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Diversity of spiders in grasslands of Kaziranga National Park, Assam, India

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Abstract

Spiders of protected areas of northeastern India are poorly documented. Grasslands are among the most dynamic ecosystems for species survival over time. We report through the present study the assemblage of spiders for their diversity and abundance in two kinds of grasslands of Kaziranga National Park, Assam, India. Through active search, we recorded 63 species, out of which 29 species belonging to 16 genera and 09 families were recorded from the short grasslands, and 50 species belonging to 36 genera and 14 families were recorded from the tall grasslands. Species dominance varied in the two kinds of grasslands having different ecology. The most abundant species, *Hippasa agelonides* was recorded from the tall grasslands only. The most abundant species in the short grasslands was *Tetragnatha mandibulata*. The study reports the arthropod fauna from the grasslands of the national park for the first time.

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Introduction

Spiders (Arachnida: *Araneae*) are essential for their supportive ecosystem service (Hore and Uniyal, 2008; Hogg and Danne, 2011; Hu *et al.,* 2020) and biomedically important silk (Ko and Wan, 2018). They play essential roles in the dynamics of a specific habitat and are sensitive to habitat loss, climatic change, and environmental upheavals (Bennett, 2001; Pearce and Venier, 2006). Therefore, a study of spider assemblage confined to a specific niche can help understand the assemblage response to climate change, habitat disturbance, and management and can serve as indicator species. Spiders have predatory feeding habits and can be very well explored for their use in the management of agricultural ecosystems. Although the spiders constitute a diverse group, they have remained peripheral in mainstream conservation studies resulting in a lack of data on their diversity, distribution, and ecology (Coddington and Levi, 1991). Only 49,933 spider species are known from across the globe (World spider catalog, 2022).

The study of spider diversity in India is scanty (Chetia and Bora, 2014; Jose *et al.*, 2018; Rajeevan *et al.*, 2019; Shabnam *et al.,* 2021) and they are very poorly documented from northeastern India. The protected forest areas can serve as a natural sink of the spider population. Therefore, we designed this study to record the diversity of spiders in grassland habitats of the protected Kaziranga National Park located in the northeastern region of India and lying within the Indo-Himalayan biodiversity hotspot region.

Materials and methods

Study area

Study sites

Kaziranga National Park (92°50′E & 93°41′E and 26°30′N and 26°50′N) is a semi-evergreen protected area and is among the highest protected tracts in the sub-Himalayan belt otherwise called as the "Biodiversity Hotspot". It spreads over an area of 859km² located within Assam, India, with the mighty Brahmaputra River in the north and the hills of Karbi Anglong in the south. The Kaziranga National Park comprises four ecological habitats, grassland (tall and short grasslands), woodland, wetland, and riverine islands (char). The habitats have been classified as "Assam valley tropical wet evergreen forest" (Champion and Seth, 1968) (Fig. 1). The habitat chosen for the present study were both short and tall grasslands of the protected area. The grassland habitats are primarily distributed in the southern and western parts of the Park. The grasslands of the protected area are riverine alluvial flood plain type in conjunction with river Brahmaputra. The tall grasslands comprise an area of about 142.56sq. km, and the short grasslands about 108.36sq. km (Fig. 2). The tall grasslands in Kaziranga National Park are distributed across all the ranges. We carried out our survey in patches, namely Tinibeel, Debeswari, and Tamulipathar- Natunbeel grasslands of Agoratoli Range; Benga, Goroimari, Baghmari, Arimora, Bokpora, and Kerasing road grasslands of Kohora Range; Roumari and Rajapukhuri grasslands of Bagori Range and Gotonga grassland of Burhapahar Range. The short grassland patches selected for the study were Sohola grasslands (East and West), grasslands near Duramari camp and Muamari camp of Agoratoli Range, Kathpora grasslands, front grasslands under MunaTongi and backside of Kerasing camp under Kohora Range, Donga- Gendamari linked grasslands and bahubeel grasslands of Bagori Range and grasslands near Ghurakhati camp of Burapahar Range. The weather in the area may be classified as subtropical hot, wet monsoon periods (May-August) and cool, dry winter (September-April). Winter rains are also not uncommon. The average rainfall is around 250 cm, and the average temperature ranges from 5°C to 38°C.

