

# The bamboo breakthrough, and the import of India's publication export

The publication in *Nature* by Nadgauda, Parasharami and Mascarenhas of the National Chemical Laboratory (NCL) in Pune of their success in consistently obtaining flowering of bamboo in tissue culture has renewed the old debate on Indian scientists' predilection for publishing their better work abroad. It has also brought up the question of patent protection of economically beneficial discoveries.

## The breakthrough

Bamboo, celebrated as the High Emperor of all the Grasses, is a remarkable plant. Among the several hundred species are those whose hollow stems reach a height of 40 metres, are 30 cm in diameter, and emerge from the soil at 4 cm per hour. Individual stems, or culms, in a clump of bamboo usually die in their third season and are replaced by stems from underground rhizomes. The most remarkable features of bamboos are that this vegetative phase, in which no flowering occurs, is prolonged in most species, as much as 15, 30 or even 120 years, and that most bamboos are also monocarpic, i.e. they flower only once in their lifetime. All populations from the same seed flower together—irrespective of what stage of growth a stem has reached—, set seed together, and die together.

Bamboo is of great economic importance as structural raw material, fodder, and source of fibre for paper manufacture. It is also the food of the Chinese giant panda, which is threatened with extinction. On account of the very long vegetative phase in most species, breeding for improved varieties, generation of hybrids, and maintaining a perennial supply of seed are almost impossible. It is important to note that intergeneric hybrids were produced in bamboo for the first time by Guangzhu and Fuqiu<sup>1</sup>. While this is indeed a major advance, on account of the prevalence of polyploidy and barriers to crossability, the method is not going to be easy. But if plants can be grown in culture and induced to flower, the first step towards a potential revolution in bamboo would have been taken.

Somatic embryogenesis and regeneration of bamboo plants in culture were achieved some years ago. *In vitro* flowering of bamboo was reported for

the first time by I. Usha Rao and I. V. Ramanuja Rao<sup>2</sup> of the Department of Botany, University of Delhi, in a paper (see abstract) presented by them at the Third International Bamboo Workshop held in Cochin in November 1988. Rao and Rao reported that somatic embryos developing from vegetative tissues, as opposed to zygotic embryos, of *Dendrocalamus strictus* and *Bambusa arundinacea* could be induced to flower within 8–10 weeks of culture. They suggested that by using this method bamboo hybrids could be produced. Now, R. S. Nadgauda, V. A. Parasharami and A. F. Mascarenhas<sup>3</sup> of the National Chemical Laboratory, Pune, have succeeded in consistently inducing flowering in tissue-cultured *Bambusa arundinacea* and *Dendrocalamus brandisii* (see abstract).

The work of Rao and Rao differs from that of Nadgauda *et al.* in two important respects. In the former instance, somatic embryos differentiated in tissue culture were induced to flower. In the latter case nodal explants of *in vitro*-raised seedlings were used. The NCL group has also mentioned the possibility of maintaining an inflorescence culture, and observed seed set and obtained normal seeds.

*In vitro* flowering of bamboo has important implications for the genetic improvement of bamboos, which are a crucial renewable plant resource in India. It offers possibilities of interspecific and intergeneric hybridization within the laboratory in a short time-frame, and the opportunity of going further in finding answers to the fascinating biological questions in bamboo.

1. Guangzhu, Z. and Fuqiu, C., in *Recent Research on Bamboos* (eds. Rao, A. N., Dhanarajan, G. and Sastry, S. B.), 1987, The Chinese Academy of Forestry and International Development Research Centre, Canada.

2. Rao, I. V. Ramanuja and Rao, I. Usha,

'Tissue-culture approaches to the mass propagation and genetic improvement of bamboos', paper presented at the Third International Bamboo Workshop, Cochin, India, 14–18 November 1988.

3. Nadgauda, R. S., Parasharami, V. A. and Mascarenhas, A. F., *Nature*, 1990, **344**, 335. See also Hanke, David, *Nature*, 1990, **344**, 291 ('News and views' article).

### Abstract of Rao and Rao

Bamboo is a critical natural resource which has not easily lent itself to modern methods of mass propagation and genetic improvement owing to its long vegetative phase and monocarpic flowering behaviour. Methods have now been standardized to produce plants of *Dendrocalamus strictus* and *Bambusa arundinacea* through somatic embryogenesis from inflorescences and embryos, and from rhizomes, nodes and leaf sheaths of juvenile plants. Multiple shoots have been induced from nodes explanted from seedlings, and plants have been raised from them through rooting. Plantlets have also been obtained from nodes of mature plants, although only 10 per cent of them form roots. Methods for precocious induction of rhizomes have also been developed to accelerate plantlet growth in the field.

