Note added in proof: An important publication on Hotspots of Endemic Plants by M. P. Nayar has been just published by the Tropical Botanic Garden and Research Institute. This is an update on Chatterjee's (1939) paper referred to in the text.

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Indian cycads cry for protection

E. J. H. Corner who was professor of Tropical Botany in the Botany School, University of Cambridge has aptly said, 'But the forests which show how trees were made are dying, they are vanishing nowhere faster than from the alluvial plains where the vestiges of the last creative phase of plant life that prepared the way for the modern world may survive.... Before machines the forest is defenceless. Human progress is clearing it with gathering speed to plant crops for quick returns'. It is, therefore, necessary to conserve the plant cover of tropical forests, and therein specially the cycads, need to be conserved. Being relics of a bygone age they are handicapped by their slow growth, relatively short stature, disadvantageous dioecism, sex ratio problems including less frequent coning of female individuals, frequently non-synchronous production of male and female cones, their inefficient pollination mechanisms, shedding of seeds with immature embryos and a long period of about 10 years required by seedlings to attain puberty for producing reproductive parts. Accordingly in various native countries of cycads, except India, there is public and governmental awareness about the need of conserving cycads against human interference.

My visits to Beaulieu-sur-Mer in southern France in 1987, to Australia in 1990 and my recent visit to China in May 1996 to attend the International Conferences on Cycad Biology have convinced me that other countries are far ahead of India in the conservation of cycads. The Cycad Societies of USA, South Africa and China and the Palm and Cycad Societies of Australia and New Zealand have played a vital role in creating such awareness about protecting their cycads *in situ* (in the areas of their occurrence) and *ex situ* (under cultivation in gardens, parks and in private collections).

In situ conservation

As a result of this awareness all native countries have started protecting their natural populations of diverse cycads in protected areas. In China alone there are about 20 or more natural population reserves where cutting of any parts of cycads or even the collection of fallen seeds is prohibited. Australia and Central America have also taken steps to protect their rare cycads. South Africa in particular has already enacted legislation to protect its cycad populations and to punish the guilty with fine and imprisonment. India, on the other hand, cannot claim even a single Cycad Reserve anywhere in the country, perhaps, because we are over-emphasizing biotechnology, agricultural production and applied sciences.

Ex situ conservation

Despite the limitations of cultivated collections of cycads, lasting conservation is offered to cycads, by various botanical gardens of the world. Some of these are situated in temperate or cold temperate countries (where the climate is not favourable for growth of cycads in the open), e.g. in the Royal Botanic Gardens at Kew in UK, the St. Petersburg (Leningrad) Botanical Garden of Russia and the Glasnevin Botanical Garden of Ireland and they all have stupendous collections of the cycads of the world. Many South African Botanical Gardens,

Cycas circinalis plants in the Nagamangala area. The top of one of the trees has been cut out.

the New York Botanical Garden and the Fairchild Tropical Garden of Miami, Florida need special mention. Practically every important city in Australia has a botanical garden and many of them give particular attention to cycads, specially the Royal Botanic Gardens in Sydney. Many of the above mentioned gardens are also involved in cycad research. The Chinese too seem to be ahead of us in the *ex situ* conservation of their cycads. Their South China Botanical Garden, Panzhihua Institute of Horticulture, Panzhihua Park and Shenzhen Fairy Lake Botanical Garden have special collections of cycads. In particular, the Shenzhen Fairy Lake Botanical Garden has an international centre for *ex situ* protection of cycads where not only Chinese cycads but cycads from other countries have been introduced. Whereas we cannot claim even a single botanical garden, with a good collection of our own cycads, or of diverse cycads of the world.

