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Arthropoda Community Structure in Sweet Corn-Turmeric Intercropping Agroecosystem

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Abstract
Arthropod diversity plays an important role in maintaining the balance and ecological resilience of agroecosystems. Intercropping systems provide more diverse habitats and resources, which can attract various arthropod species and influence community composition. This study aimed to investigate the diversity of arthropods in the sweet corn–turmeric intercropping agroecosystem. The research was conducted at the Experimental Farm of the Faculty of Agriculture, University of Jambi, and arthropod identification was carried out in the Plant Pest Laboratory. The observation variables focused on species diversity, abundance, and ecological functional groups of arthropods. Arthropod samples were collected at the early of the sweet corn vegetative phase using pitfall traps, yellow sticky traps, and sweep nets. Data were analyzed using the Shannon–Wiener diversity index (H′), dominance index (D), Evenness index (E), and true alpha diversity ($^1D = e^{H'}$). The results showed that the values of H′, D, E, and ^1D were 2.64, 0.09, 0.88, and 13,96, respectively. The ecological functional structure of arthropods consisted of herbivores (25.0%), predators (61.1%), parasitoids (2.8%), pollinators (5.6%), and decomposers (2.8%). These results indicate that the sweet corn–turmeric intercropping agroecosystem supports high arthropod diversity, a stable community structure, and provides favorable conditions for the conservation of natural enemies, particularly predators.

Keywords: Arthropod diversity; intercropping; sweet corn; turmeric; ecological roles

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INTRODUCTION

Arthropod diversity is a key component in the functioning of agricultural ecosystems, as arthropods act as herbivores, predators, parasitoids, pollinators, and decomposers. They are collectively influencing productivity, pest resistance, and the ecological resilience of agroecosystems [1]. Crop diversification practices, including intercropping, are often promoted as agroecological strategies that enhance biotic diversity in farm lands while reducing pest pressure through the enrichment of natural enemies (predators and parasitoids) and the provision of more complex habitats [2,3]. Intercropping increases overall arthropod abundance, it also creates a more balanced community where beneficial organisms are not heavily outnumbered by pests and contributes to enhanced ecological resilience [4].

Mechanistically, the effectiveness of intercropping in pest regulation is driven by changes in habitat structure (e.g., vegetation density, canopy stratification), the availability of alternative food sources, and the enrichment of non-target resources such as floral nectaries or refugia for natural enemies. These factors can alter predator–prey dynamics, enhance natural biological control, and improve the stability of arthropod communities in paddy fields or maize plots [3,5].

Maize (Zea mays) is one of the most commonly used main crops in intercropping systems and has been extensively studied for its interactions with arthropod communities, including key pests such as S. frugiperda and various Hemipteran groups. Studies in maize-based systems show considerable variation in arthropod community composition depending on companion crop species, row arrangements, and agronomic management practices [6,7].

Meanwhile, turmeric (Curcuma longa L.), a spice and medicinal crop, has increasingly been incorporated into intercropping schemes due to its economic value and flexible agronomic characteristics. Agronomic studies on turmeric highlight spatial arrangements and cultivation practices that may influence arthropod presence both within the canopy and on the soil surface [8]. However, research specifically examining arthropod communities in maize–turmeric intercropping systems remains limited. Empirical studies are therefore needed to understand how this crop combination affects community structure and ecological functions, including the conservation of natural enemies.

The assessment of arthropod diversity typically integrates multiple metrics—such as species richness, abundance, diversity indices (e.g., Shannon–Wiener index H′), and true diversity (Hill numbers)—to provide a holistic picture of community structure. True alpha diversity (e.g., Hill number of order 1, $^1D = e^{H'}$) helps translate H′ into the intuitive unit of “equivalent number of pecies,” making interpretations more meaningful for researchers and policymakers [6,9].

Moreover, management practices such as the use of synthetic insecticides often reduce non-target diversity and weaken long-term biological control services. Intercropping has emerged as a sustainable alternative that minimizes chemical dependence by leveraging natural ecological processes [1,10]. Policy reviews also emphasize that intercropping designs considering floristic composition and spatial patterns can maximize ecological benefits without significantly compromising crop yields.

