Mass flowering in the Himalayan dwarf bamboo

In many bamboos, individuals are known to flower simultaneously once in their lifetime (monocarpic), generally ranging from 7 to 120 years[1]. Populations die subsequent to flowering. *Drepanostachyum falcatum* (Nees) Keng (earlier called *Arundinaria falcata*), a common undergrowth bamboo (generally 2 to 3 m tall) of oak (*Quercus* species) forests of Himalaya is in gregarious flowering this year (2000) after a lapse of 28 to 30 years. Both the extent and intensity of flowering are amazing. I observed it flowering in Nainital and as far as Kathmandu, the two being 700 km apart. Clearly, so strong is the physiological control that it flowers at the same age in substantially different climates. The range in altitudinal distribution is over 1000 m and in latitude about 3°. In each population observed, more than 90% of culms (shoots) were in flowering irrespective of their age. It is the age of the seed or the rhizome which decides flowering time, not of shoots. In normal years, several new shoots are formed from each rhizome (easily up to 10), but in the year of flowering neither new shoots were formed, nor shoots already formed produced new leaves. The shoots gradually turned brown and withered away. The flowering began in mid-March and continued up to mid-July.

Like many other dwarf bamboos such as *Sasatsuboiana*[2], *D. falcatum* forms dense populations, characterized by even-agedness and fewer than 10% individuals flower in years other than the mass flowering year. Herbs and shrubs are unable to form sizeable cover in the presence of bamboo thickets. In the case of *Sasa* in Japan, almost nothing is able to grow as long as its thickets exist[2]. Only a few shade-enduring species are able to survive under the bamboo thickets.

It would be interesting to investigate how herbs, shrubs and tree seedlings respond to creation of bare patches subsequent to the collapse of *D. falcatum* cover. In the present situation of heavy pressure from free grazing and fodder collection for cattle[3], the bamboo thicket provides protection to oak seedlings, resulting in more seedlings amidst bamboo clumps than outside. Thus the protective influence of the bamboo overrides the suppressive effect of its canopy on recruitment of tree seedlings, probably facilitating oak regeneration despite heavy biotic disturbance.

The post-collapse (of the bamboo) scenario includes recovery of bamboo population, release of other species from competition, accumulation of stem litter with high C:N ratio and massive input of food-rich seeds for wildlife, particularly rodents. How these changes influence ecosystem processes, affect trees and rebuild the ground vegetation is hardly known and warrants investigations. How many years are required for the full recovery of original population size of *D. falcatum*, how other species affect the recovery, and whether new populations occupy old or new patches, are some of the other questions that need to be answered.

Thirty years is a long period in science, we need to document the aftermath of this historical event, and understand its role and significance in shaping the vegetational structure. Mechanisms are required to be developed by funding agencies for timely support for research on such events. Also, events such as mast seeding in trees, severe drought and mass-scale mortality due to disease or stress warrant such timely research support.

1. ICFRE, (undated), *Bamboo*, Indian Council of Forestry, Research and Education, Dehra Dun.
2. Makita, A., Konno, Y., Fujita, N., Takada, K. and Hamabata, E., *Ecol. Res.*, 1993, **8**, 215–224.
3. Singh, S. P., Rawat, Y. S. and Garkoti, S. C., *Curr. Sci.*, 1997, **73**, 371–374.

Received 13 July 2000; accepted 10 August 2000

S. P. SINGH

Department of Botany,
Kumaun University,
Nainital 263 002, India
e-mail: surps@yahoo.com

Zoogeographical relationships of the Upper Cretaceous nonmarine Ostracoda of India

Nonmarine Ostracoda were first described from the Upper Cretaceous of Peninsular India by Sowerby[1], followed by Jones[2]. The former of these collections has recently come to light in the Natural History Museum, London, and is the topic of a current study[3]. The 19th century authors provided little more than taxonomic descriptions and no real consideration of the zoogeographical affinities of the Ostracoda was forthcoming until Indian authors began to document these faunas during the last quarter of the 20th century[4–13]. Their consensus is that the Indian Upper Cretaceous nonmarine ostracods exhibit very close affinities with contemporary faunas from Mongolia and/or China, described by a variety of authors[14–26].