Indian cycads and the need of their conservation

Indian region can claim only six species of the genus *Cycas* as its natives; *Cycas beddomei*, *C. circinalis*, *C. nathorstii*, *C. pectinata*, *C. rumphii* and *C. siamensis*. Out of these, *C. beddomei* is one of the most circumscribed endemics among all cycads growing only in the Cuddapah Hills of Andhra Pradesh. It is accordingly listed in Appendix I of the Convention on International Trade in Endangered Species of wild fauna and flora (CITES) which is administered by the United Nations Environment Programme. Its inclusion in Appendix I indicates that it is one of the endangered plants of the world and international trade in these plants or their parts is prohibited by CITES. However, their protection ir "a is our responsibility.

Our second species, *C. circinalis*, is relatively widely distributed from Kerala northwards up to Orissa. However, it has at least three varieties having a more restricted distribution: *C. circinalis* var. *circinalis* grows in the Malabar region, var. *swamyii* grows in the Hassan District of Karnataka and var. *orixensis*, in the Mals of Puri.

Among the remaining species, *C. nathorstii* is endemic to Sri Lanka, *C. pectinata* occurs in the Someshwar Hills of Bihar, the Assam region, Eastern Nepal and Sikkim Terai, *C. rumphii* grows in the Andaman and Nicobar Islands and Sri Lanka and *C. siamensis* is reported rarely from Manipur and Bhutan.

The above-mentioned restricted populations of our cycads are regularly ravaged by inhabitants of the surrounding areas for use of their leaves, the entire crowns of leaves and apical parts of stems for decorations of their temples, churches or graves. The plants are also used for medicine and food. Thatching and preparation of mats and broom sticks are other uses of cycad leaves. Cones are also used for driving away bed bugs or rice bugs.

However, the worst calamity which is overtaking our cycads is the wanton destruction of their entire populations for acquiring their habitats for human habitations including dwellings, fields and roads or for quarrying stones. In this process the habitats of cycads are rapidly shrinking and the species are threatened with extinction as happened in the case of *Encephalartos woodii* in Africa where only male plants survive in cultivation. These are vegetatively propagated from a multistemmed male which was the only plant ever collected from nature in 1895. *C. beddomei*, despite being listed in Appendix I of CITES as one of the most endangered cycads, with an embargo on its international trade, has been mercilessly destroyed in Tirupathi where an entire hillside inhabited by its beautiful plants was cleared of the vegetation by the authorities of the Tirupathi Devasthanam for their buildings, roads and gardens.

At this point I can also recall the merciless cutting of a number of large female trees of *Cycas revoluta* growing in the old Government House of Allahabad. Each of these had about 60 or more large and small branches all round and these grew from the ground surface to a height of about four metres. The thickest of their trunks must have been about a metre in diameter. Their sight was so amazing that I used to take my students and botanist friends to see them. Suddenly one day I came to know that all of them had been cut down and the branches thrown away because the State Government had decided to convert the Allahabad Government House into the Moti Lal Nehru Medical College. The trees must have been planted at least

about two hundred years earlier. Obviously, no one, not even the Government cares for such valuable monuments of nature. If the authorities concerned had cared the trees could have been carefully dug out with the roots and transplanted. In other countries old cycads are valued and protected wherever they grow. The Chinese and Japanese plant cycads in their temples and some of their famous oldest and largest trees are situated there, e.g. the Ryugeji Temple near Tokyo has many old trees of *Cycas revoluta*. Surely we could emulate this practice in our temples and churches instead of decorating them with cut leaves and crowns.

Suggested methods for conservation of Indian cycads

The manner in which India could embark on a programme for the protection of its cycads is envisaged as follows:

1. A survey of the natural areas and population counts of all our cycads in an All-India basis along with a search for new forms.
2. Protection of their habitats by declaring some of their habitat areas as 'Cycad Reserves'.
3. A programme should be embarked for the education of the public in the areas of our cycads and also elsewhere on the need of protecting our cycads wherever they grow, and, if necessary, we should embark on legislation for the protection of cycads in nature and old plants in cultivation. We should have a Cycad Society, if necessary subsidized by the Government, for education and research on cycads like the cycad societies of other countries. This could help us in developing our much needed research on different aspects of cycads.
4. India should have a few cycad gardens and special cycad sections in all botanical gardens. Indeed India needs many more botanical gardens in different parts of the country to preserve the diversity of its flora. We could encourage cultivation of cycads in parks, road sides and private gardens by providing a subsidy for the purpose.