Using conventional breeding methods, genetic improvement of the woody bamboos is not possible because of the near impossibility of getting two desirable parents to flower simultaneously. Using tissue culture methods, *in vitro* flowering of somatic embryos has been achieved both in *D. strictus* and *B. arundinacea* within 8–10 weeks of *in vitro* culture. Using this method bamboo hybrids can be produced. A method of clonal marking has been initiated by which tissue-culture clones that prove superior in the field can be selectively mass-propagated. Protoplasts have been successfully isolated from juvenile and embryogenic tissues of *D. strictus*. This opens up the possibility of successfully obtaining newer variants and somatic hybrids. Somaclonal variants have also been isolated and are being assessed as sources of desirable characters.



**Abstract of Nadgauda *et al.***

Bamboo flowers only once during its lifetime, dying at the end of its first fruiting season. This monocarpic flowering is intriguing not only in that it occurs after a lapse of 12 to 120 years, but because it is 'gregarious', local populations of bamboo flowering together and then dying. New bamboo plants are produced either by vegetative subdivision or from seed. Breeding of bamboo, however, has proved to be extremely difficult: seed production depends on unpredictable circumstances and events, and the basis of gregarious flowering, and the causes of death and flowering, are not known. Flowering *in vitro* has previously been studied by culturing explants of stem tips, mature stems, roots, petioles, leaves, inflorescences, flowers and so on. Although bamboo plantlets have been formed by means of organogenesis and embryogenesis, *in vitro* flowering has not previously been reported for bamboo. We now report on an *in vitro* system in which we could consistently induce flowering in the two species of bamboo *Bambusa arundinacea* Willd and *Dendrocalamus brandisii* Kurz. Inflorescence explants containing a panicle of spikelets gave rise to several viable inflorescences on sub-culture; fertile seeds were also produced. Further refinements to this system could lead to the introduction of breeding programmes to improve bamboo, and to the production of perennial seeds for bamboo, as well as to a better understanding of the physiology underlying flowering behaviour in bamboo.

**Extract from news item in *The Times*:**

... Now a group of researchers working with Dr A. F. Mascarenhas, at the National Chemical Laboratory, in Pune, India, with help from scientists at Wye College, London University, have shown in the laboratory greenhouse how to break this extraordinary cycle and make bamboo flower to order. ...

**Papers, journals and the press, and Indian science**

*V. Siddhartha*

On April 10 last, *The Statesman* carried a prominently displayed item. Under the copy headline 'Making the bamboo bloom', it was a story about some novel, pathbreaking work done at our National Chemical Laboratory (NCL) in Pune. The item was a reproduction of a piece which appeared in *The Times* of London, written by a certain Pearce Wright. (Those familiar with *The Statesman* will know that verbatim reproductions from *The Times* are a regular feature in it.) Annexed is an extract from the article [see below].

Notice the phrase 'with help from scientists at Wye College, London University'. Intrigued, I read the original paper in *Nature*. It turns out that the 'Wye College scientists' have been correctly acknowledged in the standard courtesy way. They are not cited authors, let alone co-researchers. Intrigued further, I made enquiries. I was informed that the NCL team sought and received from Wye advice on how to format the paper for *Nature*! (NCL has apparently other collaborative work with Wye, but not on bamboo.)

I made further enquiries and learnt with dismay that the paper had been sent for publication to *Nature* without professional advice having been first sought regarding the patentability (or other statutory protection being accorded) to the technique reported in the paper. I would not be surprised if a foreign company commercializes the technique and an Indian company thereafter applies, and is granted, 'foreign collaboration' with that company for commercial exploitation of the technique even in India, not to say abroad.

I believe these raise important issues with regard to reporting and publicizing the results of scientific work performed in our country. In outline, these issues are:

(i) The primary purpose of scientific journals is quality control. It is only secondarily communication. This *raison d'être* of the Indian scientific journal was eloquently expressed in the first issue of *Pramana* [see below]. The quality, integrity, impact and health of Indian science can be regularly and consistently, even if incrementally, improved only if papers of this quality and importance are published in an Indian

journal first. Short notices may be published in international fast-reaction journals but complete papers must appear only in Indian journals. Furthermore, *The Times* type of press notices, with barely disguised, supercilious racism, reproduced ditto in the English-language Indian press, are bound to appear if we rely on foreign peer review, which is inevitable if we publish abroad. If the above publishing practice is not self-imposed voluntarily by the scientific community, should we be surprised if there is public and parliamentary pressure to arrange for such compliance by making it a 'conduct rule' for all scientists paid out of the public purse? Whatever the scientific community might think of the wisdom of such a requirement, administratively such a rule would be valid.

