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Original Article

Species diversity and community characteristics of understorey vegetation in a tropical moist deciduous forest of Assam, India

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Abstract

The study presents a comprehensive assessment of species diversity and community characteristics of understorey vegetation in a tropical moist deciduous forest of Assam, India. An extensive field survey was conducted in the selected study site, i.e., Fatasil Reserve Forest (FRF), between 2022 and 2025, and the stratified random sampling method was employed. 300 quadrats of the size 25 m^2 and 600 quadrats of the size 1 m^2 were laid for shrubs and herbs, respectively. Thus, a total of 900 quadrats were used for the study. Total density and total basal cover (TBC) were reported as 1545 stem ha^{-1} and 4.92 m^2 ha^{-1}, respectively, for shrubs; and 8861.11 stem ha^{-1} and 0.58 m^2 ha^{-1}, respectively, for herbs. Based on the Importance Value Index (IVI), the most dominant shrub species were *Lantana camara*, *Ocimum tenuiflorum*, and *Solanum torvum*, and the most dominant herb species were *Ageratum conyzoides*, *Leucas aspera*, and *Acmella paniculata*. Moreover, shrub vegetation exhibited moderate diversity and richness, whereas herbaceous vegetation exhibited high diversity and richness in the study site. There was high species evenness of both shrub and herb vegetation, which reflects the uniform distribution of species, indicating stable understorey plant communities in the study site. However, the observed moderate diversity and richness of shrub vegetation raise concerns, underscoring the need for appropriate and well-planned management strategies aimed at habitat conservation and minimizing anthropogenic disturbances to ensure its long-term sustainability.

Keywords: Density; Evenness; Importance Value Index; Richness; Stratified random sampling; Total basal cover

Introduction

Tropical forests represent a common heritage, providing livelihood for a large portion of the population, particularly in developing countries (Panda et al. 2013). They are globally recognised as rich centres of biodiversity (Khaine *et al.*, 2017). Despite occupying only about 7% of the land area, these forests support over half of the world's biodiversity (Subashree *et al*., 2021). However, human activities such as land alteration, pollution, and overgrazing are altering these forests by affecting their floral diversity, which in turn leads to changes in their structure, composition, and productivity, with global ecological consequences (Thakur 2018). Tropical countries can effectively protect ecosystems and meet their biodiversity conservation goals by implementing legal safeguards for regions with high biodiversity value (Sullivan *et al*., 2017).

Understorey vegetation is crucial for understanding plant diversity, species sustenance, ecosystem function, and responses to environmental changes (Deng *et al.*, 2023, Haq *et al.*, 2024), making it a prominent focus in ecological research. It maintains many essential ecological services, including nutrient cycling, energy flow, and productivity (Khan *et al.*, 2019, Su *et al.*, 2019). They also favor the regeneration of trees, prevent soil erosion, and provide food and habitat for herbivores (Tiscar-Oliver 2015). Moreover, understorey vegetation is a fundamental component of forest ecosystems, representing a significant portion of the overall floristic composition and diversity, and playing a vital role in influencing the ecological characteristics of the forests (Thakur 2018). Furthermore, all species in a forest ecosystem are directly or indirectly interdependent, each utilizing different resources for sustenance (Behera et al. 2023). Consequently, recording biodiversity data is essential for promoting the sustainable development of a forest and establishing effective conservation priorities.

Numerous surveys have been carried out previously to understand the species diversity and community characteristics of understorey vegetation of forests across national (Thakur 2018, Khan *et al.*,

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2019, Nag *et al.*, 2021, Bargali *et al.*, 2022, Behera *et al.*, 2023, Gachhadar *et al.*, 2023, Malav *et al.*, 2023, Sangry *et al.*, 2024, Upadhyay *et al.*, 2025), regional (Barua & Hazarika 2020, Barbhuyan *et al.*, 2021, Malunguja *et al*., 2021, Borah *et al*., 2022, Mir *et al.*, 2022, Ao *et al.*, 2023, Nautiyal & Manish 2025), and at global scale (Rahman et al. 2021, Su et al. 2022, Deng *et al.*, 2022, Tian *et al.*, 2023, Ullah *et al.*, 2024, Yang *et al.*, 2025). However, very few such studies have been conducted in the tropical moist deciduous forests of Assam (Deka *et al.*, 2012, Dutta & Devi 2013a,b). With this view in mind, the present study was undertaken to investigate the species diversity and community characteristics of understorey vegetation in a tropical moist deciduous forest of Assam, India.