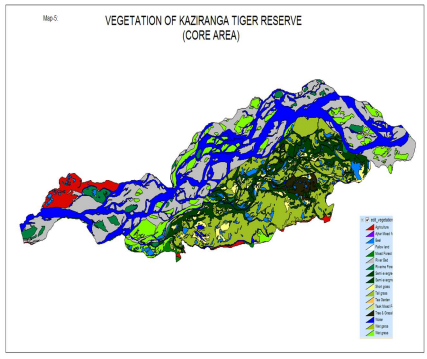

Fig. 1. LULC map of Kaziranga National Park.

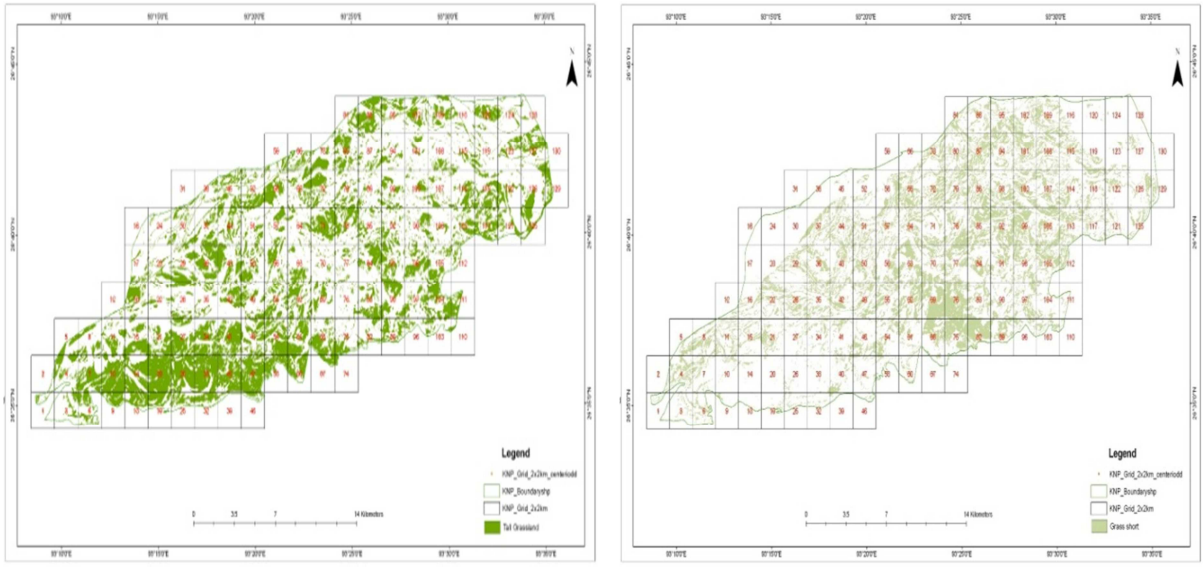

Fig. 2. Vegetation grid distribution of Tall grassland (left) and short grasslands (right) patches inKaziranga National Park [Source: Eastern Wildlife Division, Kaziranga National Park, Bokakhat].

Sampling

The grasslands of Kaziranga National Park are wet alluvial grasslands (Champion and Seth, 1968). The tall grasslands comprise about 61%, and the short grasslands comprise about 3% of the total area (Anon., 2007) of Kaziranga National Park (Plate 1, 2). Spiders were visually searched for a maximum of two hours (0900-1100 hrs) during sampling, using (20x20m^2) quadrate size from January to December 2019. The quadrates were chosen about 50m inwards in both the grassland patches near different habitats comprising short grassland, woodland, wetlands, and natural/ artificial tracks or trails. The reason for using the quadrates 50m inwards was to avoid any sampling error due to the edge effect (Haddad *et al.*, 2015). Web pattern, habitat types were recorded with every encounter. The collected spiders were preserved separately on labeled vials with 100% ethyl alcohol. The sampling methods used during the study were as follows.

