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Journal of Threatened Taxa

10.11609/jott.2024.16.6.25283-25494
www.threatenedtaxa.org

26 June 2024 (Online & Print)
16(6): 25283-25494
ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

Open Access

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

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Cover: Emperor Tamarin *Saguinus imperator*: a look into a better world through the mustache lens – mixed media illustration. © Maya Santhanakrishnan.

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 June 2024 | 16(6): 25453–25460

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

https://doi.org/10.11609/jott.8855.16.6.25453-25460

#8855 | Received 27 March 2023 | Final received 20 January 2024 | Finally accepted 29 May 2024

OPEN ACCESS

COMMUNICATION

Woody flora of Karumpuliyuthu Hill, Tenkasi, Tamil Nadu, India: a checklist

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Abstract: Qualitative field surveys were conducted to record the woody plant (tree, shrub, and liana) wealth in Karumpuliyuthu Hill, Tenkasi district, Tamil Nadu. All the recorded species were confirmed with regional floras. The qualitative field survey allowed us to record 42 species in 32 genera and 19 families. The family Fabaceae had a large number of species (13 species) in the study area. The present study adds valuable information about the occurrence of 42 woody plant species in a tropical thorn forest ecosystem. The woody plant community is dominated by native plants, and only three are introduced. Nearly half of the recorded species produce fleshy fruits, thus providing food to small mammals and birds.

Keywords: Dry forest, fruit, peninsular India, southern thorn forest, woody plant wealth.

Tamil: தமிழ்நாட்டிலுள்ள தென்காசி மாவட்டத்தில் அமைந்துள்ள கரும்புளியூத்து மலையில் வாழ்ந்து வரும் கட்டைத்தன்மை வாய்ந்த தாவரங்களான மரம், குறுமரம் மற்றும் பெருங்கொடிகளின் வளங்களை பட்டியலிடுவதற்காக பண்பறி களஆய்வுகள் மேற்கொள்ளப்பட்டன. சேகரிக்கப்பட்ட அனைத்து தாவரங்களும் அங்கீகரிக்கப்பட்ட தாவர வளம் குறித்த கையேடுகள் மூலம் கண்டறியப்பட்டன. பண்பறி களஆய்வுகள் மூலம் 19 குடும்பம் மற்றும் 32 பேரினங்களைச் சேர்ந்த 42 சிற்றினங்கள் பட்டியலிடப்பட்டுள்ளன. பேபேசி எனும் பயறுவகை தாவரங்களை கொண்ட குடும்பம் 13 சிற்றினங்களுடன் அதிக அளவில் காணப்படுகின்றன. இந்த ஆய்வானது 42 கட்டைத்தமை வாய்ந்த சிற்றினங்களின் இருப்பிடத் தகவலை நமக்கு அளிக்கின்றது. மேலும், இந்தக் காடானது இயல்வகை தாவரங்களின் இருப்பிடமாக விளங்குகின்றது, அயல்வகைச் சிற்றிங்கள் மூன்று மட்டுமே காணப்படுகின்றன. பட்டியலிடப்பட்ட மொத்த தாவரங்களில் இரண்டில் ஒரு பங்கு சதைப்பற்றுள்ள கனிகளை உற்பத்தி செய்வதன் மூலம் சிறிய வகை பறவைகள் மற்றும் பாலூட்டிகளுக்கு உணவினை வழங்குகின்றன.

Editor: Kannan C.S. Warrier, ICFRE - Institute of Forest Genetics and Tree Breeding, Coimbatore, India. **Date of publication:** 26 June 2024 (online & print)

Citation: Lalithalakshmi, K., A. Selvam & M. Udayakumar (2024). Woody flora of Karumpuliyuthu Hill, Tenkasi, Tamil Nadu, India: a checklist. *Journal of Threatened Taxa* 16(6): 25453–25460. https://doi.org/10.11609/jott.8855.16.6.25453-25460

Funding: None.

Competing interests: The authors declare no competing interests.