Among the Indian authors, however, a note of caution concerning the Asiatic connection is expressed by Udhoji and Mohabey[11], who, despite incorrectly identifying certain ostracods at the specific level with Mongolian taxa, argue for South American (Brazil) and North American (Mexico) affinities at the generic level on the basis of the co-occurrence of *Cytheridella* and *Meta-*

cypris. Their argument is spoiled, however, by the fact that the taxa concerned actually belong to *Gomphocythere*.

The Chinese and Mongolian Upper Cretaceous nonmarine fauna are dominated by members of the Cyprideinae, with *Cypridea* and its close allies such as *Talicypridea*, *Cristocypridea, Mongolocypris* and other genera such as *Quadracypris* (=*Limnocypridea*) and a number of taxa seemingly endemic to Mongolia and characterized by strange anterior margins such as *Gobiella, Nemegtia* and *Khandia*. Non-dominants, represented by different species in India, are *Candona, Eucypris, Cyprinotus, Cyclocypris*, etc.

The problem with the analysis of the Deccan intertrappean ostracod faunas is two-fold. Firstly, there has been a tendency to attribute their genera to Mongolian and Chinese dominant genera. This has resulted in a false overall generic resemblance being put forward between the Indian and the Mongolo-Chinese faunas. Compounding this error has been the attribution of Indian taxa to Mongolian and Chinese species when, in fact, they are quite different. The present authors cite numerous examples in three papers (to be published). We began our current study of the intertrappean Maastrichtian ostracods by examining the material from three separate localities, all in the Kachchh (Kutch) district of Gujarat. The first of these, at Anjar[27], had been recently studied by Bhandari and Colin[12]. In addition to their fauna of 12 spp., we encountered a species of *Paracypretta* described as new by Khosla and Sahni[13], and a new species of *Limnocypridea*, the first use of this taxon in India, for a species which had been incorrectly assigned to the Chinese species *Cypridea* (*Pseudocypridina*) *longa* Hou by Bhatia *et al.*[6], who later[8] accepted the generic change by Hou to *Mongolocypris*. This latter species, not encountered by Bhandari and Colin[12], is the dominant one in our collections from Anjar.

We subsequently described a fauna comprising 17 species and subspecies belonging to 12 genera from Lakshmipur in Kutch[28]. No less than 13 species/subspecies of this fauna are new. This is in part due to the fact that they have not been discovered hitherto, but many have been incorrectly assigned by other authors to Mongolian and Chinese species. It is somewhat ironic that Khanna and Mohan[4] in their description of the intertrappean beds of Kutch stated that, of the ostracod fauna of the locality near Lakshmipur, 'only a few genera could be recorded, but they are represented by a comparatively larger number of individuals'. However, we demonstrate that the Lakshmipur assemblage, while indeed being very abundant in individuals, was also substantially the most diverse intertrappean ostracod fauna described to date. This is despite the fact that several genera and species described from other intertrappean localities are absent. The genera we described from Lakshmipur are *Limnocythere, Frambocythere, Gomphocythere, Pseudocypris, Centrocypris, Zonocypris, Paracandona, Cypria, Cyprois, Cypridopsis, Eucypris* and *Mongolianella*. While some of these ostracods resemble species recorded in Mongolia and China, the only taxon we recovered from Lakshmipur which occurs in China (but not in Mongolia) is a new subspecies of a species of *Frambocythere*. However, that species also occurs in Europe! Not only is a high percentage of the species new to science but some of the genera, such as *Pseudocypris* and *Centrocypris* are not only new to the Upper Cretaceous of India, but to the pre-Cenozoic globally.

The third locality we studied is at Kora, also in Kachchh[29]. This yielded an even more diverse fauna of 23 species belonging to 13 genera: *Darwinula, Paracypretta, Cypridopsis, Sarsicypridopsis, Cyclocypris, Cetacella, Cypria, Candona, Eucypris, Mongolianella, Limnocypridea, ?Talicypridea* and *Cyprois*. No species were previously recorded from Mongolia or China. Only four were new, nine were previously described from other Indian intertrappean localities (five from Lakshmipur and one from Anjar by the present authors) and ten are left in open nomenclature because of rarity. There are no cytheraceans in the Kora fauna, despite their importance at Lakshmipur. *Cetacella* and *Sarsicypridopsis* are new for the Indian Upper Cretaceous; the latter probably also new to the pre-Cenozoic. *?Talicypridea*, which would be so important to establish an 'Asian' connection, is based upon a single carapace whose generic assignment is by no means certain.

