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Diversity and distribution of grasshopper species in Kannur district, Kerala: A comprehensive survey

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Abstract

A study on grasshopper diversity was conducted across three distinct sites in the Kannur district of Kerala: Kavvayi Island, Brennen College Campus, and Poovatharkund Waterfalls in Tholambra, over a period of six months. This study identified a total of 22 grasshopper species spanning 19 genera and four families. Acrididae family was the most represented with 14 species, followed by Pyrgomorphidae with 4 species, Tettigoniidae with 3 species, and Tetrigidae with 1 species. Notably, the endemic species *Chitaura indica* was recorded. Species richness was highest in Kavvayi Island with 18 species, followed by Poovatharkund Waterfalls with 16 species, and Brennen College Campus with 15 species. The Shannon diversity index values further supported these findings, with Kavvayi Island exhibiting the highest diversity ($H=2.77$), followed by Poovatharkund Waterfalls ($H=2.61$), and Brennen College Campus ($H=2.51$).

Keywords: Grasshopper diversity, Orthoptera, Acrididae, Shannon diversity index

Introduction

Grasshoppers play a crucial role in both ecological and agricultural contexts. As excellent ecological and biological indicators, they provide valuable insights into ecosystem qualities and the effectiveness of ecological networks^[1-4]. Their presence and diversity can reflect the health and stability of various habitats. However, grasshoppers are also significant contributors to crop damage, posing a threat to agricultural productivity^[5-6]. They live in a range of habitats, and human disturbances and habitat degradation are quickly altering their distribution pattern^[7]. With 29, 207 species worldwide, orthopterans are the most prevalent insects in terrestrial grassland habitats^[8-11]. They are also among the factors that seriously harm crops^[6, 4, 7]. A few research on the grasshopper fauna of India have been done. An inventory of India's orthoptera was created^[13]. 1033 species and subspecies of Indian Orthoptera, representing 398 genera and 21 families, are included in the checklist. Caelifera and Ensifera are the two suborders within the order Orthoptera. Grouse locusts, locusts, and short-horned grasshoppers are all members of the suborder Caelifera. Acrididae (285 species and 134 genera), Dericorythidae (04 species and 02 genera), Pamphagidae (01 species and 01 genus), Chorotypidae (09 species and 07 genera), Eumastacidae (08 species and 04 genera), Mastacideidae (08 species and 02 genera), Pyrgomorphidae (47 species and 21 genera), Tetrigidae (137 species and 39 genera), and Tridactylidae (19 species 04 genera) are the 518 species that make up the suborder Caelifera. A checklist of short-horned grasshoppers (Acrididae and Pyrgomorphidae: Orthoptera) of was published from Nepal^[14] and from Karnataka^[15]. A study conducted by^[16] identified a total of 38 species of the order Orthoptera in the Pong Dam Wetland in Kangra, Himachal Pradesh, India. A checklist and key for the short-horned grasshoppers (Orthoptera: Acrididae) was prepared from Kerala^[17]. Their work involved taxonomic studies of 41 species across two families, detailing diagnostic features of each family, genus, and species, along with their distribution, biology, and interrelationships, accompanied by relevant figures and photographs. 15 grasshopper species across 4 families were recorded in Kattappana and Pala during monsoon and summer^[18], acrididae had the highest diversity with 10 species, followed by Tettigoniidae with 3 species. Short-horned grasshoppers in Parambikulam Tiger Reserve and Eravikulam National Park was observed

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from January 2015 to May 2018 ^[19] and documented 58 species, including 18 endemic to India, using visual counts and hand searching. 35 orthopteran species were recorded in agroecosystems and grasslands in Ernakulam and Idukki districts ^[20]. The study used random sampling in 10x10 m quadrats, with Acrididae being the most dominant family (14 species). 215 species and 21 subspecies of Orthoptera in Kerala was listed, under 154 genera and 18 families. The suborder Caelifera has 127 species and Ensifera has 88 species. The number of species increased by 85 compared to the 2018 checklist ^[21]. Documenting the diversity of such a vast and underappreciated collection of insects is crucial. The dearth of knowledge regarding the diversity of grasshoppers (Caelifera) in the Kannur district served as the basis for this investigation. This study aims to document the diversity of short-horned grasshoppers (Orthoptera: Caelifera) and long-horned grasshoppers (Tettigoniidae family), compare the species richness of different grasshopper families, and assess grasshopper diversity using the Shannon diversity index in three selected habitats of Kannur district, Kerala, India.