A B C D

Plate 1 (A, B, C and D). Short grasslands in Kaziranga National Park.

E F G H

Plate 2 (E, F, G, and H). Tall grasslands in Kaziranga National Park.

I

J

Plate 3. I (*Hippasa agelonides*) and J (*Pardosa* sp 1) [Two most abundant species recorded from tall grasslands in Kaziranga National Park].

K

L

Plate 4. K (*Tetragnatha mandibulata*) and L (*Pardosa* pseudoannaluta) [Two most abundant species recorded from short grasslands in Kaziranga National Park].

Sweep Netting

The method was used to record the foliage-dwelling spiders from low-level vegetation of shrubs (up to 2 m in height). Sweep netting involves sampling the spiders through the herb layer, swinging a sweep net through the understorey vegetation of shrubs for a standard number of times (Coddington *et al.,* 1996).

Ground Hand sampling

Ground Hand sampling was done to record the spiders from ground to knee level to identify the spiders visible in the ground, litter, under broken logs, and rocks.

Aerial Hand sampling

Aerial Hand sampling helped record the spider species from knee level to arm's length level with web-builders and free-living spiders on the foliage and stems of living or dead shrubs, high herbs, and tree trunks.

Vegetation Beating

The method was used to collect the spiders living in shrubs, high herbs, bushes, and small trees and branches. The process includes beating the vegetation with a stick and collecting the spiders on an umbrella holding upside down the vegetation.

Litter sampling

Litter sampling was used to collect the spiders with the litter collection tray placed on the grassland floor prior to the collection where litters accumulate and sort the spider specimens by placing the litter on a white sheet.

Species identification

Morphological identification of sampled species was made using a binocular microscope following the standard taxonomic keys (Rod and Ken Preston-Mafham, 1983; Tikader, 1987; Pocock, 1900; Vijayalakhmi and Ahimaz, 1993; Dewing *et al.,* 1998; Jocque and Dippenaar-Schoeman, 2007; Keswani *et al*., 2012 and Platnick, 2020). Juvenile spiders were not considered for analysis. Spider samples with insufficient information and identification keys were

classified up to the morphospecies level (Oliver and Beattie, 1996; Krell, 2004).

Statistical analysis

Shannon Weiner diversity Index, Simpson Index and Pielou's species evenness were used for estimating spider species diversity and abundance in both the grassland habitats of the protected area.

Results

A total of 50 species belonging to 14 families and 36 genera were recorded from the tall grasslands (Table 1) and 29 species belonging to 07 families and 17 genera were recorded from the short grasslands (Table 2) during the study. In the tall grasslands, the family with the most abundant species was Salticidae (20%), followed by Araneidae (16%), Lycosidae (16%), Thomisidae (10%), Theridiidae (8%), Tetragnathidae (8%), Oxyopidae (6%) and Pisauridae (4%) (Fig. 3).

Singleton species was recorded from the families Cheiracanthidae, Clubionidae, Theraphosidae, Gnaphosidae, Linyphidae, and Idiopidae. The highest number of the genus was recorded in the family Salticidae (n=9) followed by Araneidae (n=6), Lycosidae (n=4), Thomisidae (n=4), Theridiidae (n=3), Oxyopidae (n=2), Pisauridae (n=2). The Singleton genus was recorded from Cheiracanthidae, Clubionidae, Theraphosidae, Gnaphosidae, Linyphidae, and Idiopidae In the family Araneidae the most abundant species is *Argiope* sp (n=24) followed by *Cyrtophora cicatrosa* (n=23), *Neoscona* sp (n=21), *Argiope pulchella* (n=18), *Argiope aemula* (n=07), *Araneus mitificus* (n=04), *Cyrtarachne* sp (n=03) and *Cyclosa spirifera* (n=01).

