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# Vegetative phenology of three bamboo species in subtropical humid climate of Assam

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Bamboo forms an important component in the homegardens of Assam, as also in other parts of northeast India. *Bambusa cacharensis* R. Majumder (betua), *B. vulgaris* Schrad. (jai borua) and *B. balcooa* Roxb. (sil borua) are the dominant village bamboos in the homegardens of Barak Valley prioritized by the rural people (Nath *et al.* 2006). The available studies on bamboo phenology report only certain aspects like periodicity of culm emergence (Banik 1999; Rao *et al.* 1990; Ueda 1960), bud break and new branching on the culm (Banik 1999; Lodhiyal *et al.*1998), leafing pattern (Rao *et al.* 1990). Plant phenologies are the result of interactions of biotic and climatic factors that through natural selection determine the most efficient timing for growth and reproduction (van Schaik *et al.* 1993). Thus there is a need of documentation of bamboo phenological behaviour that are fundamental to understanding the species-specific leaf and sheath dynamics and their ecological significance in plant adaptability being subject to the same climatic regimes. The present study aims to describe the phenological behaviour of three village bamboos.

The study was conducted in Dorgakona village, in Cachar district of Assam, and is situated between longitude 92°45´ east and latitude 24°41´ north. The climate of the study site is subtropical, warm and humid. The mean maximum temperature ranges from 24.9°C (January) to 33.7°C (August) and the mean minimum from 11.8°C (January) to 24.8°C (July). The monsoon rain normally starts from early June and continues till October. The dry season usually occurs from December to February.

Phenological studies were made on one, two and three year old culms for the three species. Twenty five culms from each age class were selected randomly and identified with numbered aluminium foil. From July 2003 to June 2005 phenological observations were made at monthly interval for sheath appearance, changes in sheath colour, sheath fall, leaf appearance, leaf fall and culm colour. During the intense phenological activity period observations on above aspects were made at two week interval. When a phenophase was observed in 20% of the tagged culms the phenophase was considered as initiated and as peak when observed in 80% or more culms.

In *B.cacharensis* and *B.balcooa* culms emerged during the period of June to August and in *B.vulgaris* from June to September, with a peak in July in all the three species. During culm emergence, sheaths are light green in

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*B.cacharensis* and *B.vulgaris* and light violet in *B.balcooa*. On maturity, sheaths are brown in *B. cacharensis* and *B. balcooa* and pale brown in *B. vulgaris*. In *B.cacharensis* green colour of sheath retained for almost 60 days where as in *B.vulgaris* it retained only for 15 days. Details of sheath phenology are described in Fig.1. Structures of sheaths are asymmetrical along the length of the culm. In all the three species in the lower half of the total length of culm, sheaths are broader than long whereas in the upper half, sheaths are longer than broad.

Colours differentiate different age classes of culms within the same species. With the maturation of culm, colour undergoes certain changes (Table 1).

Leaf phenology differs in different age classes of culms within the species and among the different species (Fig. 2). In the one year culms of *B. balcooa* and *B. vulgaris,* leaves started appearing in August whereas in *B. cacharensis* leafing starts in September. The leafing activity was completed within 3 months (August to October) in *B. balcooa*, 4 months (August to November) in *B. vulgaris* and 10 months (September to June) in *B. cacharensis*. In *B. cacharensis,* leaves started appearing in September and were confined to upper one-third portion of the culm. Leafing activity was renewed after the dormant period and continued till June when leaves cover the lower two third portion of the culm as well. Leaf appearance in one year old culms of all the three species took place twice in a year compared to two, three and four year culm ages where leaf appearance is seasonal and concentrated during the wetter months (April, May and June) of the year. In two, three and four year culms of *B. balcooa* and *B. vulgaris*, leaves that appeared during the month of April to June start falling after 6-8 months with a peak fall during February and March and the culms become leafless around the third week of March in *B. balcooa* and fourth week of March in *B. vulgaris*. In *B. cacharensis*, leaves which appeared during