Methodology

Study Area: The diversity study of grasshoppers was conducted at different sites in Kannur district, including: Kavvayi Island (12.095035°N, 75.175847°E), Brennen College Campus, Dharmadam (11.778702°N, 75.469036°E) and Poovatharkund Waterfalls, Tholambra (11.898598°N, 75.655087°E) (Figure 1).

Collections and identifications

Grasshopper species were collected from selected sites in Kannur district using insect collecting net and hand picking method (Fig 2). The study focused on the morphology and taxonomy of the species using a hand lens and comparative assessment of photographs. Photography was done using a Realme 9 5G Speed Edition mobile with a 48 MP rear camera. Collected common species were killed using chloroform or the cooling method in a killing jar. The killed grasshoppers were placed on a spreading board, pinned, and then dried either in an oven at 60 °C for up to 1 hour or using a table lamp with a tungsten filament bulb. After observation, rare and live species were released back into their original habitats. Dried specimens were preserved in an insect storage box with 4 to 5 naphthalene balls to prevent fungal and other infections. Grasshopper identification was based on characters like color, size, wing pattern, and antennae using identification keys provided Kirby (1914) ^[12] and the aid of Orthoptera Species File ^[11]. The Shannon-Weiner index and evenness of the study area were calculated using the Omni

calculator ^[22].

Results and Discussions

In the present study the Acrididae family showed significant diversity with multiple subfamilies and species. The Hemiacridinae subfamily included *Hieroglyphus banian*, found in Kavvayi Island (KI), Brennen College (BC), and Poovatharkund Waterfalls (PKW). The Oedipodinae subfamily featured *Trilophidia annulata* in KI and PKW. The Coptacrinae subfamily had *Eucoptacra praemorsa* present in all three survey sites. The Catantopinae subfamily included *Xenocatantops humilis*, *Stenocatantops splendens*, and *Diabolocantantops innotabilis*, distributed across KI, BC, and PKW. The Spathosterninae subfamily was represented by *Spathosternum prasiniferum*, found in all three sites. The Oxyinae subfamily included *Oxya hyla* and *Oxya fuscovittata*, with the former in KI and BC, and the latter in KI and PKW. *Chitaura indica* from the same subfamily was found in PKW. The Acridinae subfamily comprised *Phlaeoba infumata* in KI and BC, and *Phlaeoba antennata* in PKW. The Cyrtacanthacridinae subfamily included *Cyrtacanthacris tatarica* and *Anacridium flavescens*, both found in KI and BC. In the Pyrgomorphidae family, the Pyrgomorphinae subfamily included *Aularches miliaris* in PKW and BC, and *Atractomorpha crenulata* in KI. The Orthacridinae subfamily featured *Neorthacris simulans* in PKW and *Neorthacris acuticeps* across all three sites. The Tetrigidae family, specifically the Tetriginae subfamily, had *Paratettix cingalensis* in all three locations. The Tettigoniidae family showed diversity with the Mecopodinae subfamily including *Mecopoda elongata* found in all three sites, and the Conocephalinae subfamily represented by *Conocephalus maculatus* in KI and BC, and *Euconocephalus pallidus* in all three survey sites. The list of grasshoppers observed and recorded in the study is shown in Table 1., family and Subfamily wise distribution of grasshoppers in study area is given in Table 2 and 3 respectively. Number of individuals from different species at selected sites were shown in the table 4 and some species identified were given in Figure 4.

Site 1 (KI) exhibits the highest species diversity, richness, evenness, total number of individuals, and average population size. This site is the most diverse and balanced in terms of species distribution and abundance. Site 2 (BC) shows the lowest values for diversity index, evenness, richness, total individuals, and average population size, indicating it is the least diverse and balanced site. Site 3 (PKW), falls between Site 1 and Site 2 in all metrics, indicating a moderate level of diversity and balance (Table 5) (Figure 3).