Plexippus paykulli (n=06) was the most abundant species under Salticidae followed by *Phintella vittata* (n=04), *Hyllus* sp (n=02), *Telamonia dimidiata* (n=02), *Bavia* sp (n=02), *Rhene* sp (n=02), *Carrhotus viduus* (n=02), *Bavia kairali* (n=01), *Epocilla* sp (n=01) and *Portia* sp (n=01). In the family Lycosidae the most abundant species was *Hippasa agelonides* (n=306) followed by *Pardosa* sp 2 (n=228), *Pardosa birmanica* (n=170), *Lycosa mackenziei* (n=141), *Lycosa* sp (n=52), *Pardosa* sp 1 (n=27), *Pardosa* sp 3 (n=05) and *Agalenocosa* sp (n=03). *Chryso nigra* (n=11) was the most abundant species in the family Theridiidae followed by *Theridiidae* sp (n=02), *Argyrodes gazedes* (n=01) and *Argyrodes flavescens* (n=01).

Tetragnatha mandibulata (n=138) was the most abundant species in the family Tetragnathidae followed by *Tetragnatha viridorufa* (n=14), *Tetragnatha isidis* (n=07) and *Tetragnatha* sp (n=05). *Runcinia roonwali* (n=59) was the most dominant species in the family Thomisidae followed by *Camaricus formosus* (n=07), *Thomisus pujilis* (n=03), *Misumenops* sp (n=02) and *Thomisus* sp (n=02). In the family Oxyopidae the most dominant species is *Oxyopes birmanicus* (n=19) followed by *Oxyopes javanus* (n=14) and *Hamataliwa* sp (n=04). *Pisaura putiana* (n=20) was the abundant species in the family Pisauridae followed by *Dendrolycosa* sp 1 (n=02).

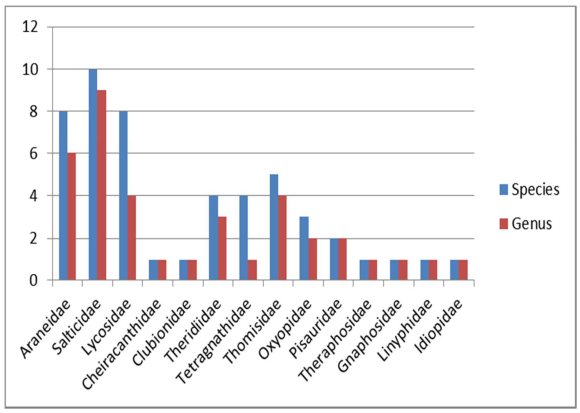

Fig. 3. Species and Genus composition in families in tall grasslands of Kaziranga National Park.

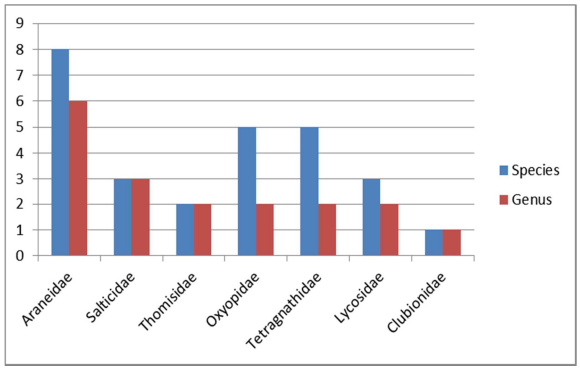

Fig. 4. Species and Genus composition in families in short grasslands of Kaziranga National Park.

Table 1. Spider species recorded during the study from tall grasslands. (DD: data deficient).