Given the limited understanding of arthropod community dynamics within sweet corn–turmeric intercropping systems, this study was designed to evaluate species composition, diversity, and ecological functional structure of arthropods in this

agroecosystem. Specifically, it aimed to quantify the diversity index (H′), dominance index (D), and true alpha diversity (^{1}D), and to assess the functional group composition including herbivores, predators, parasitoids, pollinators, and decomposers to assess the potential for natural enemy conservation and community stability. The findings are expected to provide empirical evidence supporting agroecological practices for spice and food crop production systems in tropical regions.

METHODS

This study was conducted from at the Teaching and Research Farm and the Entomology Laboratory of the Faculty of Agriculture, Universitas Jambi, located in Mendalo Indah Village, Jambi Luar Kota Subdistrict, Muaro Jambi Regency, Indonesia (1.6164404° S, 103.5218753° E), from Januari to September 2025 Identification of arthropod specimens was subsequently carried out at the Plant Pest Laboratory, Faculty of Agriculture, Universitas Jambi, and at the Entomology Laboratory of the Animal, Fish, and Plant Quarantine Agency of Jambi.

The research was designed as a field observation focusing on arthropod diversity within a sweet corn–turmeric intercropping agroecosystem covering a 20 × 10 m area. The observed field had previously been established with turmeric plants aged 25 weeks after planting (WAP), prior to the sowing of sweet corn. Turmeric was arranged at a spacing of 75 × 40 cm, while sweet corn was sown at diagonal intersection points between turmeric planting positions following a 2:1 jajar legowo pattern, in which one row was left unplanted after every two rows of corn. Consequently, the corn population within the intercropping system represented approximately two-thirds of that in monoculture cultivation.

Land conditions were maintained through routine field management practices including weed removal and soil loosening using a hoe. At 25 WAP of turmeric, sweet corn seeds were sown by placing two to three seeds per hole according to the designated pattern. Field maintenance included watering, replanting, thinning, and manual weeding. Watering was conducted daily in the morning and evening using a watering can, except on days with adequate rainfall. Replanting was performed for corn seeds that failed to germinate within seven days after sowing, using prepared replacement seedlings, and thinning ensured two plants per hole by carefully removing extra seedlings.

The observation variables focused on species diversity, abundance, and ecological functional groups of arthropods. Data included the number of individuals and species composition, encompassing herbivores, predators, parasitoids, pollinators, and decomposers.

Arthropod observations were conducted using three standard sampling methods widely applied in agroecosystem biodiversity studies—pitfall traps, yellow pan traps, and sweep nets [11-13]. Sampling was performed three times, corresponding to different crop growth stages: Observation 1 at 3 weeks after sowing (WAS) of corn and 28 WAP of turmeric, Observation 2 at 6 WAS and 31 WAP, and Observation 3 at 8 WAS and 33 WAP.

Pitfall traps consisted of plastic cups (8 cm diameter × 12 cm height) arranged systematically in a diagonal pattern, with five traps per observation area. Each trap was filled with 150 ml of detergent solution and covered with a small 20 × 20 cm plastic roof to prevent flooding. The traps were set at 10:00 a.m. and left for 24 hours to capture ground-dwelling arthropods active during both daytime and nighttime, such as ants, beetles, and spiders [13]. Yellow pan traps, made of plastic pans (15 × 25 cm) filled with 150 ml of detergent solution

(Sunlight®), were positioned at the plant canopy height using wooden supports, with five traps systematically distributed across the observation area. These traps were left in the field for 24 hours and effectively captured flying and flower-visiting insects, particularly pollinators [12]. Sweep net sampling used a cone-shaped net (30 cm opening diameter, organza fabric) swung 20 times across the vegetation between 07:00 and 10:00 a.m. to collect foliage-dwelling arthropods [11]. All captured specimens were preserved in bottles containing 70% ethanol and transported to the Plant Pest Laboratory, Faculty of Agriculture, Universitas Jambi for further identification.

Arthropods were identified to the Class, Order, Family, Genus, and Species levels based on morphological characteristics following the standard taxonomic keys of Borror, Triplehorn, and Johnson [16]. Macrophotography was employed to support non-destructive and detailed morphological observations [14]. Identification was further validated through reference to scientific publications such as undergraduate theses, journals, and dissertations, and verified via reliable online databases, including BugGuide for expert-assisted visual confirmation [15]. Identified species were subsequently categorized according to their ecological roles in the agroecosystem as herbivores, predators, parasitoids, pollinators, or detritivores.