Author details: A. Selvam is an associate professor currently handling a core research grant project funded by SERB, GoI. M. Udayakumar is an assistant professor whose interests are forest ecology and angiosperm systematics. K. Lalithalakshmi is currently pursuing a Ph.D. under the guidance of AS in the field of forest ecology.

Author contribution: AS and MU designed and conceptualized the study. AS, MU, and LK conducted field surveys, collection, identification and documentation of woody plants from study area. MU and LK prepared the first draft of the manuscript and AS corrected it.

Acknowledgements: We thank the Department of Forest, Government of Tamil Nadu for allowing us to conduct field surveys at Karumpuliyuthu hill, Tenkasi district, Tamil Nadu. We extend our thanks to the DFO, Tirunelveli for the necessary permission to conduct field works at Karumpuliyuthu hills.

INTRODUCTION

Information on plant diversity such as flora, checklist, and quantitative or qualitative ecological studies are useful for understanding the changes that take place in forest plant communities (Armonies et al. 2018). Besides, these data are vital to frame conservation measures (Francisco-Ortega et al. 2010) and forest restoration (Shetu et al. 2018). Invariably all types of forests and trees deliver an array of ecosystem services (Taye et al. 2021). There are about 61,000 tree species flourishing on this earth (Qian et al. 2019). Trees provide a range of non-timber forest products including honey, fuel wood and fiber (FAO 2014). In addition, they play important roles in combating global climate change through carbon storage and sequestration (Roebroek et al. 2023). In general, woody plants store relatively more amount of biomass than herbaceous communities in forest ecosystems (Borah et al. 2015). Tropical thorn forests support moderate woody plant diversity (Rahangdale et al. 2014; Evitex-Izayas & Udayakumar 2021; Muneeswaran & Udayakumar 2022). Data on plant diversity of tropical thorn forests in Tamil Nadu remain scarce. This study aims to explore the woody plant wealth (shrubs, trees, and woody liana) of a tropical thorn forest ecosystem existing within Karumpuliyuthu Hill located in Tenkasi district, Tamil Nadu.

MATERIALS AND METHODS

Study area

Karumpuliyuthu Hill located in Tenkasi district, Tamil Nadu (Figure 1). The district was bifurcated from Tirunelveli district in 2019. The northern, eastern, western, and southern boundaries of the district are Virudhunagar, Thoothukudi, Tirunelveli, and Kerala, respectively. The mean annual precipitation of the district is 769.2 mm, while the mean maximum and minimum temperatures are 29 and 27°C, respectively (https://mausam.imd.gov.in/chennai/). The total geographical area of the district is 2,882.43 km^2, whereas the forest cover is 439.99 km^2 (https://tenkasi.nic.in/).

Field survey

A sum of 32 field surveys have been conducted to record woody plant wealth (shrubs, trees, and liana) in the tropical thorn forest ecosystem existing within Karumpuliyuthu Hill, located in Tenkasi district, one of the southernmost districts of India. All the recorded species were identified with available regional floras and checklists (Gamble & Fischer 1921–1935; Muneeswaran & Udayakumar 2022). The nomenclature of families and the author citation of species followed Plants of the World Online (https://powo.science.kew.org/). The current status of all the recorded species was verified with the help of the IUCN Red List of Threatened Species (https://www.iucnredlist.org/). Further, the flowering and fruiting phenophases of woody plants were recorded monthly for one year. A plant with flower (bud & open) and fruit (immature & mature) considered as 'reproducing'. The length of reproductive phenophase was calculated and recorded in months.

RESULTS AND DISCUSSION

The qualitative field survey allowed us to record 42 species in 32 genera and 19 families. The family Fabaceae had the large number of species (13 species) followed by Apocynaceae and Rubiaceae (three species each). Capparaceae, Euphorbiaceae, Menispermaceae, Rhamnaceae, Malvaceae, Verbenaceae, and Vitaceae had two species each, while, nine families represented by just a single species each in the study area (Figure 2 & Table 1). Important species of study area featured in Image 1.

