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RESEARCH ARTICLE

Terrestrial orchids: The hidden jewels of Kamrup, Assam, India

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Abstract

The present study investigates the diversity of terrestrial orchid species in Kamrup district, Assam, based on extensive field surveys conducted across all the season from 2021 to 2025. The study employed with herbarium preparation and identification followed by standard protocol and using authentic literature. A total of 10 species were collected, representing 8 genera, with *Zeuxine* being the most dominating with 3 species. Each species described included their taxonomy, habitats and flowering periods. Most importantly, the work reports four rare species which underpin the ecological importance and conservation priority of these ground orchids in Kamrup. This work highlights the need to focus on understudied terrestrial orchids to protect and conserve them. Conserving orchids is essential because they are highly sensitive ecological indicator and contribute significantly to the ecosystem stability.

Keywords: ecosystem; Kamrup district; orchidaceae; orchid conservation; terrestrial orchids

Introduction

Kamrup district has a vast floral contribution to the state of Assam. The floral diversity of the district Kamrup is greatly affected by the river Brahmaputra and mountain ranges of Meghalaya. As of now approximately 1309 species of angiospermic plant species have been reported (1). When it comes to orchids, one generally never gazes towards the ground searching for terrestrial jewels. The epiphytic orchids are so popularized among the larger mass that most of the public doesn't realize that these gems can also be found lying on the ground or rock as terrestrial or lithophytic plants, respectively. The members of this unique family are already facing larger threats because of their peculiar reproductive cycle; as such, negligence and unawareness among the public about these ground members and rock dwellers put them in more danger. There are several cause that drives extinctions. Habitat loss and fragmentation from deforestation, agriculture, urbanization reduced or completely removed suitable site where they can grow (2, 3). Climate change is also a major contributor to the decline of orchid population by making existing place less suitable habitat (4). Many orchids species have very specific pollinators, decline in this insect by over use of pesticide greatly affect the reproduction of orchids (5, 6). Since many terrestrial orchids are very sensitive to microclimatic conditions and habitat integrity, they are considered effective bioindicators for ecosystem health. Terrestrial orchids, especially the rare ones often occupy threatened niches, that face pressures from agricultural expansion, over-grazing, local disturbances and altered fire regimes, such as habitats like grasslands, rock crevices, forest understories etc (7). So, documenting their presence and exploring their habitat preferences will support evidence-based conservation planning in near future and prioritizes sensitive areas for protection. Although terrestrial orchids do not provide major large-scale ecosystem services, but their ecological importance is often overlooked. As many species are highly sensitive to environmental change, they effectively indicate the overall health of that ecosystem (8). Conservation measures aiming at preserving these remarkable "ground jewels" will generate positive cascading ecological benefits, such as protecting these sensitive orchid habitats and their intricate biotic interactions will inherently safeguard the sustaining community of co-occurring taxa thereby creating a positive ecological ripple effect (9, 10).

The terrestrial orchid species that are being documented in this study represents new range expansional records for this region, that was previously underestimated. These novel findings highlight the biodiversity significance of these localized niches and the urgency to conserve these areas.

In general, the existence of ground orchids, especially those that grow unobtrusively within natural habitats rather than in gardens or greenhouses, remains largely unfamiliar; as a result, detailed taxonomic studies at the species level on these ground-dwelling plants are still relatively neglected in both public awareness and regional biodiversity research, despite their ecological significance and conservation urgency.