Many intertrappean genera common to Mongolia and China also occur contemporaneously in Europe, Africa and the Americas. Others, such as *Mongolianella* are virtually confined to India and Mongolia. However, enough 'Asian' genera are absent from the Deccan intertrappeans to cause grave doubts on the validity of the accepted zoogeographical relationship, especially since there is but a single species common between them (which differs at the subspecific level). The simple fact is that any objective analysis of the Upper Cretaceous nonmarine Ostracoda of peninsular India, must conclude that they there is as much evidence for an African or European connection as there is for an Asian one. They are actually highly endemic and Indian in character. This is perhaps difficult to understand because, given the great dispersal advantages which nonmarine Cypridacean ostracods had evolved during the Jurassic (parthenogenetic reproduction and desiccation/freezing-resistant eggs) one would certainly expect more species of this superfamily to be common constituents of all Asian Upper Cretaceous faunas[30,31]. These matters will be addressed in more detail by the authors in a subsequent study where space is not at such a premium.

1. Sowerby, J. de C., in *Trans. Geol. Soc. London* (ed. Malcolmson, J. C.), 1940, Series, 5, 532–575.
2. Jones, T. R., in *Q. J. Geol. Soc., London*, 1860, **16**, 154–189.
3. Whatley, R. C., Bajpai, S. and Whittaker, J. E. (in preparation).
4. Khanna, S. N. and Mohan, M., *Bull. Geol. Soc. India*, 1965, **2**, 48–51.
5. Bhatia, S. B. and Rana, R. S., *Mem. Geol. Soc. Fr.*, 1984, 147, 29–36.
6. Bhatia, S. B., Prasad, G. V. R. and Rana, R. S., in Contributions from a Seminar cum Workshop, IGCP 216 and 245 (eds Sahni, A. and Jolly, A.), Chandigarh, 1990, pp. 47–49.
7. Bhatia, S. B., Srinivasan, S., Bajpai, S. and Jolly, A., in Contributions from a Seminar cum Workshop, IGCP 216 and 245 (eds Sahni, A. and Jolly, A.), Chandigarh, 1990, pp. 118–119.
8. Bhatia, S. B., Prasad, G. V. R. and Rana, R. S., *Mem. Geol. Soc. India*, 1996, **37**, 297–311.
9. Mathur, A. K. and Verma, K. K., *Geol. Surv. India Spl. Publ.*, 1988, **11**, 169–174.
10. Sahni, A. and Khosla, A., *Curr. Sci.*, 1994, **67**, 456–460.

11. Udhoji, S. G. and Mohabey, D. M., in Contrib. XV Indian Colloq. Micropal. and Stratigraphy, Dehra Dun (eds Pandey, J., Amzi, R. J., Bhanadri, A. and Dave, A.), 1996, pp. 409–419.
12. Bhandari, A. and Colin, J.-P., *Rev. Micropalaeontol.*, 1999, **42**, 3–20.
13. Khosla, A. and Sahni, A., *J. Palaeontol. Soc. India*, (in press).
14. Galeeva, L. I., *Ostracoda from the Cretaceous Deposits of the People's Republic of Mongolia*, Gost. Tech. Dat. Moscow, 1955, p. 95 (in Russian).
15. Lyubimova, P. S., *Trudy VNIGRI*, Moscow, 1956, vol. 93, p. 225 (in Russian).
16. Szczechura, J., *Palaeontol. Pol.*, 1971, **25**, 85–97.
17. Szczechura, J., *Palaeontol. Pol.*, 1978, **38**, 65–121.
18. Szczechura, J. and Blaszyk, J., *Palaeontol. Pol.*, 1970, **21**, 107–118.
19. Stankevitch, E. S. and Sochava, A. V., in *Soviet–Mongolian Palaeont. Exped.*, Moscow, 1974, vol. 1, pp. 268–286 (in Russian).
20. Khand, E., *Soviet–Mongolian Palaeont. Exped.*, 1977, vol. 4, pp. 106–111 (in Russian).
21. Hou, Y. T., Ho, J. D. and Ye, C. H., *Mem. Nanjing, Inst. Geol. Palaeontol., Acad. Sin.*, 1978, 9, 129–238. (in Chinese with English abstract).
22. Hou, Y. T., *Acta Palaeontol. Sin.*, 1982, **21**, 73–82 (in Chinese with English Abstract).
23. Gou, Y. S. and Cao, M. Z., in Proc. 8th Inter. Symp. Ostracoda (ed. Maddocks, R. F.), Geosciences, Houston, 1983, pp. 381–393.
24. Swain, F. M., He, J.-D., Ye, C.H. and Zhang, X.-J., *Rev. Esp. Micropalaeontol.*, 1988, **20**, 273–323.
25. Pang, Q. and Whatley, R. C., in *Ostracoda and Global Events* (eds Whatley, R. C. and Maybury, C.), Chapman & Hall, 1990, pp. 239–250.
26. Ye, C., *Cret. Res.*, 1994, **15**, 285–303.
27. Whatley, R. C. and Bajpai, S., *Rev. micropalaeontol.*, (in press).
28. Whatley, R. C. and Bajpai, S., *Rev. Esp. Micropalaeontol.*, (in press).
29. Bajpai, S. and Whatley, R. C., *Rev. Micropalaeontol.*, (in press).
30. Whatley, R. C., in *Extinction Events in Earth History* (eds Kaufmann, E. G. and Walliser, O. H.), Lecture Notes in Earth Sciences, 30, Springer Verlag, New York, 1990, pp. 253–263.
31. Whatley, R. C., in *Aspects of Nonmarine Cretaceous Geology* (eds Mateer, N. J. and Chen, Pei-ji), China Ocean Press, China, 1992, pp. 177–192.

