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Palms through ages in southern India – A reconnaissance

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LET me at the very outset express my deep appreciation and profuse thanks to the authorities of the Birbal Sahni Institute of Palaeobotany, for the honour they have done me by inviting me to deliver the 49th Sir Albert Charles Seward Memorial Lecture. I am all the more enthralled to be present at the Institute on its Founder's Day to deliver this lecture. Prof Seward and Professor Birbal Sahni together constitute verily a Role Model for the Guru-Shishya relationship, which we in this country consider so venerable. Professor Seward, a brilliant star in the firmament of British Palaeobotany along with Professor Sahni, the Titan of the Indian Palaeobotany, though no more with us physically, continue to be the source of inspiration to all the votaries of Palaeobotany in the Indian subcontinent. When I was contacted by Dr Jayasri Banerji, the Scientist In-charge of the Institute inviting me to deliver the Seward Memorial Lecture. I readily consented and then decided that I should speak on such a topic that would kindle and generate interest in both botanists and palaeobotanists and that explains the title of my lecture. This lecture is designed to present before you a panoramic view of the gleanings of studies on fossil Palms with particular reference to their floristic, phytogeographic and environmental considerations, *vis a vis* their modern counter parts. As I stand before you, I recollect with nostalgia my association with this institute as a research student way back in 1950s, which I cherish immensely even now.

Palms referable to the family Arecaceae (Palmae) are woody and arborescent monocotyledons. They are a natural group of plants. The unbranched columnar trunk with a beautiful crown of large feathery or fan-shaped foliage imparts a majestic and regal look to palms facilitating their easy recognition. Palms constitute the "Princes" among plants and epitomize the tropics in the minds of many students of botany. As a family, Arecaceae is predominantly pantropical and the majority of palms are restricted to the zone between 20°N and 20°S latitudes in the evergreen and semi-evergreen forests. This is the zone in which the coconut (*Cocos nucifera*) is successfully cultivated. The family Arecaceae comprises 200 to 218 genera depending upon whether one is a lumper or a splitter in taxonomy. It is divided into six subfamilies viz., Coryphoideae, Calamoideae, Nypoideae, Ceroxyloideae, Arecoideae and Phytelephantoideae (Dransfield & Uhl, 1986).

In the Indian subcontinent palms are represented by 22 genera and 75 species. Many parts of peninsular India, Eastern, and Northeastern region and Andaman and Nicobar Island complexes are the major geographical regimes of palms in India. Southern India shows 11 genera referable to 3 subfamilies viz., *Borassus*, *Corypha*, *Hyphaene*, *Phoenix*, (Coryphoideae), *Calamus* (Calamoideae), and *Arenga*, *Areca*, *Bentinckia*, *Caryota*, *Cocos* and *Pinanga* (Arecoideae). *Cocos* is under extensive cultivation. Whether *Cocos* occurs naturally in India is a moot point.

The geological history of palms is fascinating. The remains of fossil Arecaceae include mostly petrified stems, petioles, and fruits, impressions and compressions of fragmented leaves and a wealth of pollen types. The family enjoys a respectable antiquity and is traceable perhaps, to the later part of Early Cretaceous. The oldest record of palms anywhere in the world consists of pollen types from the Albian-Senonian of Brazil in South America. In India, palms are known since Upper Cretaceous {(Maestrichtian), (Venkatachala, 1974)}. It is extremely difficult and hazardous to affiliate the vegetative remains of fossil palms to modern taxa. The difficulty in the identification of fossil palms is attributed to not only the

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imperfection of the fossil material but also to the woefully incomplete and imperfect knowledge of the extant palms. The situation is not that depressing and gloomy with pollen. Fossil pollen types are perhaps the most convincing indicators for palms of the past. Notwithstanding the monotonously stereotyped oval-elliptical, psilate, monosulcate pollen encountered in many of the palms, a fairly good number of palms show a bewildering variety of apertural configurations and sculptural patterns which facilitate their meaningful recognition even in *sporae dispersae*.

The palynology of modern palms has been studied extensively both under LM and SEM by a host of workers viz., Kedves, Thanikaimoni, Harley, Fergusson, Sowunmi and others. The apertural diversity of palm pollen is clearly expressed in monosulcate (brevi or longi), extended sulcate, dicolpate, ulcerate (monoporate), triporate equitorial, triporate subequitorial (latiporate) diporate, and inaperturate palynomorphs. Harley and Baker (2001) recently recognized as many as 17 aperture configurations in the pollen of Arecaceae. Some of them are of evolutionary significance and indeed useful in demarcating various palm taxa. Similarly sculptural diversity is indicated by psilate, granulate, scabrate, foveolate, verrucate, gemmate, clavate, echinate, echinulate (spinulate), reticulate, retipilate and rugulate sporoderm. Arecaceae is thus eurypalynous. As the modern palms inhabit diverse ecological niches such as mangroves, freshwater swamps, sandy beaches, river banks along the coastal belts and as many of them are denizens of rainforest vegetational complexes, the fossil palm pollen related to modern taxa would provide convincing data for interpreting environmental patterns, of the past.