Our study discloses notable botanical novelty within the terrestrial orchid flora of Kamrup, where species previously unrecorded in regional assessments are being highlighted. It

reflects broader findings of few rare and geographically confined terrestrial orchids in Assam's biodiverse environments. This study glorifies both the remarkable diversity of ground rooted orchids and the critical conservation significance of these taxa, whose limited, localized populations render them susceptible to habitat degradation and ecological alterations. In India, the family Orchidaceae comprises 1331 species (11). The epiphytic orchids comprise about 60 % of the total population of orchids in India and the rest resemble the terrestrial orchids (12). Especially, the Himalayan region has a significant contribution of about 875 species under 151 genera (13). The Northeastern region of India contributes 876 species under 151 genera, which is approximately 70 % of the total orchid species in India. In the case of Assam, Chowdhury published a list of 293 species under 75 genera (14). Khyanjeet Gogoi described 398 species and 10 intraspecific taxa belonging to 101 genera in his book "Wild Orchids of Assam" in the year 2017. Where 121 species under 48 genera, terrestrial and saprophytic. The Brahmaputra valley of Assam contributes 115 species with 4 varieties under 50 genera (15). Kamrup District contributes 65 species under 31 genera (16).

Materials and Methods

The present study is the result of several field trips covering all the seasons from 2021 to 2025 in different locations of Kamrup district. The Kamrup district lies between 25°40' and 26°37' N and 90°05' and 92°50' E at an elevation of 49 m. The district is bounded by Udalguri and Baska districts in the north and Meghalaya state in the south, Kamrup Metropolitan and Darrang district in the east and Goalpara and Nalbari district on the west (Fig. 1). The climate is hot and humid in summer and dry cold and foggy in winter. The rainfall of this area ranges from 1500 to 2600 mm, with an average relative humidity of about 75 %. The maximum temperature rises to 38.5 °C in the summer while, in the winter, the minimum temperature dips up to 7 °C. Herbarium specimens were prepared by standard methods Jain & Rao (17). Specimens were identified with the help of authentic literature: The genera and species of Orchidaceous plants; Folia Orchidacea; The orchids of the Sikkim Himalayas; A Guide to the Orchid of Sikkim; The Orchid Flora of North-West Himalaya; Orchids of Arunachal Pradesh and virtual herbaria of BSI. Herbarium specimens were deposited at the Dhakuakhana College (Autonomous) Herbarium, Dhakuakhana, Lakhimpur, Assam.

