flow of latex in rubber and that of gums and gumresins[10,11].

Over 80 per cent of the world's supply of gum arabic comes from the Sudan. The source is the leguminous tree *Acacia senegal*, commonly found in the semi-arid regions of the Sahel. It can tolerate drought, fixes nitrogen symbiotically in its roots and is a good fertilizer for crops. Although millions of trees of this species occur in Gujarat and Rajasthan, they yield very little gum. Application of ethephon through a hole in the trunk has yielded up to 900 g per tree[12].

There is need to step up the yield of the valuable Karaya gum (from *Sterculia urens*) being exported from India using modern tapping techniques. These measures can generate income to a large number of tribals in areas where agriculture is not possible[13].

India is the only country in the world which has four types of silk — mulberry, tasar, eeri and muga. Whereas much research has been done on both mulberry and silkworm in China, Japan, India and France to totally domesticate them and obtain high economic returns, this has not been possible with the other three kinds of silk because of lack of basic research on the food trees and the life-cycles of the insects involved.

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Report on the brainstorming session in the area of tree biology

The Department of Science and Technology through its Programme Advisory Committee on Plant Sciences has evolved an innovative approach for reaching out to scientists in remote universities and young scientists who need encouragement and guidance for formulation of meaningful programmes. The National Seminar on Life Sciences organized at Lucknow in December 1988, had identified ten challenging areas under Plant Sciences. A series of brainstorming sessions in the identified areas have been organized. A brief report on three earlier brainstorming sessions has recently appeared in *Current Science*. A brainstorming session in the area of tree biology was organized at the North Eastern Hill University, Shillong during February 18–20, 1992 under the chairmanship of H. Y. Mohan Ram, Department of Botany, Delhi University, Delhi.

India has a number of tree species uniquely suited for various applications such as timber, firewood and fodder production, social forestry, agro-forestry, watershed regulations and reclamation of degraded lands. However, there is very little indigenous information on their biology, so essential for breeding and selection. Although the study of trees falls under the purview of forestry, the PAC on Plant Sciences felt that encouraging fundamental studies on trees would provide basic scientific information to foresters, conservationists and agriculturists. The session provided a platform to bring together foresters and scientists from other disciplines to develop meaningful programmes.

In his keynote address, Mohan Ram outlined the importance of trees in Indian economy and emphasized the crucial role of forests in the livelihood of a large number of tribals, rural people, village artisans, etc. and emphasized the need for encouraging basic studies in this area. Other experts reviewed the state-of-the-art in reproductive biology, tree architecture and foliage dynamics, dynamics of root growth, nutrient relations of trees, cambial activity and wood formation, resin/gum secreting tissues and regeneration ecology of trees.

After detailed discussions, the following recommendations were made:

1. For afforestation work, study of natural variability of trees, selection of individuals/genotypes and superior provenances will be important as production of high-quality seeds is dependent on our understanding of their reproductive characteristics.
2. In view of the renewed interest in the study of tree architecture and foliage dynamics, particularly in tropical rain forests, studies on the effect of gap size and shape on the resultant microclimate, particularly light, are important. Modelling studies on tree architecture,

branching patterns and canopy shape and size should also be taken up.

3 The dynamic behaviour and role of roots in the functioning of forest ecosystems has only recently been recognized. At the global level, fine root production represents a large and relatively unknown portion of the tree. It was felt that studies on different aspects of root dynamics and growth should be undertaken.

4. For intensive forest management, a clear understanding of nutrient relations and nutrient dynamics of trees in various forests ecosystems is fundamentally important. This includes nutrient availability in soil, its uptake and distribution within the plant body, retranslocation before abscission of short-lived plant parts, litter fall, root turnover and decomposition. There is urgent need to intensify research in nutrient relations with respect to important trees and forests.

5. As wood is the chief product of the trees, the understanding of its formation, structure, properties, durability and utilization for various purposes have been a major concern of wood scientists. There is a need for strengthening our capabilities in this area.

6. Rubber, gums, resins, tannins and essential oils constitute major tree extractives and a national shortage of these is met by annual imports costing the country huge sums in foreign exchange. Studies on the development and fine structure of secreting tissues in relation to seasons, age and location are required to be made to develop simple, improved tapping techniques.

7. In the field of regeneration ecology, studies on soil seed banks, germination behaviour, reproductive allocation and fecundity, survival and growth of seedlings and sprouts as well as various factors like seed dispersal, predation, neighbourhood effects, microenvironmental variables are needed.

8. Out of the large number of economically important tree species growing in our country, a few selected species be identified for research work so that at the end of a reasonable period of time their biology is better understood. Eight tree species were identified for intensive studies.

9. A cooperative approach of bringing together research workers and utilizing their expertise be taken, to ensure generation of meaningful and reliable data.

10. As very few talented researchers are contributing to this difficult area of tree biology, training programmes with faculty drawn from universities and research institutions be organized urgently so that skilled, motivated manpower is available to meet future needs.

A detailed report has been brought out by the Department of Science and Technology in consultation with the Chairman and experts who participated in the brain storming session and their help and advice is gratefully acknowledged.

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Profiles of scientific philosophy: Paradigms and serendipity

A. N. Mitra

"Normal science is a rather directed cumulative process which does not as a routine aim at novelties of fact or theory. However, new and unexpected phenomena are detected from time to time, leading to radically new theories. This is in the very nature of the scientific enterprise."

The thematic component[1]

There is a broad consensus that the growth of any quantitative science depends on the healthy interaction between two distinct types of scientific ingredients—theory versus experiment—the former standing for the calculus of logic and mathematics, and the latter for empirical matters of fact, or 'data'. This interplay has been succinctly expressed by the physicist Friedrich Desauer as a five-step process[1].

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Step 1. Hypothesize a provisional statement obtained by induction from experience.

Step 2. Refine and structure the hypothesis in terms of some mathematical equations.

Step 3. Draw logical conclusions or predictions from the structured hypothesis which have promise of experimental check.

Step 4. Check these predictions against experience through a suitable experiment.

Step 5. If both tally within expected limits, together with all other allied predictions versus data based on