Table 1: List of grasshoppers observed and recorded in the study

Sl. No.	Family	Sub family	Genus	Species	Survey sites
1.	Acrididae	Hemiacridinae	<i>Hieroglyphs</i>	<i>Banian</i>	KI, BC PKW
2.	Acrididae	Oedipodinae	<i>Trilophida</i>	<i>Annulata</i>	KI, PKW
3.	Acrididae	Coptacrinae	<i>Eucoptacra</i>	<i>Praemorsa</i>	KI, BC, PKW
4.	Acrididae	Catantopinae	<i>Xenocatantops</i>	<i>Humilis</i>	KI, BC PKW
5.	Acrididae	Catantopinae	<i>Stenocatantops</i>	<i>Splendence</i>	KI, PKW
6.	Acrididae	Catantopinae	<i>Diabolocantantops</i>	<i>Innotabilis</i>	KI, PKW
7.	Acrididae	Spathosterninae	<i>Spathosternum</i>	<i>Prasiniferum</i>	KI, BC PKW
8.	Acrididae	Oxyinae	<i>Oxya</i>	<i>Hyla</i>	KI, BC
9.	Acrididae	Oxyinae	<i>Oxya</i>	<i>Fuscovitta</i>	KI PKW
10.	Acrididae	Oxyinae	<i>Chitaura</i>	<i>Indica</i>	PKW
11.	Acrididae	Acridinae	<i>Phlaeoba</i>	<i>Infumata</i>	KI, BC
12.	Acrididae	Acridinae	<i>Phlaeoba</i>	<i>Antennata</i>	PKW
13.	Acrididae	Cyrtacanthacridinae	<i>Cyrtacanthacris</i>	<i>Tatarica</i>	KI, BC

14.	Acrididae	Cyrtacanthacridinae	<i>Anacridium</i>	<i>Flavescens</i>	KI, BC
15.	Pyrgomorphidae	Pyrgomorphinae	<i>Aularches</i>	<i>Miliaris</i>	PKW, BC
16.	Pyrgomorphidae	Pyrgomorphinae	<i>Atractomorpha</i>	<i>Crenulata</i>	KI
17.	Pyrgomorphidae	Orthacridinae	<i>Neorthacris</i>	<i>Simulans</i>	PKW
18.	Pyrgomorphidae	Orthacridinae	<i>Neorthacris</i>	<i>Acuticeps</i>	KI, BC, PKW
19.	Tetrigidae	Tetriginae	<i>Paratettix</i>	<i>Cingalensis</i>	KI, BC, PKW
20.	Tettigoniidae	Mecopodinae	<i>Mecopoda</i>	<i>Elongata</i>	KI, BC PKW
21.	Tettigoniidae	Conocephalinae	<i>Conocephalus</i>	<i>Maculatus</i>	KI, BC
22.	Tettigoniidae	Conocephalinae	<i>Euconocephalus</i>	<i>Pallidus</i>	KI, BC PKW

Table 2: Family wise distribution of grasshoppers in study area

Family	Number of species	Species in %
Acrididae	14	63.63
Pyrgomorphidae	4	18.18
Tetrigidae	1	4.58
Tettigoniidae	3	13.63

Table 3: Subfamily wise distribution of grasshoppers in study area

Subfamily	Number of species	Species in %
Hemiacridinae	1	4.54
Oedipodinae	1	4.54
Oxyinae	3	13.63
Catantopinae	3	13.63
Spathosterninae	1	4.54
Coptacrinae	1	4.54
Acridinae	2	9.09
Cyrtacanthacridinae	2	9.09
Pyrgomorphinae	2	9.09
Orthacridinae	2	9.09
Tetriginae	1	4.54
Mecopodinae	1	4.54
Conocephalinae	2	9.09