Material and Methods

The present study was conducted in Fatasil Reserve Forest (FRF), located in the Kamrup Metropolitan district of Assam, India (Fig. 1). This forest covers an area of approximately 670 hectares (ha), and the geographic coordinates extend from 26°08'18.88" to 26°09'12.93" N latitude and from 91°42'48.36" to 91°43'20.34" E longitude. FRF is classified as the tropical moist deciduous type (Champion & Seth 1968).

An extensive field survey was conducted in the selected study site (FRF) between 2022 and 2025. The stratified random sampling method was employed. 300 quadrats of the size 25 m^2 and 600 quadrats of the size 1 m^2 were laid for shrubs and herbs, respectively. Thus, a total of 900 quadrats were used for the study. Plant species were identified with reference to authentic websites (https://www.worldfloraonline.org, https://indiabiodiversity.org, and http://www.plantsoftheworldonline.org/). The number of individuals of each plant species and their collar circumference at the base (CCB) were counted, and quantitative characteristics such as frequency, density, abundance, total basal cover (TBC), and Importance Value Index (IVI) were determined using standard phytosociological methods (Misra 1968). Species diversity was assessed using the Shannon-Wiener diversity index (Shannon & Weaver 1963) and Simpson's index (Simpson 1949). Species richness was measured using Margalef's species richness index (Margalef 1958), and evenness was evaluated using Pielou's species evenness index (Pielou 1966).

Results

In the present study, herb species diversity (38 species, representing 38 genera and 23 families) was more than shrub species diversity (18 species, representing 15 genera and 12 families) (Table 1). Among the shrubs, Fabaceae (5 species) was the most dominant family, followed by Asteraceae (2 species), Lamiaceae (2 species), and Solanaceae (2 species), and each of the remaining families was represented by a single species (Fig. 2). While among the herbs, Poaceae (8 species) represented the most dominant family, followed by Asteraceae (5 species), Amaranthaceae (2 species), Euphorbiaceae (2 species), Fabaceae (2 species), Lamiaceae (2 species), Rubiaceae (2 species), and the rests were represented by 1 species each (Fig. 2).

The observed frequency classes were B>C for shrub (Table 2), and B<C>D>E for herb vegetation, both of which deviated from Raunkiaer's normal frequency class (A>B>C=D<E) (Raunkiaer 1934) (Fig. 3). Total density and TBC were reported as 1545 stem ha^{-1} and 4.92 m^2 ha^{-1}, respectively, for shrubs (Table 2). *Lantana camara*, *Ocimum tenuiflorum*, and *Solanum torvum* recorded the highest values for both total density and TBC (Table 2). For herbs, total density and TBC were reported to be 8861.11 stem ha^{-1} and 0.58 m^2 ha^{-1}, respectively, with *Oxalis corniculata* and *Acmella paniculata* reported the highest density and TCS, respectively (Table 3). Based on IVI, the most dominant shrub species were *Lantana camara*, *Ocimum tenuiflorum*, and *Solanum torvum* (Table 2), and the most dominant herb species were *Ageratum conyzoides*, *Leucas aspera*, and *Acmella paniculata* (Table 3).

The Shannon-Weiner diversity index indicated moderate diversity for shrubs (H' = 2.86) and high diversity for herbs (H' = 3.59) (Table 1). The Simpson's index was calculated as 0.06 and 0.03 in the case of shrubs and herbs, respectively (Table 1). Moreover, Margalef's species richness index and Pielou's species evenness index values were 2.78 and 0.95, respectively, for shrubs, and 4.12 and 0.99, respectively, for herbs (Table 1).