The woody plant wealth of Karumpuliyuthu Hill (42 species) is comparable with a tropical thorn forest existing within Asola-Bhatti wildlife sanctuary, India (42 woody plants including 17 trees, 15 shrubs, and 10 climbers; Sharma & Chaudhry 2018); lower than in Carnatic umbrella thorn (53 and 54 in Hosur and Dharmapuri, respectively), secondary dry deciduous (48), southern dry mixed deciduous (95), southern tropical dry moist mixed deciduous (67), southern thorn (52), southern thorn scrub (53 and 49 in Hosur and Dharmapuri, respectively) and tropical dry evergreen forests in Tami Nadu (Tiwari & Ravikumar 2018a,b); and, tropical thorn forest of Gujarat (58 tree species, 44 mature, 41 seedlings, and 32 saplings; Rajendrakumar & Kalavathy 2010). However, the woody plant wealth of present study area is higher than in southern moist mixed deciduous (29), dry deciduous (22), *Hardwickia* (18 and 9 in Hosur and Dharmapuri, respectively), dry deciduous scrub (30), *Euphorbia* scrub (24), southern tropical dry deciduous (34) and southern dry scrub (16 and 34 in Hosur and Dharmapuri, respectively) forests flourishing in Tamil Nadu (Tiwari & Ravikumar 2018a,b); tropical thorn forest of Gujarat (8 climbers, 14 shrubs, and 17 trees; Patel et al. 2014); *Prosopis juliflora* invaded (27 tree species) and uninvaded southern thorn forest

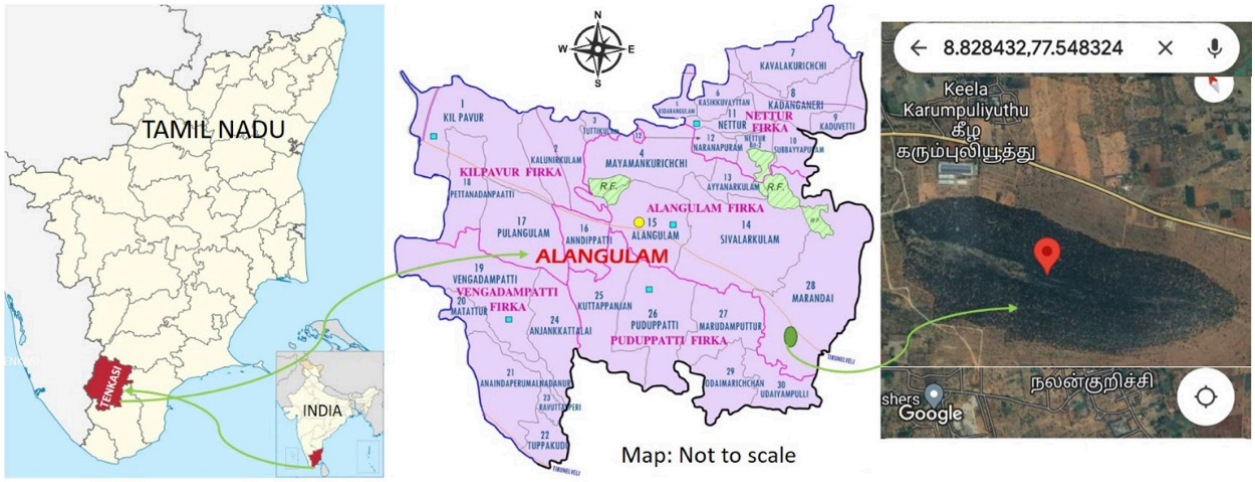

Figure 1. Map of study area in which field surveys conducted to record woody flora.

(35 tree species; Athamanakath et al. 2023).