Table 4: Number of individual's different species observed

Sl. No.	Scientific name	Site1 (KI)	Site2 (BC)	Site3 (PKW)	Total
1.	<i>Hieroglyphus banian</i>	8	12	6	26
2.	<i>Triophida annulata</i>	11	5	7	23
3.	<i>Eucoptacra praemorsa</i>	7	3	5	15
4.	<i>Xenocatantops humilis</i>	14	10	16	40
5.	<i>Stenocatantops splendence</i>	5	0	5	10
6.	<i>Diabolocantantops innotabilis</i>	6	0	5	11
7.	<i>Spathosternum prasiniiferum</i>	7	8	13	28
8.	<i>Oxya hyla</i>	6	5	0	11
9.	<i>Oxya fuscovitta</i>	5	0	7	12
10.	<i>Chitaura indica</i>	0	0	4	4
11.	<i>Phlaeoba infumata</i>	13	6	0	19
12.	<i>Phlaeoba antennata</i>	0	0	5	5
13.	<i>Cyrtacanthacris tatarica</i>	5	4	0	9
14.	<i>Anacridium flavescens</i>	4	1	0	5
15.	<i>Aularches miliaris</i>	0	3	5	8
16.	<i>Atractomorpha crenulata</i>	4	0	0	4
17.	<i>Neorthacris simulans</i>	0	0	3	3
18.	<i>Neorthacris acuticeps</i>	2	1	3	6
19.	<i>Paratettix cingalensis</i>	2	1	2	5
20.	<i>Mecopoda elongata</i>	4	6	3	13
21.	<i>Conocephalus maculatus</i>	6	5	0	11
22.	<i>Euconocephalus pallidus</i>	8	6	3	17
	Total	117	76	92	285

Table 5: Population diversity index of different sites

	Site 1 (KI)	Site 2 (BC)	Site 3 (PKW)
Shannon diversity index	2.77	2.51	2.61
Evenness	0.959	0.929	0.941
Richness (Number of species)	18	15	16
Total number of individuals	117	76	92
Average population size	6.5	5.07	5.75

