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RESEARCH ARTICLE

A preliminary report on the flowering patterns and morphological characteristics of *Bambusa tulda* Roxb. (Poaceae: Bambusoideae): in Kalimpong district of West Bengal, India

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Abstract: This research investigates the recent flowering occurrences of *Bambusa tulda* in the Kalimpong District of West Bengal, focusing primarily on documenting their timing, frequency, and morphological features. *B. tulda* is a semi-deciduous bamboo species commonly utilized in the area for construction, handicrafts, and various domestic purposes. While its distribution along hill slopes is well documented, there is limited understanding of its occasional mass-flowering behavior in this region. By gathering historical data and conducting field studies during the recent flowering event, we provide detailed accounts of culm, inflorescence, and floral morphology, along with spatial mapping of flowering populations to highlight their contributions to livelihoods and ecosystem dynamics.

Keywords: Bamboo flowering, sporadic, gregarious, synflorescence, culm

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Introduction

Bamboos are members of the sub-family Bambusoideae within the grass family Poaceae (Das *et al.,* 2008) and are important components of tropical forests and influence the diversity and productivity of the ecosystems in which they are abundant (Judziewicz *et al.,* 1999; Das *et al.,* 2017). Bamboo has drawn attention of plant lovers for their fast-growing habit (Taylor and Zisheng, 1998; Nath *et al.,* 2007), peculiar life cycle (Nath and Das, 2010; Nath *et al.,* 2012; Nath *et al.,* 2015), and unusual flowering habits (Janzen, 1976; Makita, 1992; Das *et al.,* 2014; Das *et al.,* 2017). Bamboo flowering is one of the mysterious phenomena in the plant world owing to its semelparous nature (Devi and Bhattacharyya, 2014). In Bambusoideae, three flowering regimes has been noted: (a) Sporadic, (b) Gregarious and (c) Continuous (McClure, 1966; Seethalakshmi and Kumar, 1998; Kumari and Lakra, 2023). Gregarious monocarpic flowering is the habit of the flowering at approximately regular intervals and once in lifetime, for which woody bamboos are renowned (Kumari and Lakra, 2023). Flowering is generally followed by massive dieback of individuals, population or species. In some other bamboos, sporadic flowering occurs at regular intervals with or without the death of the plant. The continuous flowering in some species may occur annually or seasonally without subsequent death (Judziewicz *et al.,* 1999). The flowering cycle may vary from 20-60 years, sometime

even 120 years (McClure, 1966). Due to their rare, irregular and long interval flowering nature, bamboos have been identified and classified in most of the literature mainly based on their vegetative characters (Devi and Bhattacharyya, 2014).

Although the clum sheath plays a significant role in the identification (Chatterji and Raizada, 1963; Sarma and Pathak, 2004) at species level, sometime it is very difficult to distinguish them due to their variations in pubescence, shape, size and texture. Even within the same clump of a plant the clum sheaths may vary. In some cases, it is very difficult to differentiate between taxa only on the basis of their vegetative characters due to ecological influences and cannot be considered as stable features in the delimitation of taxa at specific and intraspecific level. Polyploidy is also a very common occurrence in Bambusoideae. Hence, identification of species based on both vegetative and reproductive characters is much reliable (Devi and Bhattacharyya, 2014).

Bambusa tulda Roxb. is a semi-deciduous caespitose bamboo, endemic to Indo-Burma and is widely distributed in India, Bangladesh, Myanmar, Thailand (Banik, 1998; Sing *et al.,* 2010), Bhutan and Nepal (Poudyal, 2006). In India it is commonly found in West Bengal, Bihar and the northeastern states (Vanlalfakawma *et al.,* 2017) including Sikkim, Darjeeling, Kalimpong, Terai and Doars areas of West Bengal. It is a multipurpose bamboo. In India, bamboo is primarily utilized for various purposes, including construction (Rathour *et al.,* 2022), agar-bathi stick industry (Varuvel *et al.,* 20232), bamboo lumbar (Firstgreen Consulting, 2023), making pickles (Acharya *et al.,* 2023), crafting mats (Waghmare *et al.,* 2018), toys (Tewari, 1992), food grain containers (Harshawardhan *et al.,* 2024), baskets, and other traditional items (Tewari, 1992).

Fig. 1. Different stages of flowering clumps of *Bambusa tulda.* (a) Flowering culms (b) Internode and node (c) Internode with distinct yellow vertical strips (d-e) Leaf sheath with hair (f) Culm sheath with distinct (with appressed dark brown or black hairs) (g) Culm sheath of inflorescence (h-i) Spikelets comprising 4-6 fertile florets (j) Single bisexual flower showing distinct anther, filament and hairy stigma (k) Single ovary with style and stigmas and (l) Completeflower with glumes and exposed anthers.

