinae	no
Parasyscia kenyensis (Consani, 1951)	Dorylinae	yes
Parasyscia sudanensis (Weber, 1942)	Dorylinae	no
Agraulomyrmex001_GHA	Formicinae	yes
Camponotus carbo occidentalis Mayr, 1902	Formicinae	no
Camponotus maculatus species complex	Formicinae	
Camponotus sericeus (Fabricius, 1798)	Formicinae	no
Camponotus001_GHA	Formicinae	
Camponotus002_GHA	Formicinae	
Camponotus003_GHA	Formicinae	
Camponotus004_GHA	Formicinae	
Camponotus005_GHA	Formicinae	
Lepisiota capensis guineensis (Mayr, 1902)	Formicinae	no
Lepisiota capensis laevis (Santschi, 1913)	Formicinae	no
Lepisiota001_GHA	Formicinae	
Lepisiota002_GHA	Formicinae	
Nylanderia scintilla LaPolla & Fisher, 2011	Formicinae	yes
Oecophylla longinoda (Latreille, 1802)	Formicinae	no
Paratrechina longicornis (Latreille, 1802)	Formicinae	no
Polyrhachis viscosa Smith, F., 1858	Formicinae	no
Cardiocondyla emeryi Forel, 1881	Myrmicinae	no
Cardiocondyla yoruba Rigato, 2002	Myrmicinae	no
Carebara001_GHA	Myrmicinae	

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Crematogaster001_GHA	Myrmicinae	
Crematogaster002_GHA	Myrmicinae	
Crematogaster003_GHA	Myrmicinae	
Crematogaster004_GHA	Myrmicinae	
Meranoplus magrettii André, 1884	Myrmicinae	no
Monomorium afrum André, 1884	Myrmicinae	no
Monomorium balathir Bolton, 1987	Myrmicinae	no
Monomorium bicolor Emery, 1877	Myrmicinae	no
Monomorium mictilis Forel, 1910	Myrmicinae	yes
Monomorium001_GHA	Myrmicinae	
Monomorium002_GHA	Myrmicinae	
Myrmicaria salambo Wheeler, W.M., 1922	Myrmicinae	no
Myrmicaria001_GHA	Myrmicinae	
Pheidole001_GHA	Myrmicinae	
Pheidole002_GHA	Myrmicinae	
Pheidole003_GHA	Myrmicinae	
Pheidole004_GHA	Myrmicinae	
Pheidole005_GHA	Myrmicinae	
Strumigenys rufobrunea Santschi, 1914	Myrmicinae	no
Tetramorium angulinode Santschi, 1910	Myrmicinae	no
Tetramorium anxium Santschi, 1914	Myrmicinae	no
Tetramorium caldarium (Roger, 1857)	Myrmicinae	yes
Tetramorium calinum Bolton, 1980	Myrmicinae	no
Tetramorium dysderke Bolton, 1980	Myrmicinae	yes
Tetramorium ericae Arnold, 1917	Myrmicinae	yes
Tetramorium sericeiventre Emery, 1877	Myrmicinae	no
Tetramorium zapyrum Bolton, 1980	Myrmicinae	no
Tetramorium001_GHA	Myrmicinae	
Trichomyrmex abyssinicus (Forel, 1894)	Myrmicinae	no
Trichomyrmex oscaris (Forel, 1894)	Myrmicinae	no
Bothroponera silvestrii Santschi, 1914	Ponerinae	no

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Bothroponera soror (Emery, 1899)	Ponerinae	no
Brachyponera sennaarensis (Mayr, 1862)	Ponerinae	no
Hypoponera punctatissima (Roger, 1859)	Ponerinae	no
Leptogenys longiceps Santschi, 1914	Ponerinae	no
Odontomachus troglodytes Santschi, 1914	Ponerinae	no
Plectroctena macgeei Bolton, 1974	Ponerinae	no

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Table 3.

Alpha diversity of spiders and ants within each plot. Observed mean species richness, the exponent of Shannon diversity (hill q = 1), and evenness were calculated with R package 'BAT' 2.9.6. (Cardoso et al. 2015).

		Spiders
Plot	**Species richness**	**Hill q = 1**
Kumbungu 1	11.79	10.378
Kumbungu 2	8.59	5.638
Kumbungu 3	5.80	3.449
Kumbungu 4	8.40	6.858
Kumbungu 5	7.43	6.207
Dallung	8.00	6.492
Sinsablegbinni 1	12.85	11.742
Sinsablegbinni 2	10.52	9.340
Sinsablegbinni 3	8.15	6.474
Sinsablegbinni 4	8.57	6.784

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Table 4.

Community weighted mean (the average of the local distribution of a trait in a community) of spider traits within each plot. Calculated with R package 'BAT' 2.9.6. (Cardoso et al. 2015).

	Spiders					
Plot	**Total body length (mm)**	**Prosoma length (mm)**	**Prosoma width (mm)**	**Prosoma heigth (mm)**	**Tibia I length (mm)**	**Fang length (mm)**
Kumbungu 1	5.929	2.621	1.865	1.383	2.181	0.405
Kumbungu 2	5.193	2.504	1.931	1.426	1.275	0.406
Kumbungu 3	4.688	2.287	1.774	1.305	1.442	0.355
Kumbungu 4	4.381	2.264	1.853	1.292	1.424	0.386
Kumbungu 5	3.361	1.726	1.440	1.044	1.236	0.250
Dallung	3.383	1.710	1.241	0.962	1.158	0.364
Sinsablegbinni 1	3.860	1.877	1.460	1.100	1.147	0.313
Sinsablegbinni 2	2.631	1.254	0.972	0.745	0.823	0.173
Sinsablegbinni 3	2.485	1.217	0.915	0.715	0.884	0.157
Sinsablegbinni 4	2.792	1.430	1.047	0.818	0.990	0.189

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Table 5.

Community weighted mean (the average of the local distribution of a trait in a community) of ant traits within each plot. Calculated with R package 'BAT' 2.9.6. (Cardoso et al. 2015).

Ants				
Plot	**Total body length (mm)**	**Head length (mm)**	**Scape length (mm)**	**Eye distance (mm)**
Kumbungu 1	4.947	1.090	1.166	0.340
Kumbungu 2	6.821	1.343	1.295	0.426
Kumbungu 3	7.035	1.333	1.418	0.517
Kumbungu 4	3.835	0.849	0.970	0.244
Kumbungu 5	4.107	0.877	0.735	0.143
Dallung	5.015	1.129	1.185	0.274
Sinsablegbinni 1	5.112	1.043	1.171	0.334
Sinsablegbinni 2	3.702	0.817	0.991	0.203
Sinsablegbinni 3	4.409	0.925	1.028	0.233
Sinsablegbinni 4	4.187	0.891	0.789	0.156