Family Name	Species Name	Common Name	Species Abundance	Endemic (Yes/No)
Araneidae	*Araneus mitificus*(*Simon* 1886)	Kidney Garden Spider	2.863×10^{-3}	No
	Argiope pulchella (Thorell 1881)	Garden orb weaver	1.2885×10^{-2}	No
	Argiope aemula (Walckenaer 1841)	Signature spider	5.011×10^{-3}	No
	Argiope sp	Signature spider	1.718×10^{-2}	No
	Cyclosa spirifera(Simon 1889)	Orb-weaver	7.16×10^{-3}	Yes (Simon 1889)
	Cyrtophora cicatrosa (Stoliczka 1869)	Tent web spider	1.6464×10^{-2}	No
	Cyrtarachne sp	Orb-weaver	2.147×10^{-3}	No
	Neoscona sp	Spotted orb weavers	1.5032×10^{-2}	No
Cheiracanthidae	*Cheiracanthium danieli* (Tikader 1975)	Yellow sac spider	5.011×10^{-3}	Yes (Tikader 1975)
Clubionidae	*Clubiona drassodes* (Pickard-Cambridge, 1874)	Sac Spider	1.0737×10^{-2}	No
Gnaphosidae	*Scytophaeus* sp	Nocturnal Hunter	2.863×10^{-3}	No
Idiopidae	*Idiops* sp	Armoured trapdoor	7.16×10^{-4}	No
Linyphiidae	*Linyphia urbasae* (Tikader 1970)	Thread weaver	1.432×10^{-3}	No
Lycosidae	*Agalenocosa* sp	DD	2.147×10^{-3}	No
	Hippasa agelonides (Simon 1884)	Common funnel-web spider	2.19041×10^{-1}	No
	Lycosa mackenziei (Gravely 1924)	Soil lycosid spider	1.00931×10^{-1}	No
	Lycosa sp	Wolf spider	3.7223×10^{-2}	No
	Pardosa birmanica (Simon 1884)	Dark wolf spider	1.21689×10^{-1}	No
	Pardosa sp	Wolf spider	1.9327×10^{-2}	No
	Pardosa sp 1	Wolf spider	1.63207×10^{-1}	No
	Lycosa sp 1	Wolf spider	3.579×10^{-3}	No
Oxyopidae	*Oxyopes birmanicus* (Thorell 1887)	Burmese lynx spider	1.3601×10^{-2}	No
	Oxyopes javanus (Thorell 1887)	Lynx spider	1.0021×10^{-2}	No
	Hamataliwa sp	Lynx spider	2.863×10^{-3}	No
Pisauridae	*Dendrolycosa*sp 1	Nursery web spider	1.432×10^{-3}	No
	Pisauraputiana (Barrion and Litsinger 1995)	Nursery web spider	1.4316×10^{-3}	No
Salticidae	*Baviakairali* (Simon 1877)	Scorpion Jumper	7.16×10^{-4}	Yes (Simon 1877)
	Bavia sp	Jumping spider	1.432×10^{-3}	No
	Carrhotusviduus(Koch 1846)	Jumping spider	1.432×10^{-3}	No
	Epocilla sp	Jumping spider	7.16×10^{-4}	No
	Hyllus sp	Jumping spider	1.432×10^{-3}	No
	Phintellavittata(Koch 1846)	Banded phintella	2.863×10^{-3}	No
	Plexippuspaykulli(Audouin 1826)	Pantropical jumper	4.295×10^{-3}	No
	Portia sp	Jumping spider	7.16×10^{-4}	No
	Telamonia dimidiata(Simon 1899)	Two striped jumper	1.432×10^{-3}	No
	Rhene sp	Wasp mimic spider	1.432×10^{-3}	No
Tetragnathidae	*Tetragnatha isidis*(Simon 1880)	Tetragnathid spider	5.011×10^{-3}	No
	Tetragnatha mandibulata (Walckenaer 1841)	Big Jawed spider	9.8783×10^{-2}	No
	Tetragnatha viridorufa (Gravely 1921)	Green tetragnathid spider	1.0021×10^{-2}	Yes (Gravely 1921)
	Tetragnatha sp	DD	3.579×10^{-3}	No
Theridiidae	*Argyrodes flavescens* (Cambridge 1880)	Red silver spider	7.16×10^{-4}	No
	Argyrodes gazedes (Tikader, 1970)	Dew drop spider	7.16×10^{-4}	No
	Chrysso nigra (Pickard-Cambridge, 1880)	Black pearl spider	7.874×10^{-3}	No
	Theridion sp	DD	1.432×10^{-3}	No
Theraphosidae	*Chilobrachys assamensis* (Hirst 1909)	DD	7.16×10^{-4}	Yes (Hirst 1909)
Thomisidae	*Camaricus formosus* (Thorell 1887)	Crab spider	5.011×10^{-3}	No
	Misumenops sp	Crab spider	1.432×10^{-3}	No
	Thomisus pujilis (Stoliczka 1869)	Crab spider	2.147×10^{-3}	Yes (Stoliczka 1869)
	Thomisus sp	Crab spider	1.432×10^{-3}	No
	Runcinia roonwali (Tikader 1965)	Crab spider	4.2233×10^{-2}	No