In this connection it is important to point out that Indian scientists sitting in positions of power in Government Departments should take effective measures for the protection of our endangered species like *Cycas beddomei* and not merely write articles about their imminent extinction. Such statements should also be backed by actual surveys of their distribution and numbers and by the establishment of 'plant sanctuaries'. India has a number of 'National Parks' for the protection of animals facing extinction but not a single one for the protection of its endangered plants. Perhaps, I could also blame myself for this situation since I repeatedly refused positions in Government Departments.

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SCIENTIFIC CORRESPONDENCE

Evolution of the nasuta–albomicans complex of *Drosophila*

During the last two decades, the *nasuta* subgroup of the *immigrans* group of *Drosophila* has attracted the attention of taxonomists, cytogeneticists, biochemists, molecular biologists and evolutionary biologists. The *nasuta* subgroup has evolutionary peculiarities, which include little morphological differentiation despite their distribution over an enormous territory, the ability to intercross in the laboratory, often producing fertile offspring and substantial chromosomal evolution[1]. The story started with the report of *D. nasuta* by Lamb[2] from Seychelles islands. Subsequently, morphologically almost similar forms found in different parts of southeast Asia were studied by Wilson *et al.*[3]. Further investigations by Indian[4–7] and Japanese researchers[8,9] resulted in establishing the 14 different species of the *nasuta* subgroup. The females of all the species are morphologically indistinguishable, while three types of males are recognized[3,8]. On the basis of the morphology of the frons and orbits of the males, three morphophenotypic complexes have been identified[3–5,8]. The males of *D. nasuta, D. albomicans, D. kepulauana, D. kohkoa* and *D. neveifrons* with complete silvery frons constitute 'frontal sheen complex'. On the other hand, the silvery sheen is restricted to the sides of the frontal orbits in the males of *D. s. sulfurigaster, D. s. bilimbata, D. s. albostrigata, D. s. neonasuta* and *D. pulaua*, constituting the 'orbital sheen complex'. The third complex shows absence of pollinosity of frontal region and includes *D. pallidifrons*, taxons F, J, and I.

In the frontal sheen complex, *D. nasuta* and *D. albomicans* are a pair of chromosomal allopatric races (earlier they were treated as biologically valid reproductively isolated species, and hence were given different names) with $2n = 8$ and $2n = 6$, respectively[10]. The difference in the diploid number is because the sex chromosomes and the 3rd autosome exist as independent acrocentric entities in *D. nasuta*, whereas in *D. albomicans*, these two components of the karyotype exist as one unit in the form of a metacentric chromosome. In spite of the difference in diploid number, there is similarity between the corresponding chromosomes of *D. nasuta* and *D. albomicans*, as seen in the polytene chromosomes of F_1 hybrid larvae[11]. They also show variation not only in chromosome number, but also in the quantum of heterochromatin present in different chromosomes[12], and in the organization of micro (dot) chromosomes[13]. Because of this difference, the size of the respective chromosomes of *D. nasuta* and *D. albomicans* differ, and this helps to distinguish the chromosomes of these races in their hybrids. In spite of such karyotypic differences, the F_1 hybrids with $2n = 7$, (4 chromosomes of *nasuta* and 3 of *albomicans*) are fertile and the hybrid progeny can therefore be maintained for generations. The ability to identify the parentage of each chromosome in the hybrid karyotypes and to indefinitely maintain the hybrid populations have formed the basis for long range evolutionary studies of the present authors[11,14].

Hybrids of *D. nasuta* and *D. albomicans* have been maintained in our laboratory for over a decade. The F_1 with $2n = 7$