Discussion

The study presents a comprehensive assessment of species composition, vegetation structure, and diversity patterns of understorey plants in a tropical moist deciduous forest of Assam, India. The species compositions of shrub (18 species) and herb (38

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species) vegetations in the present study were comparable with those reported by earlier investigators (Devi *et al.*, 2013a, Gautam & Mandal 2018, Behera *et al.*, 2023). However, the reported values were comparatively lower than those documented in certain other studies (Barua *et al.*, 2018, Barua & Hazarika 2020). The variation in diversity and composition of the understorey vegetation across different forest ecosystems may be influenced by multiple interacting factors, including overstorey vegetation structure, stand age, substrate type, light availability, soil moisture, and nutrient levels (Nautiyal & Manish 2025). Moreover, the dominance of Fabaceae and Poaceae families in shrub and herb species composition, respectively, may be attributed to their wide distribution, ecological dominance, and high adaptability across a broad range of habitats (Kargar Chigani *et al.*, 2017, Shavanov 2021).

The observed frequency class of shrub and herb vegetation deviated from Raunkiaer's normal frequency class, indicating heterogeneous distributions of vegetation (Raunkiaer 1934) in both the strata of the study site. Comparable observations were also reported in previous reports (Kumar & Saikia 2020, Borah et al. 2022, Yumnam & Deori 2023, Kalita & Yumnam 2024a, Yumnam & Dutta 2025). Total density of shrubs (1545 stem ha^{-1}) and herbs (8861.11 stem ha^{-1}) in the present study was quite lower than those reported in a tropical moist deciduous forest of Assam, India (Dutta & Devi 2013b). Nevertheless, TBC of shrubs (4.92 m^2 ha^{-1}) corresponds well with that reported in Hojai Reserve Forest and Kumorakata Reserve Forest of Assam, India (Dutta & Devi 2013a). Differences in density and basal area of the understorey vegetation in forests across various regions might result from variation in species makeup, microclimatic conditions, anthropogenic disturbances, age and successional stage of the forests (Malav *et al.*, 2023, Kalita & Yumnam 2024b).

The findings of Shannon-Weiner diversity index revealed moderate shrub diversity (H' = 2.86) and high herb diversity (H' = 3.59) in the study site. The findings were consistent with those from Hojai Reserve Forest of Assam, India (Dutta and Devi 2013a), but comparatively higher than those reported in a tropical semi-deciduous forest of Nagaland, India (Semy & Singh 2023). The outcome of Simpson's index indicated low dominance of shrub (0.06) and herb (0.03) vegetation in the study site. In Hojai Reserve Forest of Assam, India, Dutta & Devi (2013a) recorded a comparable Simpson's index for herbs and a higher index for shrubs than those reported in the current study. The current values of Margalef's species richness index and Pielou's species evenness index of shrubs (2.78 and 0.95, respectively) and herbs (4.12 and 0.99, respectively) were consistent with those reported in Oak forests of Pakistan (Rahman *et al.*, 2021). Disparities in understorey vegetation diversity and richness may be influenced by variances in several factors, including overstorey vegetation structure, habitat heterogeneity, disturbance levels, and management practices (Khan *et al.*, 2019, Su *et al.*, 2019). Additionally, the high evenness of both shrub and herb vegetation reflects the uniform distribution of species (Kalita & Yumnam 2024a), indicating stable understorey plant communities in the study site.

Conclusion

The study presents a comprehensive assessment of species diversity and community characteristics of understorey vegetation in FRF of Assam, India. Shrub vegetation exhibited moderate diversity and richness, whereas herbaceous vegetation exhibited high diversity and richness in the study site. Moreover, the high evenness of both shrub and herb vegetation reflects the uniform distribution of species, indicating stable understorey plant communities in the study site. However, the observed moderate diversity and richness of shrub vegetation raise concerns, underscoring the need for appropriate and well-planned management strategies aimed at habitat conservation and minimizing anthropogenic disturbances to ensure its long-term sustainability.