Results

Key to the Genera

1a. Plant without leaves, saprophytic……. …. *Didymoplexis*

1b. Plant with leaves, photosynthetic ……. 2

2a. Leaves linear, grass like……..…….. *Arundina*

2b. Leaves elliptic to ovate……. 3

3a. Peduncle hispid……..…….. Zeuxine

3b. Peduncle glabrous……. 4

4a. Leaves cordate……..…….. *Nervilia*

4b. Leaves ovate to lanceolate 5

5a. Inflorescence densly flowered, ... *Goodyera*

5b. Inflorescence not dense..... 6

6a. Lip with lobes..... ..... *Peristylus*

6b. Lip without lobe 7

7a. Inflorescence bent downward ..... *Eulophia*

7b. Inflorescence upright ..... *Calanthe*

Arundina Blume

One species reported from India

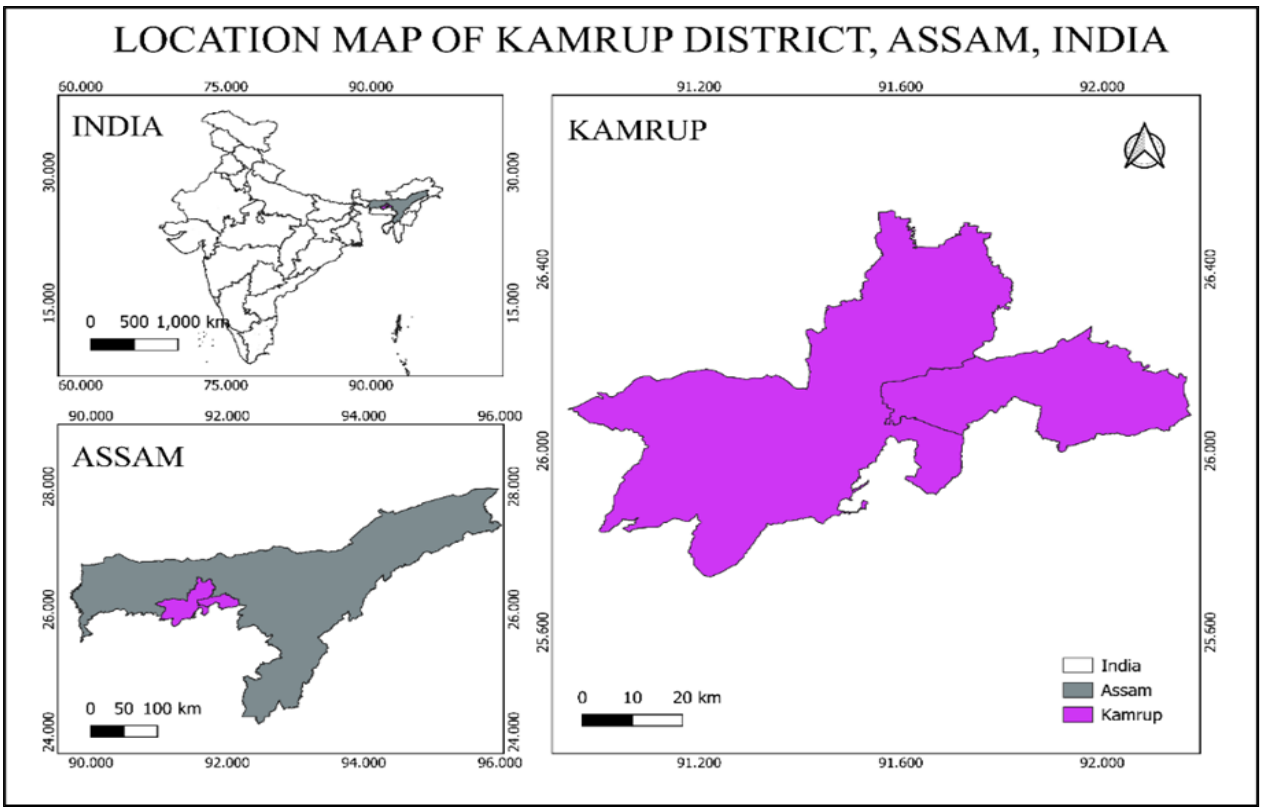

Fig. 1. Location map of Kamrup District, Assam, India.

Arundina graminifolia (D.Don) Hochr. in Bull. New York Bot. Gard. 6: 270 (1910)

Type: Nepal: Upper Nepal, suembu, Hamilton K000943823 (K)

Terrestrial, erect, grows up to 2 m; stem green, slender; rhizome short, branched. Leaves lanceolate, linear, grass-like. Inflorescence terminal raceme, 2-3 flowered. Flowers purple, about 7 cm. Habitat: Terrestrial, growing in forest. Voucher specimen: Mustafizur 09. Flowering: March-July. Specimen examined: Boko R.F. General distribution: India, Nepal, Bhutan, China.

Didymoplexis Griffith

Two species were reported from India, 1 in Assam and Kamrup district also

Didymoplexis pallens Griff. in Calcutta J. Nat. Hist. 4: t. 17 (1844); Hook. f., Fl. Brit. India 6: 122. 1890; Chowdhery, Orch. Fl. Arunachal Prad. 329. 1998.

Type: India: West Bengal, Hooghly district, Serampore, Griffith K000387608 (K)

Terrestrial, erect and leafless, slender, grows up to 7-15 cm tall, pale buff coloured, tubers fusiform. Inflorescence terminal, 3-7 flowered; flowers white, 0.7-1 cm long, Habitat: Terrestrial, growing in bamboo forest. Voucher specimen: Mustafizur 05. Flowering: March-June. Specimen examined: Jakulbari R. F, Maliata R.F. General distribution: N.E. India.

Eulophia R.Br.