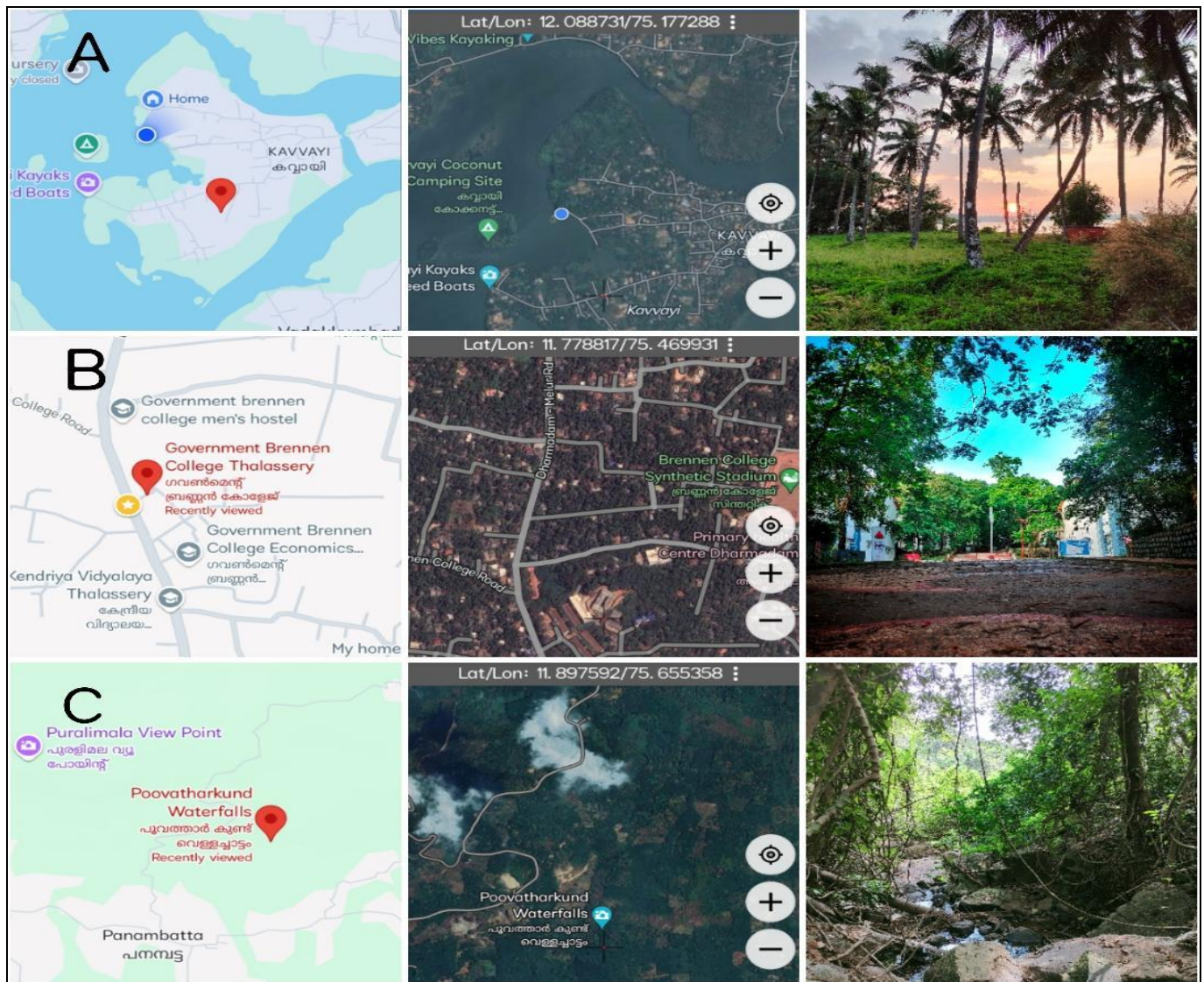


Fig 1: Study areas; A: Kavvayi island (12.095035°N, 75.175847°E), B: Brennen college campus (11.778702°N, 75.469036°E), C: Poovatharkund waterfalls (11.898598°N, 75.655087°E)