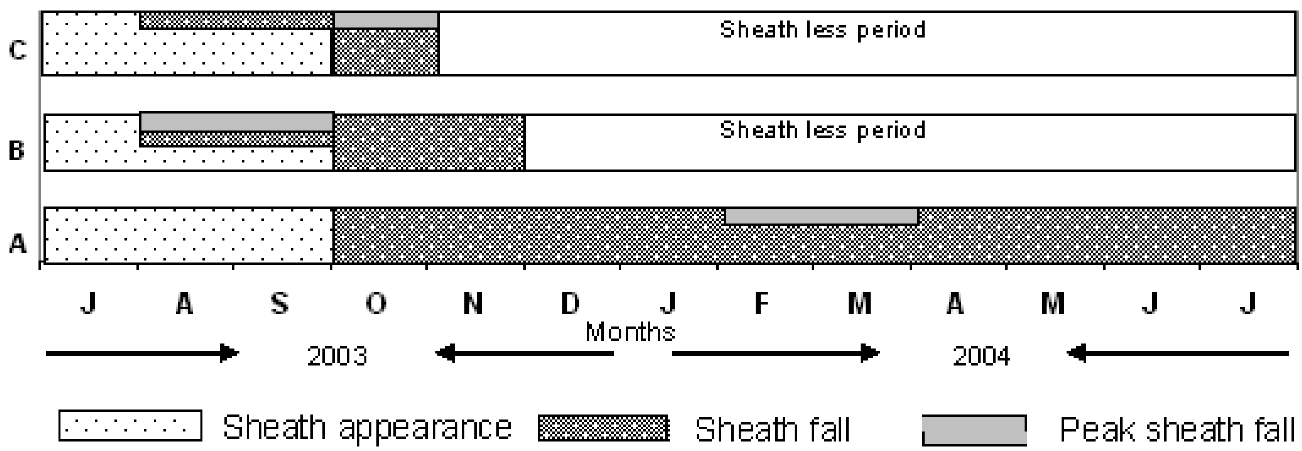


**Fig. 1.** Sheath phenology of first year culm of (A) *Bambusa cacharensis*, (B) *B. vulgaris* and **(**C) *B. balcooa*.

**Table 1.** Culm colour in different age classes of culms in *B. cacharensis, B. vulgaris* and *B. balcooa*.

| Species | Culm colour in different culm age classes (years) | | | |
|---|---|---|---|---|
| | One | Two | Three | Four |
| *B.cacharensis* | Light green | Dark green | Dark green with white patches | Dark green with larger sized white patches |
| *B.vulgaris* | Shining green | Dark green with white patches | Brownish yellow with white patches | Dark brownish with white patches |
| *B.balcooa* | Green with white powdery substances | Dark green with small black spots and white patches | Brownish with white patches | Dark brownish with white patches |

the month of April and May start falling after 8-9 months with a peak fall during February to April.

Retention of green colour of sheaths during the culm elongation period in *B. cacharensis* added advantage towards resource utilization over the other two species in the form of photosynthesis. Depending on the periodicity of sheath retention on the culm, sheath fall pattern in *B. balcooa* and *B. vulgaris* can be categorized deciduous and *B. cacharensis* as persistent. Persistent nature of sheath was reported for *M. baccifera* (Nandy *et al.* 2004). Deciduous nature of sheath fall has the advantage of early appearance of leafy branches on the culm and thus maximizing the photosynthetic activity of the plant. Peak sheath fall during the rainy season as in the cases of *B. vulgaris* and *B. balcooa* implies greater sheath decay rates and thus, potential of the sheath litter as organic