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Declaration on the conflict of interest

The authors declare that they have no conflict of interest.

Table 1. Species diversity of shrubs and herbs in the study site

Parameters	Shrubs	Herbs
No. of species	18	38
No. of genera	15	38
No. of family	12	23
Shannon-Weiner diversity index	2.86	3.59
Simpson's index	0.06	0.03
Margalef's species richness index	2.78	4.12
Pielou's species evenness index	0.95	0.99

Table 2. Community characteristics of shrub species in the study site

Name of species	Family	F (%)	D (stem ha^{-1})	TBC (m^2 ha^{-1})	IVI
Acalypha hispida Burm.f.	Euphorbiacaeae	33.33	65.00	0.06	10.77
Bergera koenigii L.	Rutaceae	38.33	100.00	0.39	18.98
Chromolaena odorata (L.) R.M.King & H.Rob.	Asteraceae	35.00	78.33	0.15	13.59
Clerodendrum infortunatum L.	Lamiaceae	36.67	80.00	0.13	13.51
Crotalaria pallida Aiton	Fabaceae	38.33	101.67	0.16	14.95
Ixora polyantha Wight	Rubiaceae	31.67	60.00	0.30	17.61
Lantana camara L.	Verbenaceae	58.33	123.33	0.77	27.71
Lawsonia inermis L.	Lythraceae	28.33	53.33	0.15	12.48
Ocimum tenuiflorum L.	Lamiaceae	58.33	116.67	0.68	26.48
Pleurolobus gangeticus (L.) J.St.-Hil. ex H.Ohashi & K.Ohashi	Fabaceae	28.33	56.67	0.28	16.77
Rhamnus alpina L.	Rhamnaceae	33.33	75.00	0.21	14.76
Senna alata (L.) Roxb.	Fabaceae	30.00	71.67	0.13	12.22

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Senna occidentalis (L.) Link	Fabaceae	36.67	93.33	0.11	13.42
Senna tora (L.) Roxb.	Fabaceae	45.00	98.33	0.20	16.56
Solanum torvum Sw.	Solanaceae	43.33	103.33	0.47	21.25
Solanum violaceum Ortega	Solanaceae	41.67	96.67	0.29	17.65
Tithonia diversifolia (Hemsl.) A.Gray	Asteraceae	36.67	81.67	0.19	14.75
Urena lobata L.	Malvaceae	38.33	90.00	0.26	16.57
Total			**1545.00**	**4.92**	**300.00**

*F = frequency, D = density, TBC = total basal cover, IVI = Importance Value Index

Table 3. Community characteristics of herb species in the study site

Name of species	Family	F (%)	D (stem ha^{-1})	TBC (m^2 ha^{-1})	IVI
Acalypha indica L.	Euphorbiaceae	42.22	226.67	0.01	6.33
Acmella paniculata (Wall. ex DC.) R.K.Jansen	Asteraceae	50.00	234.44	0.04	11.97
Ageratum conyzoides Hieron.	Asteraceae	50.00	251.11	0.04	12.76
Alternanthera sessilis (L.) DC.	Amaranthaceae	36.67	224.44	0.01	5.98
Amaranthus viridis L.	Amaranthaceae	36.67	243.33	0.02	9.18
Andrographis paniculata (Burm.f.) Wall. ex Nees	Acanthaceae	65.56	201.11	0.02	9.46
Axonopus compressus (Sw.) P.Beauv.	Poaceae	85.56	397.78	0.01	9.91
Centella asiatica (L.) Urb.	Apiaceae	41.11	367.78	0.01	7.60
Cleome rutidosperma DC.	Capparaceae	44.44	247.78	0.02	9.21
Colocasia esculenta (L.) Schott	Araceae	25.56	76.67	0.01	5.34
Commelina benghalensis L.	Commelinaceae	28.89	127.78	0.01	6.11
Cyanthillium cinereum (L.) H.Rob.	Asteraceae	36.67	165.56	0.01	6.24
Cynodon dactylon (L.) Pers.	Poaceae	56.67	536.67	0.01	10.41
Cyperus rotundus L.	Cyperaceae	64.44	540.00	0.02	11.15
Dichanthium annulatum (Forssk.) Stapf	Poaceae	38.89	175.56	0.01	4.56
Digitaria ciliaris (Retz.) Koeler	Poaceae	46.67	234.44	0.01	6.19
Drymaria cordata Willd. ex	Caryophyllaceae	50.00	217.78	0.01	5.83