32 species were reported from India, 10 species from Assam

Eulophia picta (R.Br.) Ormerod in Checkl. Papuasian Orchids: 293 (2017); Kumar et. Monilal, Cat. Ind. Orch. 75. 1994; Chowdhery, Orch. Fl. Arunachal Prad. 418. 1998.

Type: Australia: East coast, Brown K000890997 (K)

Terrestrial, grows up to 30-40 cm tall. Pseudobulb, tuberous, subglobose, enclosed by scarious sheaths. Leaves 3-4, plicate, suberect, dark green, lanceolate. Inflorescence 10-40 cm long, compact, pendent; flowers white to pinkish, 10-14 flowered. Habitat: Terrestrial in deciduous forest. Voucher specimen: Mustafizur 07. Flowering time: May - June. Specimen examined: Rani R.F. General distribution: India, Bangladesh, Thailand.

Goodyera R.Br.

19 species were reported from India and 6 in Assam.

Goodyera procera (Ker Gawl.) Hook. in Exot. Fl. 1: t. 39 (1823); Hooker *f*., Fl. Brit. India 6: 111. 1890. *Neottia procera* Ker Gawler, Bot. Reg. 8: t. 639. 1822.

Type: Nepal: Kathmandu, Wallich K000595849 (K)

Terrestrial, grows up to 70 cm tall; rhizome stout. Leaves ovate to elliptic. Inflorescence long, denesly flowered. Flowers fragrant, white. Habitat: Terrestrial, grows near small stream. Voucher specimen: Mustafizur 10. Flowering time: March-June. Specimen examined: Garbhanga R.F.General distribution: India, Bangladesh, Thailand, Nepal.

Nervilia Comm. ex Gaudich.

14 species were reported in India, with 3 in Assam.

Nervilia concolor Schltr. in Bot. Jahrb. Syst. 45(3): 404 (1911).

Type: Indonesia: Java, Mount salak, Blume s.n (L)

Terrestrial, grows up to 3-4 cm tall, tubers subglobose to ovoid. Leaves 15-20 × 10-18, broadly cordate-ovate, glabrous, margin undulate. Inflorescence 20-40 cm long, 4-15 flowered, flowers yellowish green, 3-4 cm long, lip pale green, white or pale green with purple venation. Habitat: Terrestrial, growing in forests with shaded and damp places along valleys. Voucher specimen: Mustafizur 03. Flowering time: May - June. Specimen examined: Rani R.F., Barduar R.F. General distribution: N.E. India.

Peristylus Blume

29 species were reported in India, with 4 in Assam

Peristylus constrictus Lindl. in Gen. Sp. Orchid. Pl. 300 (1835).

Type: Myanmar: Moulmyne, Wallich K000974162 (K)

Terrestrial, grows up to 45-90 cm tall, stem erect, sheathed. Leaves 6-13 × 3-5 cm, ovate to elliptic. Inflorescence 21 – 42 cm long, compact, many flowered; flowers white, fragrant, 1.5-2 cm long, sepals 0.4-0.6 cm long, pale brown, petals 0.3-0.8 cm long, white in colour, lip pure white. Habitat: Terrestrial on scrubby slopes. Voucher specimen: Mustafizur 01. Flowering time: April - September. Specimen examined: Barduar R.F., Dhupdhara, General distribution: Asia.

Calanthe R.Br.

7 species were reported in India, with 4 in Assam,

Calanthe tankervilleae (Banks) M.W. Chase, Christenh. & Schuit., in Phytotaxa 472: 165 (2020); Mishra, Orch. India 313. 2007; Chowdhery, Orch. Fl. Arunachal Prad. 583. 1998.