The anthropogenic activities (cutting of trees, fuel wood collection etc.) transformed close-canopied dry deciduous forest in to tropical thorn forest (Champion & Seth 1968). Murphy & Lugo (1986) found relationships among species richness and moisture gradients across tropical forests and shown least number of tree species in driest areas. Singh & Singh (1988) recognized tropical thorn forest as extremely poor in terms of species richness and inhabited by mostly deciduous species. Tropical thorn forests occurring in a drier habitat and experience 5–6 dry months in a year, hence act as a habitat for moderate number of woody plants. It has been investigated that range of factors including altitude, mean annual minimum and maximum temperatures, distribution and frequency of precipitation and soil moisture content influence tree density, species richness and diversity (e.g., Thakur et al. 2022). For instance, Dattaraja et al. (2018) investigated the relationship between diversity of woody plants and environmental factors in Indian tropical forests and found thorn forests support least number of woody species. Detailed studies of impact of environmental factors on thorn forest ecosystem are limited.

The members of Fabaceae dominating the woody plant community in tropical thorn forest ecosystem. It is well known that a considerable number of species belongs to the family Fabaceae (e.g., *Acacia* & *Vachellia*) are able to fix nitrogen with the help of soil bacteria (Brockwell et al. 2005). Nitrogen fixation by members of Fabaceae could enhance the fertility of soil in tropical thorn forest. Recently, Evitex-Izayas & Udayakumar (2021) in a thorn forest ecosystem, Uthumalai, Tirunelveli; Nagaraj & Udayakumar (2021) in a southern thorn forest existing within Vallanadu Blackbuck Sanctuary (VBS), Thoothukudi; Muneeswaran & Udayakumar (2022) in a Carnatic umbrella thorn forest, Therikadu, Thoothukudi observed the dominance of Fabaceae members. Notably, the members of Fabaceae constituted 52.36% of tree community in VBS (Nagaraj & Udayakumar 2021). Besides, Indian thorn forests act as home for threatened species (Joshi et al. 2012; Baskaran & Desai 2013); range of insects (Adarsh et al. 2013; Majumder et al. 2015), and birds (Narwade & Fartade 2011; Babu & Bhupathy 2013).

Mode of regeneration

All the recorded plants produce seeds and regenerate from them during wet season. Eight species viz., *Coccinea grandis*, *Cissus quadrangularis*, *C. vitiginea*, *Commiphora berryi*, *Euphorbia antiquorum*, *Morinda coreia*, *Sarcostemma acidum*, and *Tinospora cordifolia* regenerate through seeds and vegetative parts (stems and root sucker). In general, seed predation by insects and rodents affects seed germination and seedling establishment in tropical forests (e.g., Guariguata et al. 2000). Information on various functional traits of seeds and seedlings are limited, therefore, continuous field studies and monitoring are necessary for better understanding of regeneration of tropical thorn forests.

Life form and conservation status

Among three life forms (trees, shrubs, and lianas), the trees dominated the study area with 18 species, shrubs represented by 15, whereas the liana represented by nine species (Figure 3 & Table 1). Half of all the recorded species were categorized under Least Concern (LC), 20 species were identified as Not

Table 1. Botanical name, family and life form of woody plants found in Karumpuliyuthu hill, Tenkasi district, Tamil Nadu. (introduced species marked with '*' mark, wild edible plants with '@').