The flowering events of *Bambusa tulda* were first recorded in its native habitat in Mizoram during 1880-1884 and 1928-1929 (Mohan Ram and Harigopal, 1981; Vanlalfakawma *et al.,* 2017). These were followed by sporadic flowering in 1976 and a subsequent mass flowering period that lasted until 1979 (Mohan Ram and Harigopal, 1981). Additional reports documented sporadic flowering of *B. tulda* in 1997, succeeded by synchronized flowering in 2003, which was observed in Dhemaji and Lakhimpur, Assam (Sarma *et al.,* 2010). In 2003, sporadic flowering was also observed and documented in Dighra, West Bengal (Bhattacharya *et al.,* 2006). These observations suggest an intermast period of approximately 48 years for *B. tulda* (Mohan and Harigopal, 1981). Recently, the sporadic flowering of *B. tulda* was reported again from Mizoram (Vanlalfakawma *et al.,* 2017).

This preliminary report aims to document and analyze the flowering of *Bambusa tulda* in the Kalimpong District of West Bengal, India. In recent months, reports from local residents, forest officials, and botanists have indicated the occurrence of flowering in *B. tulda* populations across several areas of the Kalimpong district. Field surveys conducted by our team have confirmed the presence of flowering culms in multiple bamboo stands and forest areas within the district.

The flowering pattern and inflorescence structure were meticulously examined, revealing that in our research area, *Bambusa tulda* exclusively produced pseudo-spikelets, with no individual culm displaying solitary inflorescence sporadically. Only a small number of populations in the present study area exhibited sporadic flowering. The plants showed the following morphological characters including flower, culm-sheath etc. (Fig. 1a-i).

Clump perennial; caespitose. Rhizomes short; pachymorph. Culms erect; 45-120 mm diameter; 550 -1900 cm long (Fig. 1a); woody; nodal roots absent. Culm-internodes mostly terete (Fig. 1b); uniformly thin-walled; 36-60 cm long; mid-green, or grey with yellow vertical strips (Fig. 1c). Lateral branches dendroid; spreading uniformly. Branch complement many. Leaves cauline. Leaf-sheaths always striately veined; surface glabrous. Leaf-sheath oral hairs setose (Fig. 1 d & e); pale. Ligule an eciliate membrane. Leaf -sheath auricles perfectly falcate. Collar subtended with external ligule. Culm-sheaths (1f) 145-250 mm long; nearly triangular; cordate; pubescent; with appressed dark brown or black hairs; truncate at apex, or sometimes convex at apex; always auriculate; partly or wholly ciliate on shoulders. Leaf-blade midrib evident. Leaf-blade surface puberulous and hairy abaxially (oral setae). Leaf-blade margins scabrous. Leaf-blade apex acuminate. Culm sheath (1g) in flowering branches thin, narrow, 42-50 mm long and 15-22 mm in width; pubescent, with distinct dark brown or black hairs. Spikelets comprising 4-6 fertile florets (Fig. 1 h & i); with diminished florets at the apex. Spikelets linear; subterete; 25-76 mm long; 5 mm wide; disarticulating immediately below each fertile floret. Definite rachilla internodes; clavate; ultimately visible among lemmas; piloseat tip. Glumes many; sometime 2-4 empty glumes present. Fertile lemma ovate or roughly elliptical; 11-30 mm long; 7-10 mm wide; keel absent. Lemma margins unciliated, or ciliolate. Lemma apex acute, or acuminate; mucronate. Palea 7-9 veined. Ciliated palea keel. Lodicules 3; membranous; veined; ciliate. Anthers 6; 7-10 mm long; purple (Fig. 1 m); anther tip smooth. Stigmas 3. Ovary umbonate; pubescent on apex (Fig. 1 l). Synflorescence bractiferous; always clustered at the nodes; in untidy tufts; lax; spathaceous subtending bracts; axillary buds at base of spikelet; mostly prophyllate beneath lateral spikelets; no leaf between clusters.

In conclusion, the study shed light on the ecological and botanical significance of *Bambusa tulda*, a prominent bamboo species in the Kalimpong District of West Bengal. By documenting recent flowering occurrences and providing detailed morphological descriptions, the study contributes to our understanding of bamboo dynamics in the region. The historical flowering records underscore the sporadic nature of bamboo flowering, adding to the mystery surrounding this phenomenon. Moving forward, further research is needed to explore the underlying factors driving bamboo flowering and its implications for local ecosystems. Additionally, efforts to conserve and manage bamboo populations should consider both vegetative and reproductive traits for accurate species identification and classification. Overall, this study serves as a valuable foundation for future investigations into the biology and ecology of *B. tulda* and other bamboo species in similar ecosystems.

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