doi: will be assigned shortly

Schult.					
Eclipta prostrata (L.) L.	Asteraceae	51.11	241.11	0.02	9.99
Euphorbia hirta L.	Euphorbiaceae	37.78	226.67	0.02	8.15
Grona triflora (L.) H.Ohashi & K.Ohashi	Fabaceae	24.44	146.67	0.01	4.40
Imperata cylindrica (L.) Raeusch.	Poaceae	42.22	193.33	0.02	5.95
Leucas aspera (Willd.) Link	Lamiaceae	71.11	220.00	0.03	12.46
Mazus pumilus (Burm.f.) Steenis	Mazaceae	45.56	167.78	0.01	7.13
Mesosphaerum suaveolens (L.) Kuntze	Lamiaceae	44.44	120.00	0.01	8.73
Mimosa pudica L.	Fabaceae	50.00	223.33	0.03	11.56
Mirabilis jalapa L.	Nyctaginaceae	26.67	80.00	0.02	5.24
Oldenlandia corymbosa L.	Rubiaceae	51.11	212.22	0.01	6.68
Oplismenus hirtellus (L.) P.Beauv.	Poaceae	52.22	547.78	0.01	9.53
Oxalis corniculata L.	Oxalidaceae	53.33	548.89	0.01	10.35
Paederia foetida L.	Rubiaceae	31.11	137.78	0.01	4.20
Panicum capillare L.	Poaceae	58.89	260.00	0.02	8.94
Paspalum conjugatum P.J.Bergius	Poaceae	53.33	165.56	0.01	5.60
Peperomia pellucida (L.) Kunth	Piperaceae	36.67	114.44	0.01	4.74
Phyllanthus niruri L.	Phyllanthaceae	37.78	171.11	0.01	7.11
Scoparia dulcis L.	Plantaginaceae	34.44	175.56	0.02	8.77
Swertia chirayita (Roxb.) H.Karst.	Gentianaceae	44.44	128.89	0.01	7.87
Synedrella nodiflora Gaertn.	Asteraceae	37.78	152.22	0.01	6.89
Torenia crustacea (L.) Cham. & Schltdl.	Linderniaceae	46.67	158.89	0.01	7.48
Total			**8861.11**	**0.58**	**300.00**

*F = frequency, D = density, TBC = total basal cover, IVI = Importance Value Index