	Botanical name	Family	Life form	IUCN Red List status	Fruit type	Mode of regeneration	Flowering and fruiting season
1	*Albizia amara* (Roxb.) Boivin	Mimosaceae	Tree	Least Concern	Pod	Seed	April–July
2	*Azadirachta indica* A.Juss.	Meliaceae	Tree	Least Concern	Drupe	Seed	April–August
3	*@Borassus flabellifer* L.	Arecaceae	Tree	Least Concern	Drupe	Seed	March–August
4	*Canthium coromandelicum* (Burm.f.) Alston	Rubiaceae	Tree	Not Evaluated	Berry	Seed	January–June
5	*Capparis sepiaria* L.	Capparidaceae	Shrub	Least Concern	Berry	Seed	April–August
6	*Capparis grandiflora* Wall. ex Hook.f. & Thomson	Capparidaceae	Liana	Not Evaluated	Berry	Seed	April–July
7	*@Carissa spinarum* L.	Apocynaceae	Shrub	Least Concern	Berry	Seed	March–July
8	*Catunaregam spinosa* (Thunb.) Tirveng.	Rubiaceae	Shrub	Least Concern	Drupe	Seed	April–September
9	*Coccinia grandis* (L.) Voigt	Cucurbitaceae	Liana	Not Evaluated	Pepo	Seed and vegetative	Throughout the year
10	*@Cissus quadrangularis* L.	Vitaceae	Liana	Not Evaluated	Berry	Seed and vegetative	February–August
11	*Cissus vitiginea* L.	Vitaceae	Liana	Not Evaluated	Berry	Seed and vegetative	March–July
12	*Cocculus hirsutus* (L.) W.Theob.	Menispermaceae	Liana	Not Evaluated	Berry	Seed	February–June
13	*Commiphora berryi* (Arn.) Engl.	Burseraceae	Shrub	Not Evaluated	Drupe	Seed and vegetative	April–September
14	*Dalbergia spinosa* Roxb.	Papilionaceae	Shrub	Least Concern	Pod	Seed	March–August
15	*Dichrostachys cinerea* (L.) Wight & Arn.	Mimosaceae	Tree	Least Concern	Pod	Seed	February–June
16	*Dodonaea viscosa* Jacq.	Sapindaceae	Shrub	Least Concern	Capsule	Seed	Throughout the year
17	*Ehretia aspera* Willd.	Boraginaceae	Tree	Data Deficient	Berry	Seed	April–September
18	*Euphorbia antiquorum* L.	Euphorbiaceae	Shrub	Least Concern	Capsule	Seed and vegetative	Throughout the year
19	*Flueggea leucopyrus* Willd.	Euphorbiaceae	Shrub	Least Concern	Berry	Seed	October–January
20	*Gmelina asiatica* L.	Verbenaceae	Shrub	Least Concern	Drupe	Seed	February–September
21	*Grewia hirsuta* Vahl	Tiliaceae	Liana	Least Concern	Drupe	Seed	February–June
22	*Grewia serrulata* DC.	Tiliaceae	Shrub	Not Evaluated	Drupe	Seed	March–June
23	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae	Tree	Not Evaluated	Samara	Seed	February–August
24	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Tree	Least Concern	Drupe	Seed	April–July
25	*@Morinda coreia* Buch.-Ham.	Rubiaceae	Tree	Not Evaluated	Berry	Seed and root sucker	Throughout the year
26	*Premna tomentosa* Willd.	Verbenaceae	Shrub	Least Concern	Drupe	Seed	March–August
27	*Prosopis cineraria* (L.) Druce	Mimosaceae	Shrub	Not Evaluated	Lomentum	Seed	April–September
28	**Prosopis juliflora* (Sw.) DC.	Mimosaceae	Tree	Not Evaluated	Lomentum	Seed	Throughout the year
29	*Rivea hypocrateriformis* (Desr.) Choisy	Convolvulaceae	Liana	Least Concern	Capsule	Seed	October–April
30	*Sarcostemma acidum* (Roxb.) Voigt	Apocynaceae	Liana	Not Evaluated	Follicle	Seed and vegetative	February–July
31	*Senegalia chundra* (Roxb. ex Rottler) Maslin	Mimosaceae	Tree	Not Evaluated	Pod	Seed	March–July
32	**Senegalia mellifera* (Benth.) Seigler & Ebinger	Mimosaceae	Tree	Least Concern	Pod	Seed	March–July
33	*Senna auriculata* (L.) Roxb.	Caesalpiniaceae	Shrub	Not Evaluated	Pod	Seed	Throughout the year
34	*Tinospora cordifolia* (Willd.) Hook.f. & Thomson	Menispermaceae	Liana	Not Evaluated	Berry	Seed and vegetative	February–June
35	*Vachellia horrida* (L.) Kyal. & Boatwr.	Mimosaceae	Tree	Not Evaluated	Pod	Seed	July–November
36	*Vachellia leucophloea* (Roxb.) Maslin, Seigler & Ebinger	Mimosaceae	Tree	Least Concern	Pod	Seed	March–July
37	*Vachellia nilotica* (L.) P.J.H.Hurter & Mabb.	Mimosaceae	Tree	Least Concern	Lomentum	Seed	July–December