Table 2. Spider species recorded during the study from short grasslands. (DD: data deficient).

Family Name	Species Name	Common Name	Species Abundance	Endemic (Yes/No)
Araneidae	*Araneus ellipticus* (Tikader and Bal 1981)	Smooth sphered Araneid	4.2654×10^{-2}	No
	Araneus mitificus(*Simon* 1886)	Kidney Garden Spider	1.4218×10^{-2}	No
	Argiope pulchella(Thorell 1881)	Garden orb weaver	4.739×10^{-3}	No
	Argiope sp	Signature spider	4.739×10^{-3}	No
	Cyclosa spirifera(Simon 1889)	Orb-weaver	4.2654×10^{-2}	No
	Gea spinifes (Koch 1843)	Spiny Gea	1.6588×10^{-2}	No
	Neoscona sp	Spotted orb weavers	2.1327×10^{-2}	No
	Neoscona sp 1	Spotted orb weavers	2.8436×10^{-2}	No
Clubionidae	*Clubiona drassodes*(Pickard- Cambridge 1874)	Sac Spider	4.739×10^{-3}	No
Lycosidae	*Lycosa mackenziei*(Gravely 1924)	Soil lycosid spider	6.3981×10^{-2}	No
	Pardosa birmanica(Simon 1884)	Dark wolf spider	8.7678×10^{-2}	No
	Pardosa pseudoannulata (Bosenberg& Strand 1906)	Pond wolf spider	1.30332×10^{-1}	No
Oxyopidae	*Hamataliwa* sp	Lynx spider	2.37×10^{-3}	No
	Oxyopes birmanicus(Thorell 1887)	Burmese lynx spider	4.739×10^{-3}	No
	Oxyopes javanus(Thorell 1887)	Lynx spider	2.6066×10^{-2}	No
	Oxyopes sp	Lynx spider	2.1327×10^{-2}	No
	Oxyopes schweta (Tikader, 1970)	Lynx spider	4.739×10^{-3}	No
Salticidae	*Epeus indicus* (Proszynski 1992)	White spotted green jumper	2.37×10^{-3}	No
	Hasarius adansoni (Audouin 1826)	Adanson's house jumper	2.37×10^{-3}	No
	Phintella vittata(Koch 1846)	Banded phintella	2.37×10^{-3}	No
Tetragnathidae	*Guizygiella* sp 1	DD	7.109×10^{-2}	No
	Guizygiella sp 2	DD	7.109×10^{-3}	No
	Leucauge decorata (Walckenaer 1842)	Decorative silver orb weaver	6.6351×10^{-3}	No
	Tetragnatha isidis (Simon 1880)	Tetragnathid spider	1.6588×10^{-2}	No
	Tetragnatha mandibulata (Walckenaer 1841)	Big Jawed spider	1.84834×10^{-1}	No
	Tetragnatha viridorufa(Gravely 1921)	Green tetragnathid spider	1.18483×10^{-1}	No
	Tetragnatha sp 1	DD	2.37×10^{-3}	No
Thomisidae	*Mastira* sp	DD	2.37×10^{-3}	No
	Thomisus sp	Crab spider	2.37×10^{-3}	No