(ii) I submit that the situation would be worsened by so-called Indian editions of foreign journals, particularly if such editions have mixed Indian-foreign editorial boards different from those of the parent editions. Thus, part of another article on 10 April 1992 by Sally Wong in *The Times* of London (dutifully reproduced ditto in *The Statesman* a few days later) might read: 'Although carried in the local Indian edition of the *International Journal of Grasses*, experts at Kew Gardens point out that this alleged improvement on the 1990 technique is not in the class of what might be reported in the UK edition. These experts add that the results reported are more an exercise in filling the pages of a local broadsheet rather than a new contribution to the field.'

(iii) Press hand-outs must be very carefully worded and made available first to Indian newspapers, before being flashed abroad.

(iv) Competent professional advice should be sought by researchers regarding patenting and other forms of intellectual-property protection before rushing to print or otherwise bringing the results of their work into the public domain.

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*Extract from the editorial in Pramana:*

... Serious research in the physical sciences may be said to have started in India at the turn of the century. It was during the twenties and thirties, the most remarkable years for the *quality* of research done in the country, that a number of Indian scientific journals came into being through the efforts of the great names that dominated Indian science at that time. Since then there has been an enormous increase in the *quantity* of research work done in India. However, the fashionable notion that it is more prestigious to publish in foreign journals, and the consequent lowering of the quality of papers sent to and published in the existing Indian journals formed a vicious circle, leading to the present unsatisfactory situation.

The publication in foreign journals of the major part of the work done in India today is having a deleterious effect on Indian science. Relegating the refereeing of our best scientific work leads to loss of judgement and self-confidence. This process has sapped the inner resources of Indian scientists and, among other things, has led them to follow blindly fashions set elsewhere in choosing fields of work.

All this has caused much unrest among active scientists in India and led quite recently to a united attempt to find a solution. *Pramana* (which in Sanskrit means a source of valid knowledge, a standard, etc.) is the outcome of a nationwide effort by Indian physicists to create a vehicle for their best efforts in physics. The publication in it of good papers received from abroad can only add to its strength, and is most heartily welcomed. ...

S. RAMASESHAN

*R. S. Nadgauda, V. A. Parasharami and A. F. Mascarenhas reply:*

We appreciate the comments made by V. Siddhartha on our work on bamboo. Our response to the specific comments that pertain to our paper is as follows:

(i) The work was carried out entirely at NCL. It was by a coincidence that one of us (R.S.N.) was at Wye College in the UK in connection with the ALIS programme supported by the British Council during 10 September 1989 to 10 December 1989. The manuscript of this paper was being finalized at the time R.S.N. was in Wye College. The Wye College scientists gave suggestions about the improvement of the manuscript. The acknowledgement was a standard courtesy extended to them. Interestingly, this acknowledgement has been misinterpreted only by *The Times* of London, and all other leading international newspapers and journals, such as *The New York Times*, *Guardian*, *Japan Times*, *Newsweek* and *New Scientist*, carried no such misunderstanding.

(ii) We appreciate the concern expressed by Siddhartha concerning the patenting of our work. We would like to emphasize that we belong to a laboratory that is extremely patent-conscious. During 1989 alone it has filed 31 national/international patents, which we dare say is the highest number coming from any single research laboratory or a unit in India today. We are filing patents for both formulation and process with the help of professional advice from the CSIR Patent Unit. We have given nothing by way of vital information in the paper which could pose difficulties in patent filing.

(iii) As regards the advisability of publishing papers in an Indian journal and raising the standards of Indian journals,

we personally do not want to express a view. However, we wish to emphasize once again that we belong to a laboratory which believes that (a) science is universal, (b) choice of journal for publication is a fundamental right of the investigator, and (c) potential world-class breakthroughs should be published in world-class journals, which provide the toughest scrutiny of the claims.

(iv) As regards the publicity that this work has received, we are simply overwhelmed. We wish to re-emphasize that we did not give any press release or hand-outs to any newspaper in India or abroad immediately after the publication of our paper. We simply treated it as a simple scientific paper. The fact of the matter is that the paper was published on 22 March in *Nature*, and the same issue also carried a 'News and views' article. It was picked up by *The New York Times* on 22 March, *The Times* of London on 23 March, *Bangkok Times* and *Japan Times* on 24 March, and international magazines (*Newsweek*, *New Scientist*, etc.) and news agencies around the world in the following weeks. We must add that the first Indian newspaper to pick it up was *Maharashtra Herald*, which published a report on 24 March. They picked it up from a teleprinter message that was based on the *New York Times* report and not because of a hand-out given by us. We as a team were interviewed by them on their own initiative and this report was published on 25 March. We thought this should be clarified since there is a feeling in a section of the press that the news was given to foreign agencies first and also because Siddhartha makes a point about press hand-outs.