Data on arthropod richness and abundance were tabulated and analyzed descriptively. Community structure and diversity were quantified using the Shannon–Wiener Index (H') [17,18], True Alpha Diversity (q = 1) [19], Simpson's Dominance Index (D) [20], and Evenness index (E) [18].

RESULTS AND DISCUSSION

Results

Characteristics of the arthropod community in the sweet corn–turmeric intercropping agroecosystem at 3 weeks after sowing (3 WAS) for sweet corn and 28 weeks after planting (28 WAP) for turmeric are presented in table 1 table 2 and table 3.

Table 1. Species diversity and abundance of arthropods in maize–turmeric intercropping agroecosystems

Class	Order	Family	Species	Ecological Function	Number
Arachnida	Aranae	Lycosidae	Pardosa sp.	Predator	1
		Salticidae	Telamonia dimidiata	Predator	2
Insecta	Orthoptera	Trigonidiidae	Dianemobious nigrofasciatus	Herbivore	2
	Coleoptera	Carabidae	Dromius agilis	Predator	2
		Chrysomelidae	Aulacophora frontaslis	Herbivore	1
			Aulacophora indica	Herbivore	1
			Psylliodes chrysocephala	Herbivore	2
		Coccinellidae	Verania discolor	Predator	1
		Lycidae	Calopteron terminale	Predator,	3
	Dermaptera	Anisolabididae	Euborellia annulipes	Predator	1
	Diptera	Dolichopodidae	Condylostylus longicornis	Predator	9
		Calliphoridae	Lucilia sericata	Pollinator	2
		Micropezidae	Mimegralla coeruleifrons	Predator	1
		Muscidae	Phaonia rufiventris	Parasitoid	1
		Sarcophagidae	Sarcophaga carnaria	Predator	2
	Hemiptera	Alydidae	Leptocorisa acuta	Herbivore	1

		Lygaeidae	Graptostethus nigricipes	Herbivore	1
		Membracidae	Centrotus cornutus	Herbivore	1
Crustacea	Isopoda	Philosciidae	Philoscia affinis	Decomposer	1
Diplopoda	Polydesmida	Paradoxosomatidae	Oxidus gracilis	Herbivore	1

Table 1 presents the composition, ecological functions, and abundance of arthropod species recorded in the maize–turmeric intercropping agroecosystem at 3 weeks after sowing (WAS) of maize and 28 weeks after planting (WAP) of turmeric. A total of 20 species representing 18 families, 8 orders, and 4 classes (Insecta, Arachnida, Crustacea, and Diplopoda) were identified.

The class Insecta dominated the community in both diversity and abundance, encompassing six orders: Orthoptera, Coleoptera, Dermaptera, Diptera, and Hemiptera. Predators were the most prevalent functional group, with Condylostylus longicornis (Dolichopodidae) exhibiting the highest abundance (9 individuals), followed by Calopteron terminale (Lycidae) and Dromius agilis (Carabidae). Herbivorous species such as Aulacophora frontalis, Psylliodes chrysocephala, and Leptocorisa acuta were also commonly found. Decomposers and pollinators were represented by Philoscia affinis (Philosciidae) and Lucilia sericata (Calliphoridae), respectively. Overall, the arthropod community structure indicated a predominance of predatory taxa, suggesting a potentially stable trophic balance and natural biological control potential in the early stage of the intercropping system.

Table 2. Ecological diversity indices for the arthropod community of the maize–turmeric intercropping agroecosystem

Index	Value	Ecological Interpretation
Shannon–Wiener (H′)	2.635	High species diversity; stable community
Dominance (D)	0.086	No single species dominates
Evenness (E)	0.88	Species are evenly distributed across the community
True α-diversity	13.96	Equivalent to ~14 equally abundant species

Table 2 summarizes the ecological diversity indices of the arthropod community in the maize–turmeric intercropping agroecosystem. The Shannon–Wiener diversity index (H′ = 2.635) indicates high species diversity and a stable community structure. The dominance index (D = 0.086) shows that no single species dominates the community, suggesting balanced species interactions. The evenness value (E = 0.88) reflects that individuals are relatively evenly distributed among species, while the true α-diversity value (13.96) corresponds to approximately 14 equally abundant species, indicating a well-balanced and ecologically resilient arthropod community within the intercropping system.