In the short grasslands, the family with the most abundant species was Araneidae (27.58%), followed by Tetragnathidae (24.13%), Oxyopidae (17.24%), Salticidae (10.34%), Lycosidae (10.34%), and Thomisidae (6.89%) (Fig. 4). Singleton species was recorded from the family Clubionidae. The highest number of the genus was recorded in the family Araneidae (n=6) followed by Tetragnathidae (n=3), Salticidae (n=3), Thomisidae (n=2), Oxyopidae (n=2), Lycosidae (n=2). In the family Araneidae the most abundant species is *Cyclosa spirifera* (n=18) and *Araneus ellipticus* (n=18) followed by *Neoscona* sp 1 (n=12), *Neoscona* sp (n=09), *Gea spinifes* (n=07), *Araneus mitificus* (n=06), *Argiope pulchella* (n=02) and *Argiope* sp (n=02). In the family Salticidae equal number of abundance were observed among *Phintella vittata* (n=01), *Epeus indicus* (n=01) and *Hasarius adansoni* (n=01). Likewise in the family Thomisidae equal abundance were observed among *Thomisus* sp (n=01) and *Mastira* sp (n=01). In the family Oxyopidae the most abundant species is *Oxyopes javanus* (n=11) followed by *Oxyopes* sp (n=09), *Oxyopes birmanicus* (n=02), *Oxyopes* sp 1 (n=02) and *Hamataliwa* sp (n=01). In the family Tetragnathidae the most abundant species is *Tetragnatha mandibulata* (n=78), *Tetragnatha viridorufa* (n=50), *Guizygiella* sp 1 (n=30), *Leucauge decorata* (n=28), *Tetragnatha isidis* (n=07), *Guizygeilla* sp 2 (n=03) and *Tetragnatha* sp 2 (n=01). *Pardosa pseudoannulata* (n=55) was the most abundant species in the family Lycosidae followed by *Pardosa birmanica* (n=37) and *Lycosa mackenziei* (n=27).

The Shannon Weiner Index obtained for the species recorded in tall grasslands is 2.64, and in short,

grasslands is 2.67. The Simpson Index obtained for the species recorded in the tall grasslands is 0.89, and in short, grasslands is 0.91. The effective number of species obtained for the species recorded in the tall grasslands is 14.06, and in short, grasslands is 14.52. The Pielou's species evenness obtained for the species recorded in tall grasslands is 0.675 and in short grasslands is 0.794.

Discussion

In northeast India, particularly Assam, studies on spiders in protected areas concerning specific habitats are scanty. Checklists or records of Indian spiders are limited to forest areas like Tarai, Western ghat, Gibbon Wildlife Sanctuary, and Chakrashila Wildlife Sanctuary (Hore and Uniyal, 2008; Chetia and Kalita, 2012; Chetia and Bora, 2014; Basumataryand Brahma, 2017). Our study recorded the presence of spiders belonging to 14 families in the grasslands speciose worldwide. Lauren *et al.* (2021) also reported 14 families in their study in the arid grassland of northwest pacific USA. Structurally more complex herbs and shrubs can support a more diverse spider community (Uetz, 1991). The dominant floral vegetation type of the tall grasslands in Kaziranga National Park includes *Miscanthus fuscus*, *Saccharum spontaneum, Imperata cylindrica, Phragmites karka, Vetivera zizanoides, Arundo donax, Erianthus ravaneae* etc. including invasive tree species like *Bombax ceiba*. The dominant floral vegetation type of the short grasslands includes *Imperata cylindrica, Chrysopogon aciculatus, Eragrostis* spp and *Hemarthia compressa*.