doi: will be assigned shortly

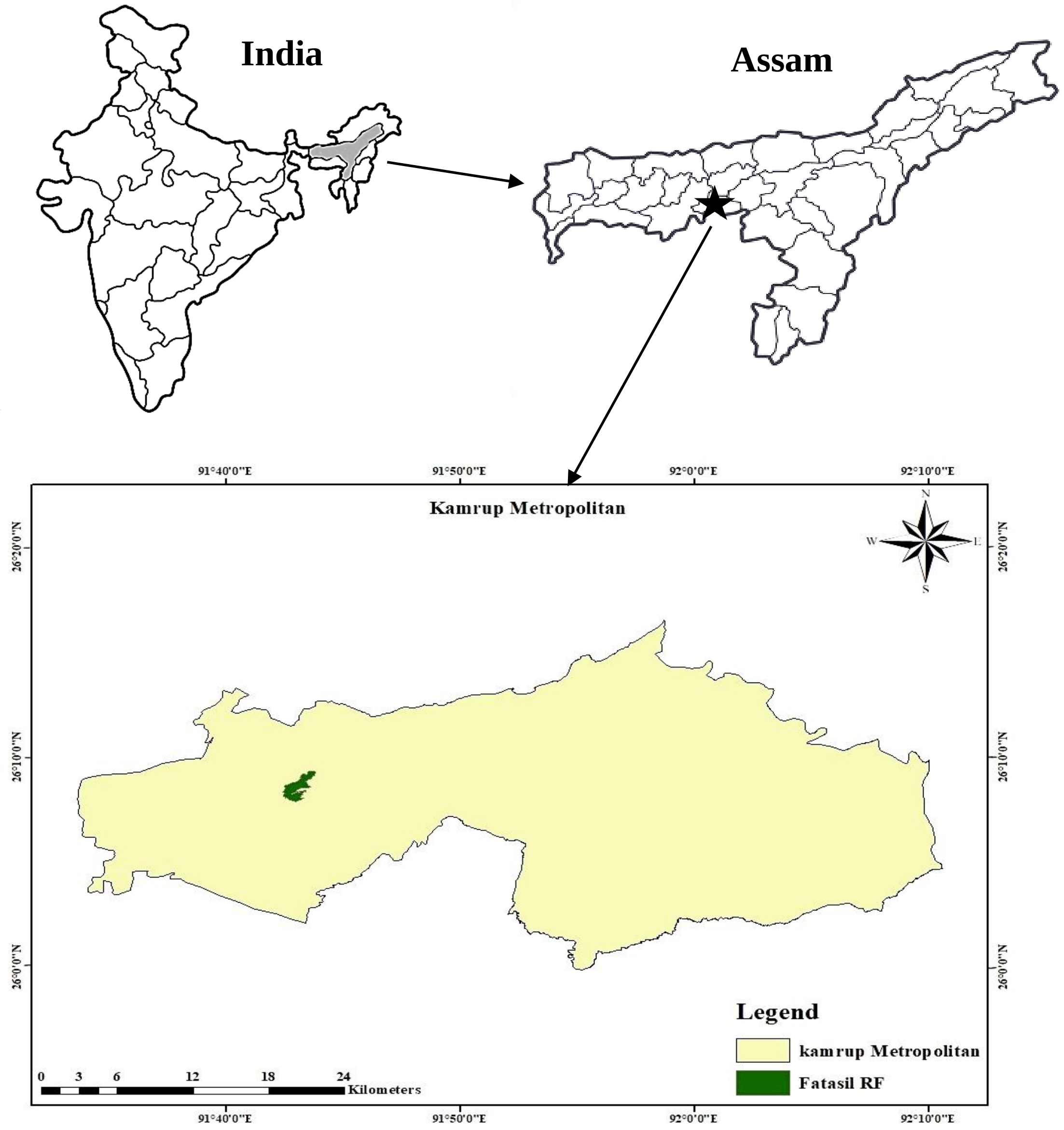

Fig. 1. Map of the study site

doi: will be assigned shortly

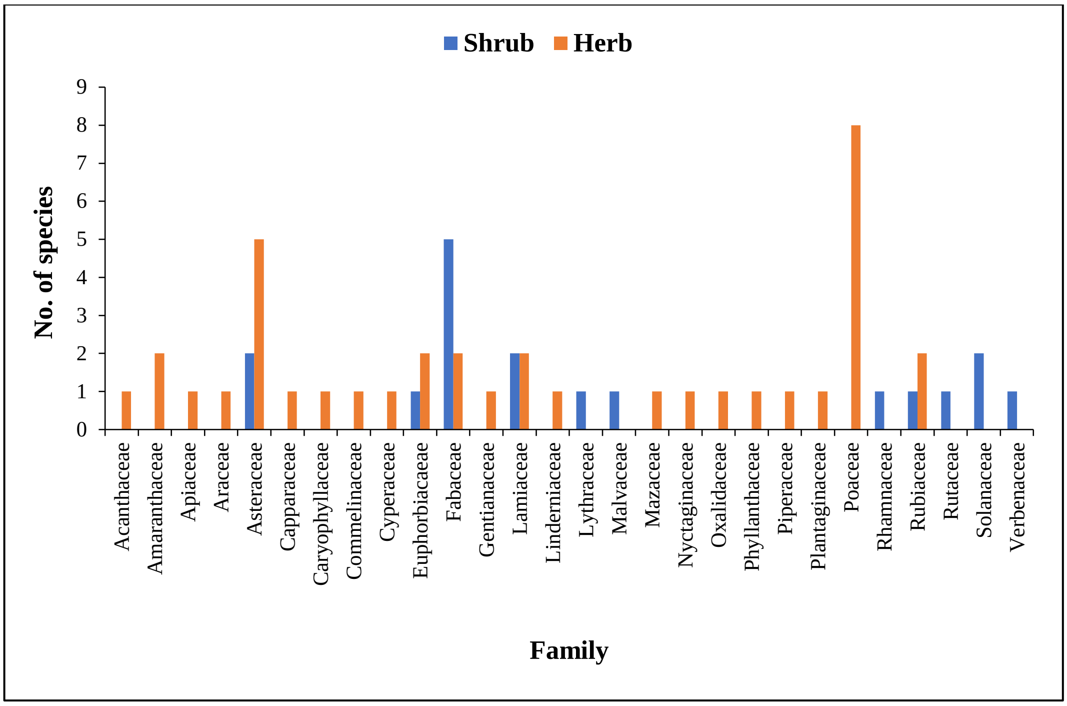