Barring a few reports of megafossils viz., impressions of fragmented leaves (*Palmophyllum*) and a fruit from the Rajahmundry Sandstones in Andhra Pradesh and silicified stems (*Palmoxylon pondicherriense*, *P. arcotense* and *P. puratanam*) from the Cuddalore Sandstones in Tamil Nadu, most of the records of fossil palms from southern India constitute varied pollen types documented from the Upper Cretaceous (Maestrichtian) and Tertiary sediments of the Krishna-Godavari Basin in Andhra Pradesh the Cauvery Basin in Tamil Nadu, the Kerala Basin in Kerala and from near Mangalore in the West Coast of Karnataka. *Palmoxylon arcotense*, incidentally in its pronouncedly lacunar ground tissue and details of its fibrovascular bundles shows strong resemblances with the modern palm *Livistona*, of the subfamily Coryphoideae.

The Tertiary sediments in southern India are generally replete with a good number of pollen types referable unequivocally to Arecaceae. On the whole, 19 pollen taxa comprising 60 species are known from these sediments viz., *Dorreenipites*, *Quilonipollenites*, *Jacobipollenites*, *Paravuripollis*, *Dicolpopollis*, *Disulcipollis*, *Spinizonocolpites*, *Longapertites*, *Arecipites*, *Dracaenoipollis*, *Proxapertites*, *Arengapollenites*, *Clavapalmaedites*, *Gemmamonocolpites*, *Neotrichotomosulcites*, *Palmaepollenites*, *Verrumonocolpites*,

Age	Krishna-Godavari Basin	Cauvery Basin	Kerala Basin
PALAEOGENE	*Mauritiidites* *Proxapertites* *Spinizonocolpites* *Palmaepollenites*	*Proxapertites* *Spinizonocolpites* *Arecipites* *Palmaepollenites*	*Proxapertites* *Spinizonocolpites* *Palmaepollenites* *Jacobipollenites* *Dicolpopollis* *Neocouperipollis*
NEOGENE	*Mauritiidites* *Spinizonocolpites* *Palmaepollenites* *Dicolpopollis* *Disulcipollis* *Longapertites* *Quilonipollenites* *Neotrichotomosulcites* *Arecipites*	*Spinizonocolpites* *Palmaepollenites* *Dicolpopollis* *Disulcipollis* *Longapertites* *Proxapertites* *Quilonipollenites* *Dracaenoipollis* *Neotrichotomosulcites* *Paravuripollis* *Clavapalmaedites* *Jacobipollenites* *Arengapollenites* *Dorreenipites* *Gemmamonocolpites* *Arecipites*	*Spinizonocolpites* *Palmaepollenites* *Dicolpopollis* *Disulcipollis* *Longapertites* *Quilonipollenites* *Neotrichotomosulcites* *Paravuripollis* *Clavapalmaedites* *Jacobipollenites* *Dorreenipites* *Verrumonocolpites* *Arecipites*

Fig. 1—Basin-wise occurrence of Palm Pollen types.

Mauritiidites and *Neocouperipollis* (see Ramanujam *et al.*, 2001). Of these, 8 genera are known from the Palaeogene (Palaeocene-Eocene) strata and 18 from the Neogene (mostly Miocene) strata. *Spinizonocolpites* is the only genus recorded from the Maestrichtian. This clearly shows that the fossil palms enjoy much better representation in the Neogene than in the Palaeogene. Wherever it is available, the percentage frequency of the palms *vis a vis* the rest of the angiosperms is revealing; it is 10-12% in the Palaeogene as against 20-28% in the Neogene.

Fig. 1 provides basin-wise occurrence of fossil palm pollen taxa. For the basin wise occurrence of various species of fossil palm pollen, reference may be made to Ramanujam *et al.* (2001). The palm pollen assemblage from the Neogene of the Mangalore area is remarkably similar to that of the Kerala Basin. As indicated by the number of taxa, Arecaceae is better represented in the Tertiary deposits of the Cauvery and Kerala basins than in the Krishna-Godavari Basin. 3 genera viz., *Proxapertites*, *Spinizonocolpites* and *Palmaepollenites* are common to the Palaeogene of all the 3 basins and 8 genera viz., *Dorreenipites*, *Quilonipollenites*, *Dicolpopollis*, *Spinizonocolpites*, *Longapertites*, *Arecipites*, *Neotrichotomosulcites* and *Palmaepollenites* represent common pollen types of the Neogene of all the basins.