A higher count of spiders in tall grassland may account for enhanced facilitation for web-building opportunities provided by tall grasses and trees. The anterior part of tall grasses like *Miscanthus fuscus* and *Saccharum spontaneum* were used by *Runcinia roonwali* (Family Thomisidae) for nest building and by *Tetragnatha mandibulata*, *Tetragnatha isidis,* (Family Tetragnathidae) for web building. Likewise, the ground and litter layers of tall grasses and trees were used by the lycosids like *Hippasa agelonides*, *Pardosa birmanica*, *Pardosa* sp 2 and *Lycosa mackenziei*. Thus the study showed that tall grasslands provided ideal microhabitats for the spiders in Kaziranga National Park. We observed a difference in the ecology of short grassland for spiders in the protected area. The short grasslands of Kaziranga National Park are in mosaic with the wetland habitats. The annual flood during the monsoon season raises the water level. Both the rain and floodwater spread along the entire short grassland area. The perennial and temporary wetlands are the primary water source for all the faunal species within the protected area. The mammals like *Rhinoceros unicornis*, eastern swamp deer (*Recervus duvaucelii ranjitsinhii*), Asiatic elephant (*Elephas maximus*), water buffalo (*Bubalus bubalis*), hog deer (*Axis porcinus*), migratory birds, bar-headed geese (*Anser indicus*) along with other indigenous wetland and short grassland birds were dependent on the floral vegetations of short grasslands for food and grazing. Therefore, there is greater resource partition among the faunal community in short grasslands, decreasing the spiders' food and shelter resource, leading to a low count of spider fauna in the short grasslands. That diversity and abundance of spiders are greatly influenced by grazing in grasslands has been shown in several studies (Horvath *et al.*, 2009; Dennis *et al.,* 2015; Freiberg *et al.*, 2020).

We recorded species common to both grasslands and the unique ones among the grasslands during the present study. The species common among both the grasslands were *Araneus mitificus, Argiope pulchella*, *Argiope*sp, *Cyclosa spirifera*, *Neoscona* sp, *Phintella vittata*, *Pardosa birmanica*, *Lycosa mackenziei*, *Clubiona drassodes*, *Tetragnatha mandibulata*, *Tetragnatha viridorufa*, *Tetragnatha isidis*, *Thomisus pujilis*, *Thomisus* sp, *Oxyopes javanus*, *Oxyopes birmanicus* and *Hamataliwa* sp. The most abundant species recorded only from tall grasslands was *Hippasa agelonides* followed by *Pardosa* sp 1 (Plate 3). Likewise, *Tetragnatha mandibulata* was the most abundant species recorded from the short grasslands, followed by *Pardosa pseudoannulata* (Plate 4).

Among the ground dwellers, *Pardosa birmanica* was the most dominant species in tall grasslands, followed by *Lycosa mackenziei*. However, in short grasslands, *Pardosa pseudoannulata* was more dominant in comparison to *Pardosa birmanica* and *Lycosa mackenziei*. Thus, it was observed that the dominance of species varied with the kinds of grasslands. Nina (2021) reported a similar observation regarding the dissimilarity of the dominance of similar species in different grasslands. However, few common species in both the grasslands showed a similar dominance. *Tetragnatha mandibulata* and *Tetragnatha viridorufa* of the family Tetragnathidae were similar in terms of dominance in both the grasslands of Kaziranga National Park. During the study, we recorded six endemic species, namely *Cyclosa spirifera* (Family Araneidae), *Bavia kairali* (Family Salicidae), *Cheiracanthium danieli* (Family Cheiracanthidae), *Tetragnatha viridorufa* (Family Tetragnathidae), *Thomisus pujilis* (Family Thomisidae) and *Chilobrachys assamensis* (Family Theraphosidae).We have also recorded for the first time from the state of Assam, three species under Tetragnathidae, *Tetragnatha isidis* in tall and short grasslands, and *Guizygiella*sp1 and *Guizygiella* sp2 in short grasslands. Thus, the present study provides information related to the diversity of spider species and their distribution in specific grassland habitats of Kaziranga National Park. Such studies also contribute towards a knowledgebase for using spiders as indicator species for issues associated with the environment (Noss, 1990; Kapoor, 2008).

Conclusion

The above study in grassland habitats was baseline information on the diversity and abundance of spiders in Kaziranga National Park. The tall grasslands have higher species diversity with the ground dwellers (Family Lycosidae) as most abundant group as compared to the short grasslands with the long jawed orb-weavers (Family: Tetragnathidae) as the most abundant ones. The study showed both the habitats to have provided suitable microhabitat for the spider diversity and abundance.

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