Fig 2: A: Insects collection net, B: Collection containers

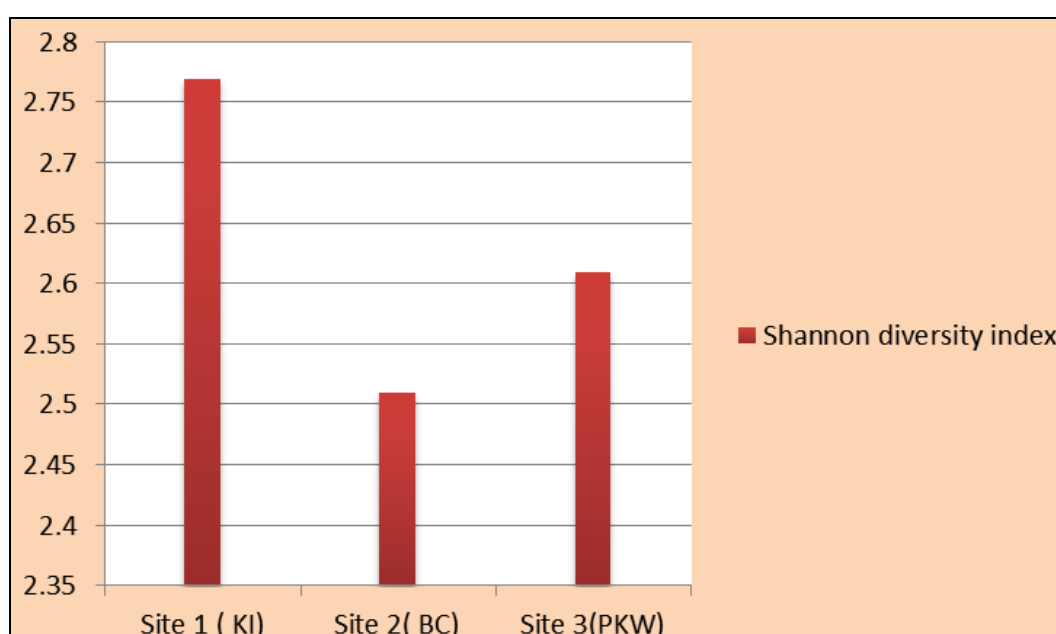


Fig 3: Shannon diversity index of different study sites

The survey of grasshopper diversity in Kannur district revealed a rich and varied assemblage of species across different habitats. The study documented grasshopper species from three major families: Acrididae, Pyrgomorphidae, Tetrigidae, and Tettigoniidae, underscoring the ecological diversity of the region. The Acrididae family was the most diverse, with multiple subfamilies and species recorded across the survey sites. Notably, the subfamily Catantopinae demonstrated significant representation with species like *Xenocatantops humilis*, *Stenocatantops splendens*, and *Diabolocatantops innotabilis* found in all sites. The widespread presence of these species suggests their adaptability to different environmental conditions within Kannur district. Additionally, the subfamily Oxyinae, with species such as *Oxya hyla* and *Oxya fuscovittata*, exhibited notable adaptability and abundance, particularly in the wetland areas of Kavvayi Island and Poovatharkund Waterfalls.

The Spathosterninae subfamily was represented by *Spathosternum prasiniferum* across all three sites, indicating its broad ecological niche. The presence of *Cyrtacanthacris tatarica* and *Anacridium flavescens* from the Cyrtacanthacridinae subfamily in both Kavvayi Island and

Brennen College suggests these species favor the vegetation and climatic conditions in these locations.

The Pyrgomorphidae family, represented by subfamilies Pyrgomorphinae and Orthacridinae, showed a more restricted distribution. Species like *Aularches miliaris* were found in Poovatharkund Waterfalls and Brennen College, indicating their preference for specific microhabitats. The presence of *Atractomorpha crenulata* only in Kavvayi Island might suggest its specialization to the unique habitat of this island. Similarly, *Neorthacris simulans* and *Neorthacris acuticeps* were found in all three sites, suggesting a broader ecological tolerance and adaptability. The Tetrigidae family, with the species *Paratettix cingalensis*, showed a widespread presence across all sites. This indicates that the microhabitats in Kannur are conducive for this species. The Tettigoniidae family, represented by *Mecopoda elongata*, found in all sites, and *Conocephalus maculatus* and *Euconocephalus pallidus*, also exhibited adaptability to various environments.

Only a few studies on grasshoppers have been documented in Kerala, and no detailed studies have been reported from Kannur district. In Kattappana and Pala of Kerala, during monsoon and summer, 15 grasshopper species across 4 families were recorded, with Acrididae having the highest

diversity with 10 species, followed by Tettigoniidae with 3 species ^[18]. In the Eravikulam National Park and Parambikulam Tiger Reserve, 58 species were documented, including 18 endemic to India, using visual counts and hand searching ^[19]. In agroecosystems and grasslands in Ernakulam and Idukki districts, 35 orthopteran species were recorded using random sampling in 10x10 m quadrats, with Acrididae being the most dominant family (14 species) ^[20]. A comprehensive list of 215 species and 21 subspecies of Orthoptera in Kerala was provided, under 154 genera and 18 families, with the suborder Caelifera having 127 species and Ensifera having 88 species ^[21]. The present study underscores

the importance of habitat diversity in supporting grasshopper biodiversity. The varying microhabitats in Kannur district, from wetlands to forested areas and rugged terrains, create niches that support a wide array of grasshopper species. The presence of rare species in certain sites also highlights the need for conservation efforts to preserve these unique habitats and their associated biodiversity. The study's reliance on identification keys by Kirby (1914) ^[12] and the aid of Orthoptera Species File ^[11] provided a solid framework for species identification. Future studies could benefit from integrating molecular techniques for more precise species identification and understanding phylogenetic relationships.