## The bamboo plant, Indian journals and Government orders

*P. Balaram*

The report on precocious flowering of bamboo in tissue culture by Nadgauda, Parasharami and Mascarenhas has attracted considerable attention and indeed appears to constitute a major advance in the area of plant breeding.

While most reaction has been laudatory, V. Siddhartha's letter in the adjoining columns raises important issues regarding the publication of research, particularly that with potential for commercial application. He also raises the

spectre of unfair treatment of Indian findings in the Western press, bringing to the fore the perennial bogey of racism. Some of his concerns, like the charge of biased analysis in the popular press, can be dismissed without much



ado. After all, how often is the popular press in any country completely free from providing a local slant to any discovery? Have we not all read our own newspapers on superconductivity, hot and cold fusion and cancer cures? Have not Indian discoveries followed one another in blinding succession in these highly visible areas? The 'News and views' article in the same issue of *Nature* by David Hanke of Cambridge University does much to dispel Siddhartha's charge of biased reporting. It is indeed this scholarly assessment by Hanke which places the Indian research in proper perspective and gives the Pune group due credit for their work.

Siddhartha's concern that Indian work should first be published in our own journals has been voiced before, but deserves serious consideration in the present context. What is unfortunate is that he has raised the spectre of Government orders (the GO's so beloved of our bureaucracy) to compel Indian scientists to publish results of Government-supported research (almost all research in our country) in local journals. Would the NCL work on bamboo have attracted the same attention, so quickly, if published in *Current Science*? Would we (as editors) have recognized the importance of the paper and highlighted it in our News columns?

The answer, of course, is, probably not. So the course chosen by the Pune authors is a fair one and it is to their credit that their paper has been published in a highly respected journal.

Should something be done to change the state of affairs of Indian journals? Undoubtedly, the answer is, yes, but the improvement of the content and credibility of our journals is not something that can be accomplished overnight. Would Government edicts on publishing practices help? Past experience tells us that Government fiat are rarely successful, even in more pressing matters. Interference with the basic freedom of the scientific community is unlikely to meet with quiet compliance. Coercion is also unlikely to improve the quality of our scientific output. An insular approach hardly seems the path to the twenty-first century. Patriotism should not be based on paranoia.

Siddhartha's letter addresses the important issue of whether results with definite commercial importance should be protected by patents before publication. It is in the interests of individuals and institutions to do so, but in most places moribund procedures often tempt the less pragmatic among us to take the easy course of publication. The Pune work, the public reaction it has generated, and Siddhartha's letter remind us

that science has become an increasingly complex affair. It would be counter-productive to meet contemporary challenges by espousing a scientific 'Monroe doctrine' as suggested by Siddhartha. Rather, it is incumbent on the Indian scientific community to improve the quality of our journals so as to make them appropriate places in which to publish [important] results. It is also imperative that Indian results must generate a rational, balanced assessment from Indian critics. Only then will we need to look Westward for approbation less often. The absence of peer groups of sufficient size in most disciplines is a serious hindrance. More distressing is the increasing absence of intellectually sound, honest judgements of science and the growing tendency to perpetuate mediocrity at all levels of our scientific establishments. India's community of scientists has many problems to address. Siddhartha's letter raises some of these and hints of solutions, which, although Draconian, may very well sound attractive to Delhi. If acted upon, it would be yet another case of throwing the baby out with the bathwater.

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*Three science administrators give their personal views:*

Regarding the paper published by Mascarenhas and his colleagues on bamboo I have the following comments: (i) It will certainly be highly desirable to publish important papers of Indian scientists in Indian journals. However, this cannot be enforced. On the other hand, leading Indian scientists would have to be persuaded to publish their full-length publications only in Indian journals while they may send short communications of their work anywhere. (ii) The outstanding piece of scientific work carried out by Mascarenhas' group at NCL has received recognition in India itself only after the popular press in the UK and the USA first highlighted it. NCL, which has received a major grant from the Department of Biotechnology (DBT) for setting up a pilot plant for tissue culture-based

woody plants (including bamboos), should greatly benefit from the breakthrough in speeding up the process of bamboo breeding. We wish the NCL and its scientists all success.