Proxapertites is an overwhelmingly Palaeocene-Eocene taxon. Its exact affinities with any of the extant palms are still enigmatic. *Quilonipollenites*, *Clavapalmaedites* and *Paravuripollis* have been recorded to date only from the Neogene deposits. *Jacobipollenites* is best seen in the Neogene strata. Similarly the best representation of *Dicolpopollis* in southern India is in the Neogene. *Dorreenipites* though recorded from the Neogene of all the basins, attained its peak in the Miocene of the Cauvery Basin. The pollen record clearly indicates that *Dorreenipites* migrated rapidly along the Kerala Coast encircling the southern tip of the Indian peninsula and reached the Cauvery Basin, and from there towards north to Krishna-Godavari Basin. There is no convincing record of its continuity further northwards (Misra *et al.*, 1996). *Spinizonocolpites* is known from more or less all through the Tertiary sequence.

Fossil Palm Taxa	Affinities with Modern Palm Taxa
Palmoxylon arcotense	*Livistona*
Arengapollenites	*Arenga*
Clavapalmaedites	*Oncosperma*
Dicolpopollis	*Calamus*
Disulcipollis	*Metroxylon*
Dorreenipites	Related to *Sclerosperma*
Dracaenoipollis	*Pritchardia/Raphia*
Gemmamonocolpites	*Hyphaene*
Jacobipollenites	*Borassodendron*
Neotrichotomosulcites	*Elaeis*
Paravuripollis	*Salacca/Korthalsia*
Quilonipollenites	*Eugeissona*
Spinizonocolpites	*Nypa*

Fig. 2—Showing affinities of Fossil Palms.

Genus	Subfamily	Tribe
Livistona	Coryphoideae	Livistoneae
Borassodendron	Coryphoideae	Borasseae
Hyphaene	Coryphoideae	Borasseae
Pritchardia	Coryphoideae	Coryphaeae
Eugeissona	Calamoideae	Calameae
Metroxylon	Calamoideae	Calameae
Calamus	Calamoideae	Calameae
Salacca	Calamoideae	Calameae
Raphia	Calamoideae	Calameae
Korthalsia	Calamoideae	Calameae
Nypa	Nypoideae	
Arenga	Arecoideae	Areceae
Sclerosperma	Arecoideae	Areceae
Oncosperma	Arecoideae	Areceae
Elaeis	Arecoideae	Cocoeae

Fig. 3—Systematic position of extant palms represented by their fossils (Stem and Pollen) in southern India. [(In accordance with classification of Arecaceae by Dransfield & Uhl (1986)].

Because of the singularly characteristic morphography the affinities of a number of fossil pollen with the extant palms could be reliably deciphered. The following Fig. 2 provides information on the affinities of fossil palm taxa from southern India.

Four subfamilies and six tribes of palms in accordance with the classification of Dransfield and Uhl (1986) could be recognized in the Tertiaries of southern India. The subfamilies are Coryphoideae, Calamoideae, Nypoideae and Arecoideae (Fig. 3).

Nypa and *Calamus* represented by their fossil pollen *Spinizonocolpites* and *Dicolpopollis* respectively, are geologically the oldest palms as evidenced by their occurrence in the Maestrichtian deposits (global data).

COMMENTS ON PHYTOGEOGRAPHY

Of the modern palm taxa with which the fossil pollen show striking resemblances, *Arenga* and *Calamus* are still encountered in southern India. *Hyphaene* is restricted to the West Coast from Mangalore-Goa region to Gujarat. *Korthalsia* is not found in the main land but confined to Andaman and Nicobar Islands. The past and present phytogeography of many of the above palms is indeed significant and merits special comments. All these experienced more extensive geographical distribution in the past but suffered subsequently heavy territorial loss as evidenced by their present day highly telescoped spread.

Nypa, *Calamus*, *Eugeissona*, *Borassodendron* and *Arenga* deserve special mentioning in this context. *Nypa*, the mangrove palm in particular is credited with an extensive fossil record. The fruits, pollen and other remains of *Nypa*, are known from the Maestrichtian and various Tertiary deposits of

America, Europe, southern England, and South-East Asia including India (see Ramanujam *et al.*, 2001). In India it enjoyed extensive distribution during Palaeogene and Neogene, but is now restricted to Sunderbans in West Bengal. *Nypa* suffered drastic diminution in its geographical spread during the post Miocene times. The disappearance of *Nypa* form southern India seems to be geologically a recent event. The idea put forward by some that *Nypa* disappeared during the post Eocene times and reappeared in the Holocene is patently untenable.