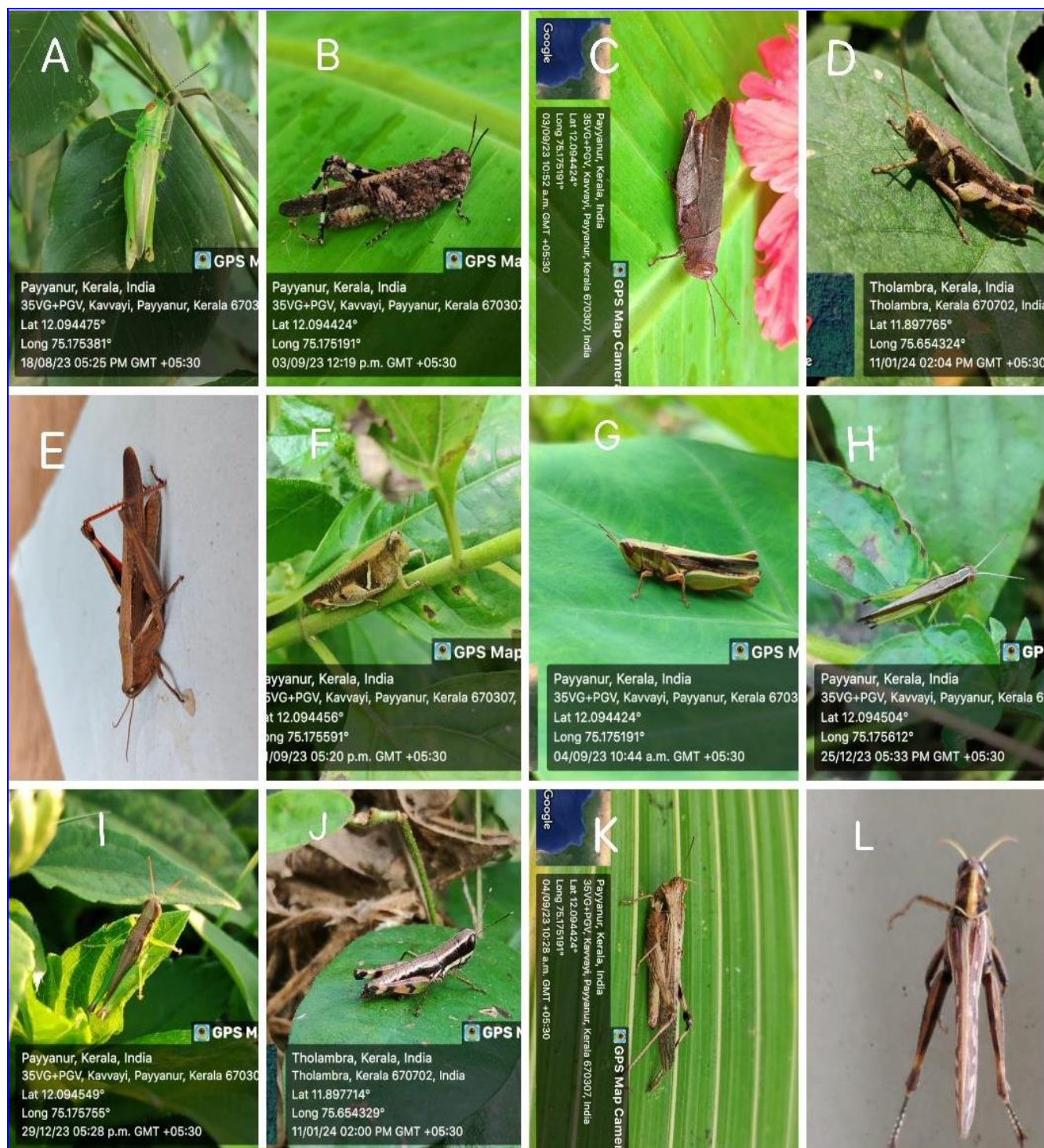


Fig 4: Some species identified A: *Hieroglyphus banian*, B: *Triophida annulata*, C: *Eucoptacra praemorsa*, D: *Xenocatantops humilis*, E: *Stenocatantops splendens*, F: *Diabolocatantops innotabilis*, G: *Spathosternum prasinerum*, H: *Oxya hyla*, I: *Oxya fuscovittata*, J: *Chitaura indica*, K: *Phlaeoba infumata*, L: *Cyrtacanthacris tatarica*

Conclusion

The diversity of grasshoppers in Kannur district is a testament to the ecological richness of the region. The study highlights the importance of varied habitats in supporting insect biodiversity and underscores the need for ongoing conservation efforts to protect these environments. The findings contribute valuable baseline data for future ecological and conservation research in the region.

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