Type: French polynesia: Ulietea, Banks K000974265 (K)

Terrestrial, grows up to 50-80 cm tall. Pseudobulbs 3-7cm long, green, sheathed by leaf bases. Leaves 4-5, elliptic to lanceolate, long petiolated. Inflorescence 20-70 cm long, lateral, laxly 6 to 20 flowered. Flowers bright pink to light brownish; sepals and petals whitish outside, reddish brown or brown inside; lip white toward base, pink or red-pink toward entrance with white stripes on inside. Habitat: Terrestrial. Shaded place in forest. Voucher specimen: Mustafizur 08. Flowering time: January- March. Specimen examined: Basistha hill, Hajo. General distribution: India, Sri Lanka, Bhutan, Burma, China, Japan, Thailand.

Zeuxine Lindl.

19 species were reported in India with 11 species in Assam

Key to the species

1a. Leaves stalked ..... *Zeuxine nervosa*

1b. Leaves not stalked ……..2

2a. Leaves linear ……. *Zeuxine strateumatica*

2b. Leaves ovate ……. *Zeuxine longilabris*

Zeuxine longilabris (Lindl.) Trimen in Syst. Cat. Fl. Pl. Ceylon 90. (1885); Hook. f., Fl. Brit. India 6: 107.1890; Chowdhery, Orch. Fl. Arunachal Prad. 695. 1998.

Type: Sri Lanka: Near Julio Mts, Macrae K000895717 (K)

Terrestrial, grows up to 15-20 cm tall. Leaves 2-3 × 1- 2 cm, ovate to oblong, 5-7 nerved, drooping, copper-brown white coloured, petiole short. Inflorescence 2-6 cm long, 3-6 flowered; flowers white, 1 - 1.5 cm long, sepals green, lips are white. Habitat: Terrestrial growing in grassland and bamboo forest. Voucher specimen: Mustafizur 02. Flowering time: March - May. Specimen examined: Jalukbari R.F., Kamakhya hill, General distribution: Nepal, Sri Lanka, Bangladesh, Thailand.

Zeuxine nervosa (Wall. ex Lindl.) Benth. ex Trimen. in J. Ceylon Branch Roy. Asiat. Soc. 9: 90 (1885).

Type: Bangladesh: Derwani, Hamilton 7381a (K-LINDL)

Terrestrial, grows up to 18-30 cm tall, slender, stem erect, hispid. Leaves 4-6 ×1.5-2.5, ovate to elliptic. Inflorescence 10-20 cm long, 4-10 flowered; flowers white, 1 - 2 cm long, sepals green, lip white or pale yellow. Habitat: Terrestrial growing in grassland and bamboo forest. Voucher specimen: Mustafizur 06. Flowering time: February - April. Specimen examined: Jalukbari R.F., Maliata R.F., General distribution: India, Sri Lanka, Eastern Himalayas, Nepal, Thailand, Taiwan, China, Bangladesh.

Zeuxine strateumatica (L.) Schltr. in Bot. Jahrb. Syst. 45(3): 394, in obs. (1911).

Type: Sri Lanka: Colombo, Hermann 000621635 (BM)

Terrestrial, grows up to 15-25 cm tall, rhizome short, stem erect. Leaves 2-7 × 0.3-0.6 cm, linear to lanceolate. Inflorescence 4-7 cm, compact, many flowered, flowers greenish white, 0.5-1.5 cm long, lip whitish yellow. Habitat: Terrestrial growing in grassland. Voucher specimen: Mustafizur 04. Flowering time: January-April. Specimen examined: Rani R.F., General distribution: India, Eastern Himalayas.