The American records of the fossil *Nypa* are still to be confirmed beyond doubt. *Calamus* is currently confined mostly to Indo-Malayan region with a few species seen in Africa. As indicated by its fossil pollen *Dicolpopollis*, this genus experienced almost global distribution during the Tertiary times (see Ramanujam *et al.*, 2001). It has been recorded from various parts of Europe, Gulf-Coast of America, Middle East, India, Malaysia and Borneo (Ramanujam *et al.*, 1997; Ediger *et al.*, 1990). *Eugeissona* (*Quilonipollenites*) now restricted to the rich rain forests in Malaysia and Borneo has been recorded convincingly from the Lower Miocene of Kerala, Cauvery and K-G basins and also from the Mangalore area in the West Coast of Karnataka and Ratnagiri area in Maharashtra.

Borassodendron (*Jacobipollenites*) now restricted to Malaysia and Borneo has been recorded from the Eocene and Miocene of Kerala and Miocene of Cauvery Basin. *Arenga* is a common element of the tropical forests of Indo-Malayan region. The Indian Tertiary records of its fossil pollen (*Arengapollenites*), however, are from Gujarat (Eocene) and Cauvery (Miocene) basins.

COMMENTS ON PALAEOECOLOGY

There are a number of palms, which are known for their ecological and habitat specificity. In this context *Calamus, Eugeissona, Borassodendron, Arenga, Nypa* and *Oncosperma* which are ecologically significant palms merit special observations. Palaeoecological interpretations would be credible only if attempted on the basis of modern analogues as guides. The modern *Calamus* belonging to the group of climbing rattan palms is seen in the riparian margins of the tropical forests with high precipitation. Similar ecological niches were perhaps prevalent during the Tertiary period of southern India. In both Cauvery and Kerala basins *Calamus* pollen type (*Dicolpopollis*) is encountered commonly in the lignite bearing horizons and hence may be regarded as a facies element (Harley & Morley, 1995). Muller (1979) earlier commented upon the dominance of this pollen type in the Neogene coal samples of Malaysia. *Eugeissona* and *Borassodendron* are typical rain forest palms. The recognition of their fossil pollen types *Quilonipollenites* and *Jacobipollenites* respectively, in Kerala and Cauvery basins points towards the prevalence of similar ecological conditions sustaining tropical wet evergreen forests in these areas, particularly during the Neogene. The possible occurrence of *Salacca/Korthalsia* in these basins also highlights similar ecological scenario.

Arenga (*Arengapollenites*) now confined to the tropical moist evergreen forests of Karnataka and Assam, indicates similar ecological conditions in the Cauvery Basin where it has been recorded. The occurrence of *Nypa* and *Oncosperma* in all the basins of southern India highlights prevalence of extensive mangrove conditions during the Tertiary of this region.

The extinction of tropical moist evergreen palms such as *Eugeissona, Borassodendron, Metroxylon, Salacca/ Korthalsia* from India is attributable to the post Miocene deterioration of climate resulting in very much depleted and diminished precipitation. The disappearance of mangrove *Nypa* and *Oncosperma* unfolds similar situation.

It is said that past is an index to the present. Howsoever imperfect and incomplete our knowledge of the past is, it adds thrill and beauty to our understanding of the present. Studies on fossil palms are no exception to this dictum. Palm research is as fascinating as palms. It is like an intoxicating drink. The more you indulge in it, the more you crave for it.

REFERENCES

Dransfield J & Uhl NA 1986. An outline of a classification of Palms. Principes 30: 1-11.

Ediger VS, Bate Z & Alison C 1990. Palaeopalynology and palaeoecology of *Calamus*-like disulcate pollen grains. Review of Palaeobotany & Palynology 62: 92-105.

Madeline M, Harley & Morley RJ 1995. Ultrastructural studies of some fossil and extant palm pollen and the reconstruction of the biostratigraphical history of subtribes Iguanurinae and Calaminae. Review of Palaeobotany & Palynology 83: 153-182.

Madeline M, Harley & Baker WJ 2001. Pollen aperture morphology in Arecaceae: application within phylogenetic analysis and a summary of the fossil record of palm-like pollen. Grana 40: 45-77.

Misra BK, Singh A & Ramanujam CGK 1996. Trilatiporate pollen from Indian Palaeogene and Neogene sequence, evolution, migration and continental drift. Review of Palaeobotany & Palynology 91 331-352.

Muller J 1979. Reflection on fossil palm pollen. *IV International Palynological Congress Lucknow* (1976-77) 1: 568-578.

Ramanujam CGK, Reddy PR & Ramakrishna H 1997 Dicolpate palm pollen from the Neogene deposits of Godavari-Krishna Basin, A.P. Journal of Palynology 33: 129-136.

Ramanujam CGK, Reddy PR & Ramakrishna H 2001. Pollen types of Arecaceae from Tertiary deposites of southern India. – A critical appraisal. J. Swamy Bot. Cl. 18: 51-63.

Venkatachala BS 1974. Palynological zonation of Mesozoic and Tertiary sub-surface sediments in the Cauvery Basin. Aspects and Appraisal of Indian Palaeobotany, B.S.I.P. Lucknow : 471-495.