Bamboo flowering and famine

Bamboos occur in greatest abundance and variety in the south and southeast Asian countries, where traditionally they are used for a variety of purposes[1]. Presently bamboos constitute an important industrial raw-material, and are vital to the economy of many countries[2]. Most bamboos are distinct from ordinary grasses in their perennial tree-like growth habits, and flowering (and seeding) only once, at the end of very long vegetative growth phases, followed often by the death of the flowered clumps[3]. Death of bamboo forests after gregarious flowering results in much loss, and precipitates an ecological crisis, most strikingly for the giant pandas[4,5]. This peculiar behaviour of bamboos has intrigued mankind for long[1–3,6], and still remains a mystery[2] (death of the flowered clumps *per se* may not be a peculiarity of bamboos, but an extension of similar behaviour very common among grasses[7]).

From time immemorial many beliefs are associated with bamboo flowering. In general, bamboo flowering is considered as a bad omen[8,9]. Reference to this can be found in the *Mahabharata* written more than 5000 years ago. Recently, Koshy and Harikumar[10] have reported that their work was seriously hampered when local people at Cherthala (in Alappuzha district of Kerala) burnt down the flowered clumps of *Bambusa vulgaris* because of a belief that 'flowering of bamboo heralds disaster'. This shows how widespread this belief is. Interestingly Cherthala, a coastal region, has no large bamboo forests as in northeast India.

People in northeast India[11] and elsewhere in the world[12], believe that bamboo flowering is the harbinger of famine. The popular belief is that the gregarious flowering of bamboo produces large quantities of seeds (it is reported that 'a 40 square yard clump of Indian *Dendrocalamus strictus* can produce 320 pounds of seeds[13], and there are 800–1000 seeds to an ounce'[14]), resulting in a population explosion of rats (having short lifecycles), which in turn leads to famine. Though such famines are common in some East Asian countries like Myanmar and Japan, and also southern Africa, in the Indo-Myanmar frontier tract, especially in Mizoram, they cause much devastation. The scientific community in general perceives a connection between bamboo flowering, increase in rat population and famines, as hypothetical[11]. It is reported that just before the 1959 famine (the first in post-independent India), on 29 October 1958, the Mizo District Council passed a resolution cautioning the (Assam) government of the impending famine following bamboo flowering and increase in rat population, soliciting financial assistance for relief measures; but the government rejected it on the grounds that such anticipation of famine was unscientific[11].

From our observations of the flowering of natural bamboo stands for the past several (more than 10) years, we feel that this belief may not be a myth but may have some basis.

According to our observations the sequence of events is as follows: gregarious flowering of bamboos starts in September–October, immediately after the rainy season (June–September). Initially there are many young inflorescences. Within a few weeks whole clumps get transformed into huge inflorescences (Figure 1). There is wind pollination and seed-set. Seed-shed starts in December. By January, there is a thin layer of seeds on the forest floor below the bamboo stands. The seed-shed attracts seed predators, mostly rats

Figure 1. One flowering clump of bamboo. Note that the entire clump has transformed into a huge inflorescence.

Figure 2. Sequence of events in bamboo flowering. ***a***, View of few flowering clumps of bamboo with a layer of seeds covering the ground under the clumps; ***b***, Close-up of the ground under bamboo clumps by the end of summer showing a layer of seeds (note also the seedlings of some weeds germinated in the pre-monsoon showers that occur in late summer; ***c***, Same area (as in (***b***)) in the early monsoon season showing a lush green carpet of bamboo seedlings (note that the weeds have grown further).

(species of *Mus* and *Rattus*). In the following months during summer (February–May), there is an increase in seed-shed. By the end of summer (last week of May to first week of June) there are enough seeds on the forest floor (Figure 2 *a*, *b*) and a large number of rats relishing on the abundant food supply. We have noticed many rats, which are normally nocturnal, feeding on bamboo seeds even during mid-day. Then starts the rainy season. The transition from summer to the rainy season is very rapid and crucial. With the onset of the rains, bamboo seeds germinate in a few days. Now, instead of a layer of bamboo seeds there is a lush green carpet of bamboo seedlings (Figure 2 *c*). All of a sudden there is no food for the seed predators. But there is sufficient food for herbivores.

In places where there are large bamboo forests, the sudden transition from plenty of food to the near-total absence of food forces millions of rats out of the bamboo forests. They land in farms in the vicinity and play havoc with the standing crops, and devour the grains stored in granaries, thus bringing about famine as an aftermath of bamboo flowering. This dynamic interaction between bamboo flowering, bamboo-seed predators (mainly rats), climatic change (the sudden transition from summer to the rainy season) and the rapid transformation of seeds into seedlings (not a gradual depletion), was not realized earlier. Interestingly, Janzen[7] has stated that 'As the seed is exhausted by predation and germination, the rats emigrate.' Nag[11] has quoted the following from a letter to the administration by the Reverend Lorrain, 'It appears that the rats began to get more than extraordinarily troublesome years before the simultaneous seeding of the mau-thing bamboos, but as soon as the seeding was over they increased to such an extent that no human power could save the crops from their depredation.' This also indicates that the exodus of rats occurs at the end and not during seeding.

In Mizoram, people have been experiencing famines at regular intervals, that they can predict the impending famine. The famine of 1862 is well documented. About 30 years later there was another famine (as was expected)[11]. In more recent history, in the early 1960s there was a coincidence of large-scale bamboo flowering and a severe famine in northeast India. In Mizoram, when there was large-scale flowering of bamboos in the latter half of 1970s, there was a phenomenal increase in the rat population. About 2.5 million rats were reportedly killed in just one year, i.e. 1978 (ref. 9).

The northeastern region of India is very rich in bamboo forests. Slash and burn shifting cultivation (clearing a part of the forest, burning the resultant biomass and adding it as a manure, and cultivating the land for few years, before shifting to a new site to do the same) is very common in this part of the country[15]. This practice leaves many small farms in the midst of (bamboo) forests. Given the peculiar geography and cultivation practice in northeast India, we strongly feel that this belief, of a connection between incidences of bamboo flowering and famines, may not be a myth but a real happening.

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Antibacterial properties of cyanobacteria: A cost-effective and eco-friendly approach to control bacterial leaf spot disease of chilli

Excessive use of toxic chemicals for controlling crop diseases has caused unprecedented ill-effects on the environment. The growing concern about the harmful effects of such chemicals has necessitated the need for a change in our approach to manage crop diseases in an eco-friendly manner. Search for alternatives with less harmful effects on the environment attracted scientists to look for biocides from plants, including those of microbial origin[1,2]. This has particular concern for countries like ours where agriculture is the prime occupation. Cyanobacteria, which constitute a versatile group of microorganisms, occur in diverse habitats ranging from alkaline hot springs to permanent snow fields in the poles. In addition to their ability to fix atmospheric carbon, many cyanobacteria are capable of fixing molecular nitrogen. Certain cyanobacterial species are known for their toxin-production properties[3,4]. Three such strains namely *Lyngbya majuscula*, *Microcystis aeruginosa* and *Plectonema boryanum* were tested for their antibacterial properties