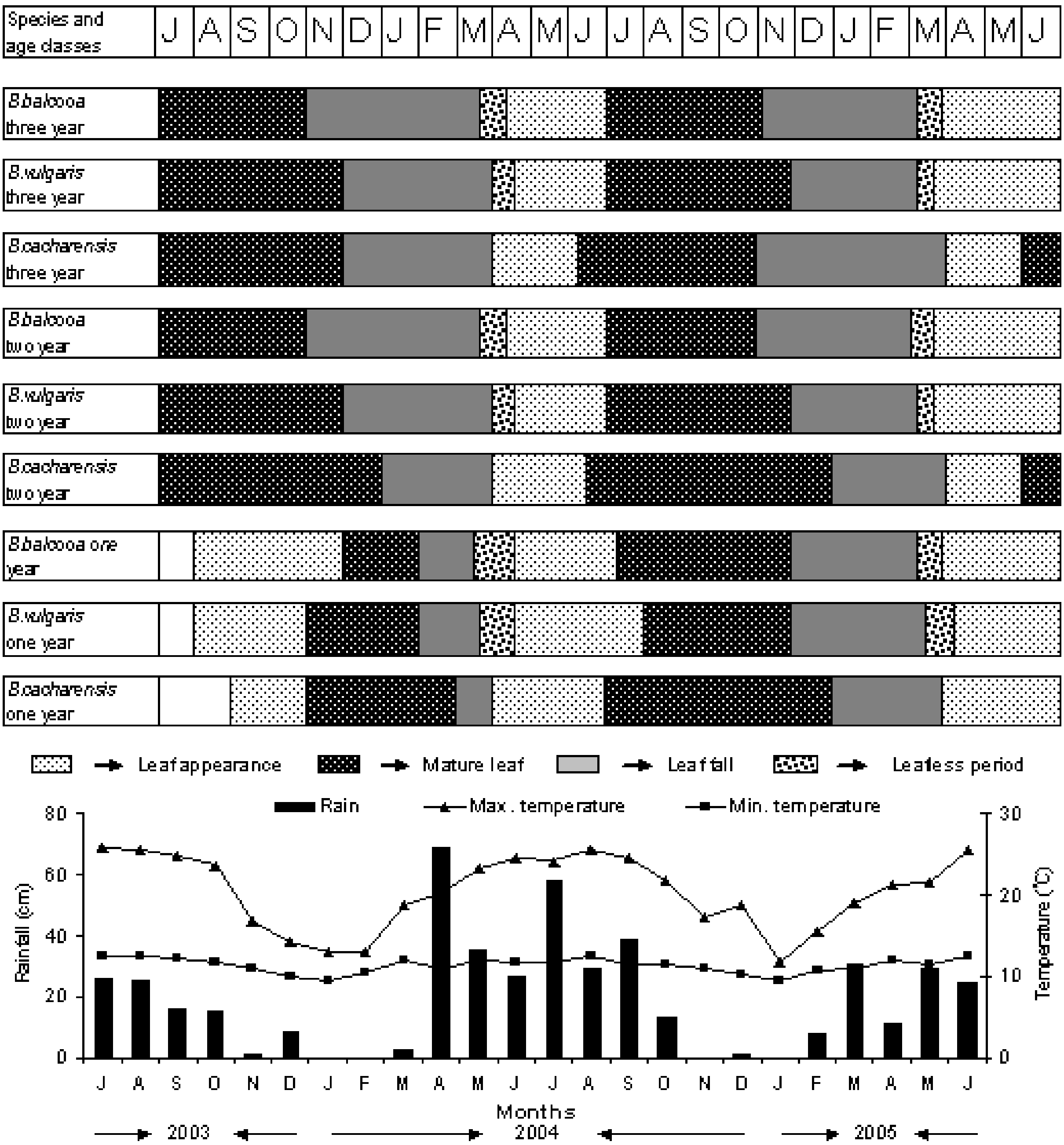


**Fig. 2.** Leaf phenology and climate data of the study site.

nutrient pool under the canopy of these two species. Sheath fall during the rainy season can also play an important role in soil moisture conservation. In *B. balcooa* and *B. vulgaris,* branch appearance begins during the culm elongation period and proceeds acropetally leading to a base-to-top ward pattern of sheath fall compared to *B.cacharensis* where branch appearance begins after the culm attains its full height and proceeds basipetally leading to a top-to-base ward pattern of sheath fall.

Differences in the leaf appearance activity between younger (one year old) and older (two and three and four year old) culms among the species can be attributed to their physiological adaptability. Peak leaf fall during the winter season (December-February) in the present study is consistent with peak leaf fall period in *Dendrocalamus strictus*, a common bamboo in dry tropical region in India (Tripathi & Singh 1995). The tendency of leaf fall in bamboo to be concentrated during the winter is possibly related to a combination of decreased temperature and lowered soil moisture during that period (Nath *et al.* 2004; Tripathi & Singh 1995). In different age classes of culms of both *B. balcooa* and *B. vulgaris* leaf less period in March is followed by the appearance of new leaves from April and thus the leafing pattern is periodic growth deciduous type. Similar leafing pattern was also reported in *D. hamiltonii* (Rao *et al.* 1990). Leafless period is adaptive in the sense that it reduces transpiration under conditions in which water lost is hard to replace (Richards 1996). Two, three and four year culms of *B. cacharensis* exhibited the periodic growth leaf exchange type, as peak leaf fall is associated with peak leaf appearance. This pattern of differential leafing activity in culms of different ages between the species is likely an adaptive strategy towards the success of these species under the prevailing environmental condition. In the present investigation, early onset of rain during 2005 (Fig. 2) produced early flushing and reduced the leaf less period in *B.balcooa* to 10-15 days from 20-30 days and in *B.vulgaris* 7-10 days from 10-20 days of the preceding year. Variation in the date of onset of monsoon may affect factors regulating the soil-plant-atmosphere water continuum (Singh & Kushwaha 2005) that in turn can alter the length of deciduous period by early leaf flushing in bamboos.

Phenological behaviour of bamboo in the present study offers insights into how the species subject to same environmental regime share phenological patterns to varying degrees independently of their strategies in which water and nutrients are sequestered and utilized. Almost similar phenological pattern in *B. balcooa* and *B. vulgaris* and their difference with *B. cacharensis* reflects differential ecological adaptability among the species growing under the same environmental condition possibly to reduce competition for resource acquisition.

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