ACKNOWLEDGEMENTS. S.B. thanks the British Council and the Association of Commonwealth Universities (UK) for the fellowship that enabled him to study in Aberystwyth and to visit the British Museum (Natural History), London.

Received 13 July 2000; accepted 4 August 2000

R. C. WHATLEY[†]
SUNIL BAJPAI[*,‡]

[†]*Department of Geology,*
University of Wales,
Aberystwyth, Cardiganshire,
SW 23 DB, UK
**Department of Earth Sciences,*
University of Roorkee,
Roorkee 247 667, India
[‡]*For correspondence.*
(e-mail: sunilfes@rurkiu.ernet.in)

Agar depolymerizing (Agarolytic) bacteria isolated from mangrove soil samples of Andaman

The Andaman and Nicobar group of islands are covered by one lakh fifteen thousand hectares of mangrove forests, which is approximately 25% of the total mangrove area of India. Mangrove ecosystem is a resource of plants, animals and microbes which are interdependent and living in close association. Microbes play an important role in nutrient recycling in this unique ecosystem and have become an important area of study in the search for novel microbial products, including enzymes. In this article, isolation and identification of microbial source of agarase enzyme from mangroves of Andaman is described.

About 1000 soil samples collected from various mangrove inhabited areas of South Andaman were subjected to isolation of bacteria in Zobell Agar (ZA) medium containing yeast extract, 5.0 g; peptone, 1.0 g; K_2HPO_4, 0.5 g; a trace amount of ferrous sulphate; agar, 15.0 g; distilled water, 250 ml and filtered sea water, 750 ml. Diverse cultural, morphological and metabolic types of bacteria were screened simultaneously using enriched and selective media such as xylanolytic, cellulolytic, sulphur oxidizing, DNase producing, halophillic, starch – caesin, tributyrin, milk and alginate-containing media[1]. Pour-plated soil samples after 24 h of incubation showed depressions simultaneous to the bacterial growth on ZA plates (Figure 1). On subsequent subculturing in fresh ZA medium plates, depressions continued to appear around the bacterial colonies. Among six such bacterial isolates recorded, one isolate namely BR 6/3 liquefied the solid medium completely within 72 h (Figure 2). Incubation of this liquefied medium at 4°C showed complete loss of gelling property of the agar in the medium. The pure culture of the isolate was obtained by incorporating a graded concentration of agar up to 3% in Zobell Broth medium and by repeated sub-culturing in the early logarithmic growth phase. The isolate produced white, opaque, butyrious colonies on ZA within 4 to 6 h culturing. It was motile, gram-negative curved/elliptical rod-shaped bacteria having polar flagellum. The isolate produced gelatinase, amylase and lipase enzymes. The organism was positive to oxidase and methyl red and negative to catalase, citrate, Voges-Proskauer, H_2S and ammonia tests. The strain produced acid from galactose, fructose, sucrose, maltose, dextrose, arabinose, melibiose, xylose and raffinose. Based on cultural, morphological and biochemical tests, the isolate was identified as *Alteromonas* spp.

The strain was able to degrade different types of agar and agarose used for protein and nucleic acid separation. The