Discussion

The present study reveals that the Kamrup district of Assam, cocooned in lush green, is already recognized for its rich floral diversity and also harbours a notable assemblage of terrestrial orchids, represented here by 10 species under 8 different genera (Fig. 2). Among the recorded genera, *Zeuxine* exhibit highest number of species (*Z. longilabris, Z. nervosa and Z. strateumatica*). This dominance may be attributed to the ecological adaptability of the genus, particularly its ability to colonize open grasslands, forest edges and bamboo groves, habitats that are relatively widespread in the Kamrup district. This broader ecological adaptability of the genus may also be attributed to its mycorrhizal flexibility and phenological plasticity. These orchids occupy specialized niches like grassland, bamboo forests and forest understories, highlighting the ecological importance of small, localized habitat within the district. A high abundance and diversification of *Zeuxine* sp. may also indicate a relatively lower habitat specialization compared to other, more specialized rare taxa. Thus, from the perspective of terrestrial orchid ecology, we can infer that Zeuxine is a generalist taxon with broader ecological niches in these areas owing to its ecological plasticity compared to other specialized taxa like *Didymoplexis*, *Nervilia,* etc., with very narrow ecological requirements. The occurrence of ecologically sensitive and rare taxa like *Didymoplexis pallens* and *Nervilia concolor* emphasises the conservation value of shaded forest understories and bamboo-dominated habitats in the district. Along a disturbance gradient, generalist ground orchid taxa (e.g. *Zeuxine*) may dominate secondary, regenerating forests, whereas specialist ones (e.g. *Didymoplexis, Nervilia*) reside only on minimally disturbed habitats with stable microclimates, intact leaf litter layers and specific soil fungal interactions. Thus, the presence of the later genera in the Kamrup district area indicates ecological maturity of the ecosystem with very high habitat integrity, microhabitat stability and minimally disturbed or undisturbed forest conditions. So, conservation of this habitat is extremely necessary as these taxa are extremely vulnerable to disturbances with poor natural recovery, behaving like bio-indicators of the pristine forest floor ecosystem.

The leafless, myco-heterotrophic orchid *Didymoplexis pallens* relies heavily on undisturbed soil fungal networks and consistent microclimatic conditions. Its existence signifies largely untroubled forest grounds, highlighting the importance of conserving these microhabitats. The presence of this achlorophyllous member indicates a functionally intact late successional forest floor ecosystem with very well-established mycorrhizal networks, suggesting its high ecological potential to harbour additional obligately specialized myco-heterotrophic plant genera. Therefore, conservation is essential to safeguard the healthy population of these fragile fungus-dependent and disturbance-sensitive plants; that are otherwise irrecoverable once degraded.

The work also addresses a major knowledge gap that terrestrial orchids remain largely unknown to the public and comparatively neglected in regional research as compared to epiphytic orchids. Globally, orchids have been studied for their diversity and conservation needs, but comparative works explicitly detailing ground orchids' ecology distinct from epiphytic orchids remain very limited, hindering a comprehensive understanding of their specific ecological adaptivity and their responses to environmental change.

Conclusion

The study reveals that the Kamrup district supports a distinct and previously under-documented assemblage of terrestrial orchids, with *Zeuxine* as the dominant genus. Through rigorous multi-season field surveys and detailed species-level treatment, the article not only clarifies the taxonomy, habitats, phenology and ecology of these orchids but also underscores their value as sensitive bioindicators that reflect the health of grasslands, bamboo groves, forest understories and other specialized niches in the state. By drawing attention to the largely overlooked "ground jewels" of the district, this work calls for greater research focus, habitat-based protection and public awareness, positioning terrestrial orchids as focal elements in evidence-based conservation planning and as gateways to safeguarding the wider ecological communities with which they are intricately linked.

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Authors' contributions

MR collected and identified the orchids. RK and DM wrote the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

Fig. 2. A. *Zeuxine longilabris* Trimen. **B.** *Didymoplexis pallens* Griff. **C.** *Peristylus constrictus* Lindl. **D.** *Goodyera procera* (Ker Gawl.) Hook. **E.** *Zeuxine nervosa* (Wall. ex Lindl.) Benth. ex Trimen **F.** *Phaius tankervilleae* (Banks) Blume **G.** *Nervilia concolor* Schltr. **H.** *Eulophia picta* (R.Br.) Ormerod **I.** *Arundina graminifolia* (D.Don) Hochr. **J.** *Zeuxine strateumatica* (L.) Schltr.

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