	Botanical name	Family	Life form	IUCN Red List status	Fruit type	Mode of regeneration	Flowering and fruiting season
38	*Vachellia planifrons* (Wight & Arn.) Ragup., Seigler, Ebinger & Maslin	Mimosaceae	Tree	Not Evaluated	Pod	Seed	February–July
39	**Vachellia tortilis* (Forssk.) Galasso & Banfi	Mimosaceae	Tree	Least Concern	Pod	Seed	March–July
40	*Wrightia tinctoria* B.Heyne ex Roth.	Apocynaceae	Tree	Not Evaluated	Follicle	Seed	December–June
41	*@Ziziphus nummularia* (Burm.f.) Wight & Arn.	Rhamnaceae	Shrub	Not Evaluated	Drupe	Seed	October–May
42	*Ziziphus xylopyrus* (Retz.) Willd.	Rhamnaceae	Shrub	Not Evaluated	Drupe	Seed	October–June

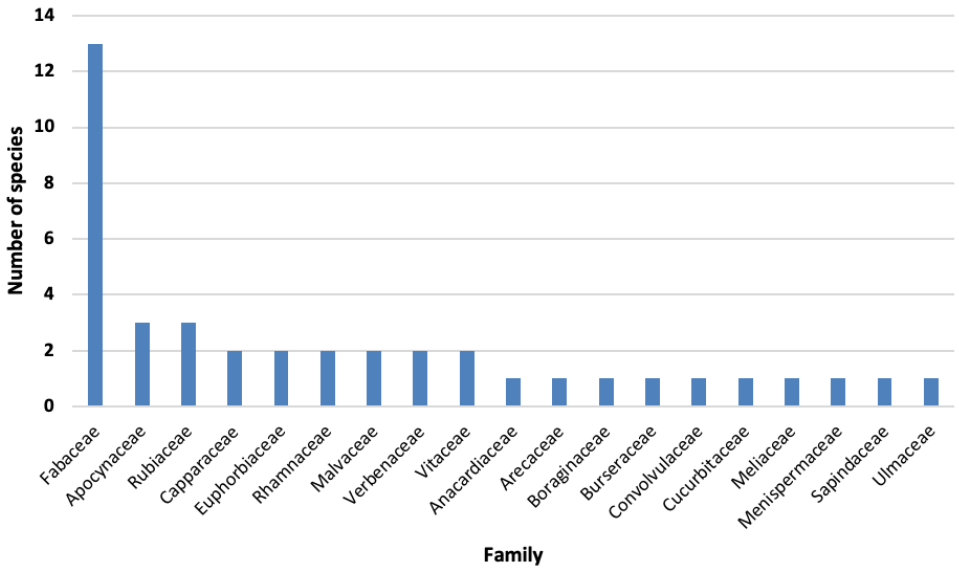

Figure 2. Number of species represented by families in study area.

Evaluated (NE) and only one was listed as Data Deficient (DD) (Table 1). All the listed species are native to India, except *Prosopis juliflora*, *Senegalia mellifera,* and *Vachellia tortilis*. Twenty-three species produced fleshy fruits (berry or drupe), remaining formed dry fruits (pod, lomentum, dehiscent and indehiscent capsules), thus the existing woody plant community in the study area partially fulfilled the food requirement of various birds (e.g., Bulbul, Myna) and small mammals (e.g., Squirrel, Civet, Forest rat). In addition, 21 species had mechanical protective structures either spine or thorn. It is well known that the presence of sharp protective structures (spine, thorn, prickle) is one of the common features for species growing in drier environments.