S. RAMACHANDRAN

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I share Siddhartha's views almost completely. I do believe that there is urgent need for our scientific community to draw up and strictly apply (enforce?) a 'code of conduct' of publishing papers first in our own scientific journals.

I also fully share Siddhartha's concerns regarding our scientific community's total failure to protect the patenting aspect of scientific discoveries/inventions/potential inventions prior to publication. Through the National Research and Development Council's (NRDC) workshops on patents and technology transfer in different parts of the country, N. K. Sharma, Managing Director, NRDC, and I have been trying to sensitize scientists in CSIR laboratories, Indian Institutes of Technology and even in-house R&D units of public and private industry to this vital aspect. But the pressure to publish is deeply ingrained in our scientists. Consequently sensitivity to the fact that, when they are working on applied research and engineering development-oriented projects, the commercial dimen-

sion must take precedence over the purely scientific is very difficult to inculcate. I hope that *Current Science* would publish articles on the serious and deleterious implications of 'publishing before patenting'.

A. PARTHASARATHI

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Like many other scientists, my colleagues and I in the Department of Science and Technology (DST) have also been concerned about the publication of research papers in Indian journals by Indian scientists. Since DST funds projects under its Science and Engineering Research Council (SERC) scheme, we felt that we may be in a position to cajole the Indian scientific community into publishing research findings arising out of DST-funded projects in identified Indian journals.

This subject was debated at the last meeting of the SERC and I am enclosing a note on the subject [see below]. The final paragraph indicates the general support given by SERC to this proposal.

Since *Current Science* plays an important role in sensitizing the Indian scientific community to science and technology policy issues, we feel that sharing this note with you may help us in promoting our concern amongst the Indian scientific community as well.

P. J. LAVAKARE

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### **Publication in Indian journals by Indian scientists who have DST projects**

#### *Preamble*

This paper is towards developing some

guidelines to help DST motivate Indian scientists to publish in Indian journals. The number of papers published by the Indian scientific community has increased over the years. However, the quality of Indian journals has to be greatly improved. This is a well-known problem and has been discussed at various fora. It has also been discussed with some eminent senior scientists. There was general support to the idea that DST should make conscious efforts to appeal to the Indian scientific community, which is being supported through DST projects, to publish the outcome of their research in selected Indian journals. Hence this appeal.

#### *Some reasons for Indian scientists not publishing in Indian journals*

The reasons for a preference for publishing in foreign journals are well known. It may, however, be useful to recall the ones that are most frequently mentioned.

(i) The selection/promotion criteria for academic positions in educational institutions value 'foreign' publications more than 'Indian' ones. So much so, application forms for positions in many universities ask the applicant for the number of papers published in 'Indian' and 'foreign' journals separately. This forces the academic community to publish in foreign journals, even though some of these foreign journals may not be of very high quality and in no way better than some of the good Indian journals.

(ii) Indian journals take a long time to (a) acknowledge a paper, (b) referee/accept the paper, and (c) finally print the paper. Most of the journals also do not come out regularly.

(iii) Papers published in Indian journals tend to go unnoticed.

(iv) The scientific literature now has specialized journals for various areas in a particular discipline. Scientists prefer to publish in those because it improves their visibility among their peers. The Indian journals, on the other hand, are still very general.

#### *Possible solutions to these problems*

(i) Regarding reason (i) above, one

could possibly adopt something similar to the recommendations of the Harvard Medical School (see *Current Science*, 58, 735). We should not ask the applicant for the complete list of his/her publications but only for his/her 5, 7, or 10 best publications for appointment at the level of lecturer, reader or professor respectively. These papers could then be scrutinized by the selection committee. Indian universities and research institutes may consider this approach for implementation.

(ii) Regarding reasons (ii), (iii) and (iv) above, the organizational structure of, at least, the journals included in *Current Contents* could be strengthened. Various professional bodies may ensure quality, regularity and wider distribution of Indian journals.

(iii) Senior and established scientists in the field should start publishing in Indian journals, setting a trend for other scientists to follow.

(iv) Project investigators working on DST- and other S&T department-sponsored projects should publish at least one paper in the best relevant Indian journals from the work carried out in the projects.

(v) All S&T agencies/departments, S&T institutions, educational institutions, etc. should implement the above guidelines and continually monitor them.

The Science and Engineering Research Council, an expert body of scientists responsible for promoting newly emerging and frontline areas of research, discussed these issues and broadly endorsed the suggestions.

*DST has already written to members of the Programme Advisory Committees (PACs) for the major areas of science and engineering, asking them to name Indian journals in which principal investigators of DST-funded projects could be requested to publish at least one of their research papers.*

- Ed.