Fig. 2. Number of shrub and herb species belonging to different families

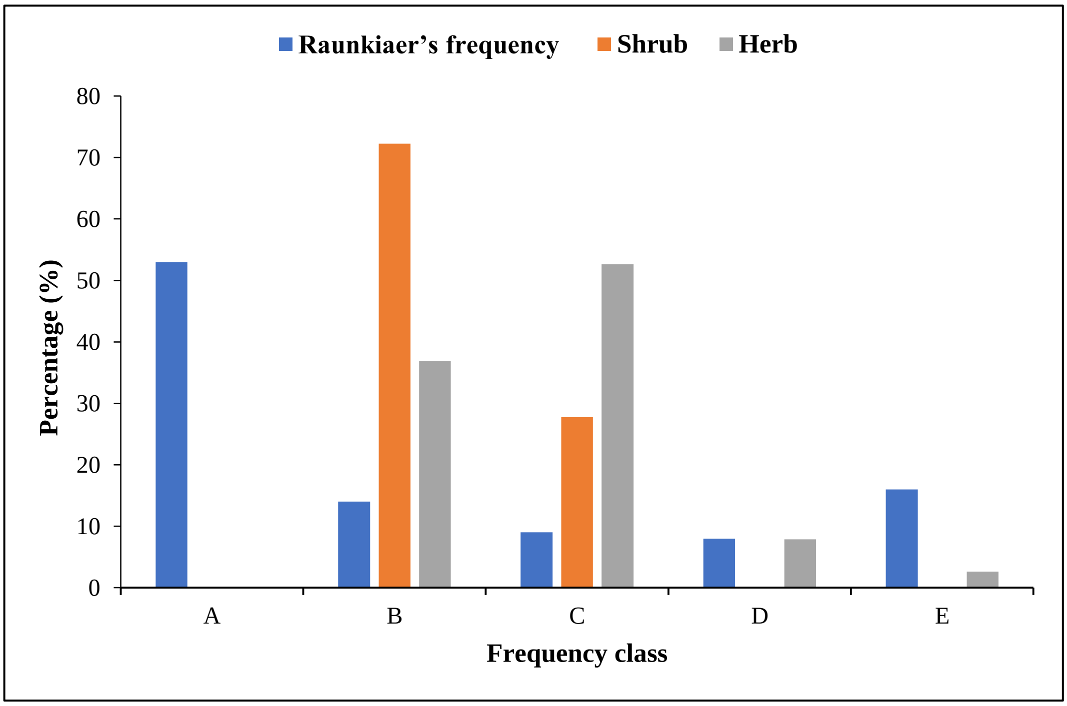

Fig. 3. Raunkiaer's frequency class and observed frequency class of shrubs and herbs

doi: will be assigned shortly