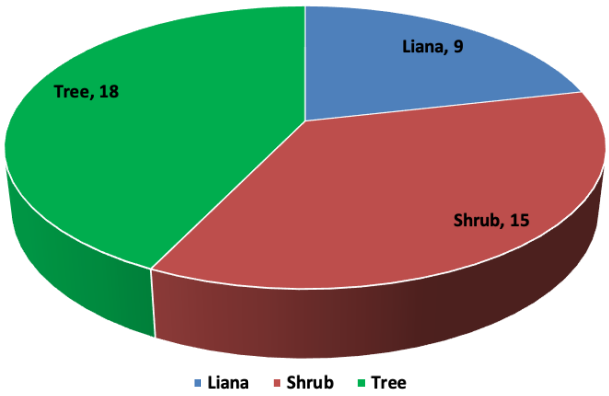

Figure 3. Life form composition of woody plants recorded from study area.

Reproductive phenophase of woody plants

The length of reproductive phenophase varied across species. Of 41 species, five species had four months of reproductive phenophase, 12 had five months, 11 had six months and six reproduced throughout the year (Table 1). The mean duration of reproductive phenophase of studied species was 5.214 ± 2.469 months. The reproductive phenophase peaked in April (39 species) followed by May (38), June (37), and July

Image 1. 1—*Ehretia aspera* | 2—*Capparis sepiaria* | 3—*Vachelia planifrons* | 4—*Albizia amara* | 5—*Commiphora berryi* | 6—*Carissa spinarum* | 7—*Dalbergia spinosa* | 8—*Sarcostemma acidum* | 9—*Albizia amara* Tree stand | 10—*Albizia amara* with multiple stems. © M. Udayakumar.

(31). Whereas, 12 species each reproduced in January, October, November, and December. Most of the species tends to reproduce after north-east monsoon (October–December). Researchers found close relationships among reproduction of trees, relative humidity and moisture content of tropical forests (Bhat 1992; Sundarapandian et al. 2005; Selwyn et al. 2006; Nanda et al. 2014).

Wild edible plants

The thorn forest acts as a home for five wild edible plants. The palmyra palm *Borassus flabelliber* provides edible tender and mature fruits, seed haustoria, and

seedling. It has been well documented and known that many parts of the palmyra palm are economically important (Rahman et al. 2021). *Carissa spinarum*, *Morinda coreia,* and *Ziziphus nummularia* yield edible fruits. A large number of researchers made a detailed study on these fruits and recorded vitamin, mineral, anti-oxidant, and nutrient contents (*C. spinarum*: Liu et al. 2021; *M. coreia*: Chandra & Meel 2020; *Z. nummularia*: Uddin et al. 2022). Young and tender stems of *Cissus quadrangularis* is edible and medicinal. A considerable number of medicinally important bioactive chemical compounds have been isolated from *C. quadrangularis* (Bafna et al. 2021).

CONCLUSION

The present study adds valuable information about the occurrence of 42 woody plant species in the tropical thorn forest ecosystem located at Karumpuliyuthu Hill, Tenkasi district, Tamil Nadu. The forest ecosystem supports a moderate woody plant diversity and five wild-edible plants. Most of the recorded woody plants belong to India, except three species. Tropical thorn forests are least explored in terms of ecology and taxonomy, thus extensive quantitative field studies are to be carried out to record the plant wealth and realize the range of ecosystem services. Further, the thorn forests are endowed with substantial number of trees with nitrogen fixing ability, research on these lines are helpful to understand the evolution and survival of drought tolerant forest systems.

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Journal of Threatened Taxa is indexed/abstracted in Bibliography of Systematic Mycology, Biological Abstracts, BIOSIS Previews, CAB Abstracts, EBSCO, Google Scholar, Index Copernicus, Index Fungorum, JournalSeek, National Academy of Agricultural Sciences, NewJour, OCLC WorldCat, SCOPUS, Stanford University Libraries, Virtual Library of Biology, Zoological Records.

NAAS rating (India) 5.64

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Journal of Threatened Taxa

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

June 2024 | Vol. 16 | No. 6 | Pages: 25283–25494
Date of Publication: 26 June 2024 (Online & Print)
DOI: 10.11609/jott.2024.16.6.25283-25494

Publisher & Host

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