Table 3. Species richness and abundance by ecological function of the arthropod community of the maize–turmeric intercropping agroecosystem

Ecological Function	Number of Species	Total Individuals	Percentage (%)
Predator	9	22	61.1
Herbivore	7	9	25.0
Pollinator	1	2	5.6
Parasitoid	1	1	2.8
Decomposer	1	1	2.8
Total	19	36	100.0

Table 3 presents the species richness and abundance of arthropods categorized by their ecological functions in the maize–turmeric intercropping agroecosystem. Predators dominated the community, comprising 9 species and 61.1% of total individuals, followed by herbivores with 7 species (25.0%). Pollinators, parasitoids, and decomposers were represented by a single species each, with relatively low abundances (2.8–5.6%). These results indicate that the arthropod community is predator-dominated, suggesting a potentially strong natural

Discussion

The arthropod community recorded in the maize–turmeric intercropping system showed moderate to high species diversity (H' = 2.635) with high evenness (E = 0.88) and low dominance (D = 0.086), corresponding to a true alpha diversity of approximately 14 equally abundant species. These indices collectively indicate a relatively diverse and well-balanced assemblage at the sampling moment, where no single taxon monopolized the community and individuals were distributed across taxa rather than concentrated in a few species [19]. High evenness together with substantive Shannon diversity generally reflects greater community stability and resilience to short-term perturbations, since energy and trophic links are not concentrated in a single species [10].

Functionally, the community was predator-dominated: predators comprised the largest proportion of individuals (61.1%) and the highest number of species (9 species) relative to herbivores and other groups (Table 3). This dominance of natural enemies aligns with meta-analytic and field studies showing that intercropping and increased plant diversity tend to enhance populations of predators and parasitoids by provision of alternative food (pollen, nectar), microclimatic refuges and structural complexity that support natural-enemy life cycles [1,3]. The particularly high abundance of a dolichopodid species (Condylostylus longicornis) and other predators suggests strong potential for top-down regulation of herbivores in this system, which is consistent with observations that intercrops can shift predator–prey balances toward improved biological control [5].

The relatively lower representation of pollinators, parasitoids, and decomposers in absolute numbers does not necessarily imply these functions are unimportant; rather, it may reflect temporal and methodological sampling constraints. Many pollinators and parasitoids show strong diel and phenological peaks linked to flowering and host phenology; short sampling windows or trapping techniques biased toward ground and hover-foraging taxa may underestimate these groups [21]. Thus, while the present dataset convincingly demonstrates a predator-rich community at the sampled stage, complementary sampling across seasons and with targeted pollinator/parasitoid methods (e.g., timed floral observations, malaise traps) would better resolve those functions.

From an applied standpoint, the results suggest that maize–turmeric intercropping may enhance ecosystem services related to pest suppression. Predator-rich communities can suppress herbivore outbreaks and reduce the need for chemical inputs, thereby contributing to sustainable pest management in smallholder systems [3,10]. However, the net outcome for crop damage and yield depends on many interacting factors (predator-prey functional responses, intraguild predation, landscape context), so field-level assessments of pest pressure and yield under the observed community structure are essential before management prescriptions are issued [5].

Limitations of the present study include restricted temporal replication (three observation dates) and potential biases of the employed sampling toolbox (pitfall, yellow

pan, sweep-net), which each sample particular microhabitats and foraging modes. Future work should expand temporal coverage across the full crop cycle, incorporate complementary trapping (e.g., malaise traps, timed visual transects) and molecular tools (DNA barcoding) to improve taxonomic resolution (especially for cryptic or immature stages), and assess functional outcomes such as predation rates (sentinel prey or exclusion experiments) and crop yield responses [1,21]. Finally, partitioning diversity into alpha and beta components using "true diversity" frameworks can aid comparisons across systems and scales and avoid misinterpretation that arises when richness alone is reported [19].

CONCLUSIONS

The sweet corn–turmeric intercropping agroecosystem supports high arthropod diversity, a stable community structure, and provides favorable conditions for the conservation of natural enemies, particularly predators.

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AUTHOR CONTRIBUTIONS

W was responsible for conceiving, designing, conducting, monitoring, and evaluating the research, and also contributed to the preparation of the manuscript; DR Contributed to the critical review and, including technical corrections and language editing; A Contributed to the implementation of the research, and the preparation of the manuscript; FN Contributed to the design of the research plan, the implementation of the research, and the drafting of the manuscript.

CONFLICT OF INTEREST

No conflict of interest to declare.

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