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RESEARCH ARTICLE

A POLLEN MORPHOLOGICAL ANALYSIS OF SOUTH INDIAN LECYTHIDACEAE

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ABSTRACT

Lecythidaceae comprises members which are either trees or shrubs. In South India the family is represented by five species coming in three genera. The pollen morphology of all the five species was examined using LM and SEM observations. The pollen grains are basically 3-zonoaperturate and the aperture structure varies from syncolpate, to syncolporate and colporate. The shape of the pollen grains and the exine surface ornamentation also differ in different genara and species. Even though the pollen grains in some members are syncolporate the pollen has unique morphological features that are quite different from that of other Myrtallean members in many aspects which justifies their separation from this order.

INTRODUCTION

Lecythidaceae comprises 25 genera and 315 species the world over. The family is represented by tall to small trees and shrubs largely distributed in the moist lowland neotropics and others restricted to tropical West and East Africa, Madagascar, Mauritius, and tropical Asia to North Australia (Appel, 2004; Prance, 2004; Prance and Mori, 2004). A main centre of diversity is lowland Amazonia, in which the two most famous Lecythidaceae species grow; the Brazil nut, Bertholletia excelsa known for its edible seeds and the spectacular cannon-ball tree, *Couropita guainensis* which is grown in the tropical and subtropical gardens as an ornamental plant and as a botanical curiosity. The family Lecythidaceae is better known as the Brazil nut family due to the presence of the member *Bertholettia excelsa*, the Brazil nut. Lecythidaceae family comprises members which were included in the family Myrtaceae in the order Myrtales by classical taxonomic treatments and as a distinct family, Lecythidaceae in the order Myrtales and later as a separate order in different classifications (Paynes, 1967). In India it is represented by six species belonging to four genera (Santapu and Henry, 1972). Pollen morphology of the family has been studied by Erdtman (1952), Guinet (1962, Kubitzki (1965), Paynes (1967), Muller (1972, 1973) and Rao and Ong (1974). Pollen morphology of five Indian Lecythidaceae has been studied by Murthy (1996). The present study comprises the pollen morphological studies on five species of Lecythidaceae that are distributed in South India. They include three species of *Barringtonia, Careya arborea* and *Couropita guainensis*. Pollen morphology as a useful tool in resolving problems of taxonomy and also in the recognition, identification and interpretation of relationships of plants at various taxonomic levels has been stressed by Erdtman (1952) and Nair (1974) and its application in plant taxonomy is amply evidenced in many angiosperm families.

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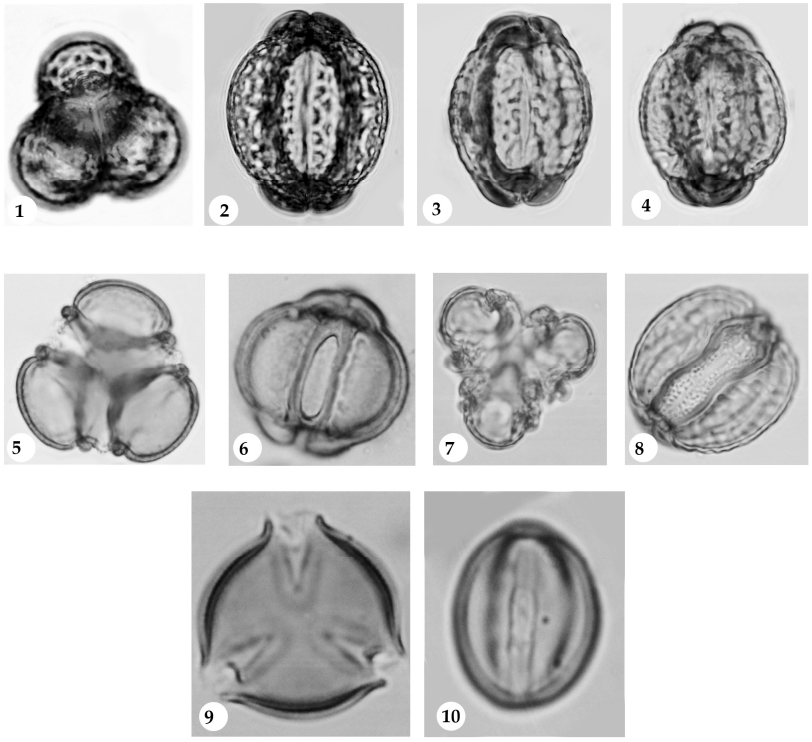
MATERIALS AND METHODS

The pollen material for the present investigation was procured from different parts of South India. Mature flower buds were collected and fixed in 70% ethyl alcohol. Pollen preparations were done by the acetolysis method proposed by Erdtman (1952). Pollen morphological features were studied by both LM and SEM observations. The palyno-morphic characters were analysed using the terminology of Nair (1964). Average pollen size was calculated and the various morphological features are described in the order, the aperture character, shape and size (range, $\overline{X}$,σ) and exine sculpturing.

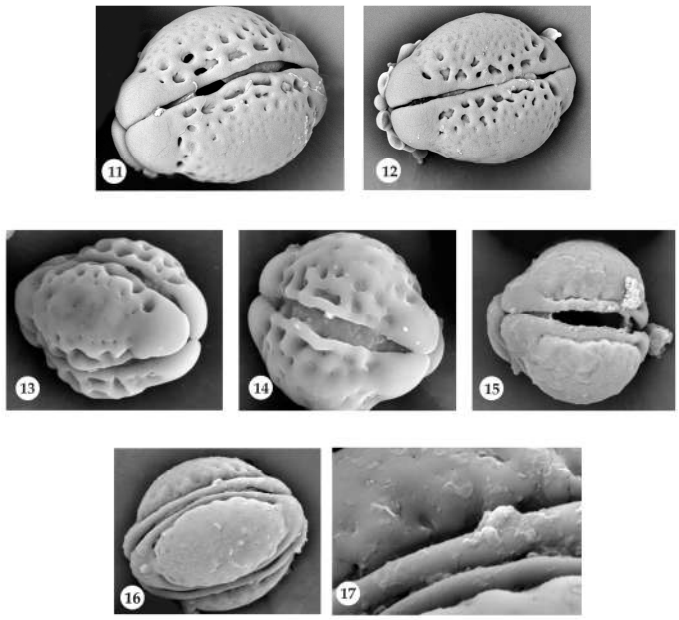
RESULTS

***Barrigtonia racemosa* (L.).**

This is a medium sized ornamental tree with large, cream-coloured flowers with pink stamens in pendulous racemes and large brownish-red fruits. For the present investigation material was obtained from Moothakunnam, Ernakulam district. Pollen grains are 3-zonocolpate, syncolpate; subprolate in lateral view and three-lobed in polar view; grain size range (56 - 66.5 × 42 -49.5µm), $\overline{X}$ = (59.32 × 46.55µm), and σ = (2.45 x 1.92); Colpus narrow covering the whole polar diameter; polar ends compressed and forms the polar cushions; mesocolpium bulged; exine 2.62µm thick; colpus sub-margin characterized by two to three rows of geometrically shaped depressions, which being triangular to circular, large or small or macro-reticulate) (Figs. 1-2 & 11-12).



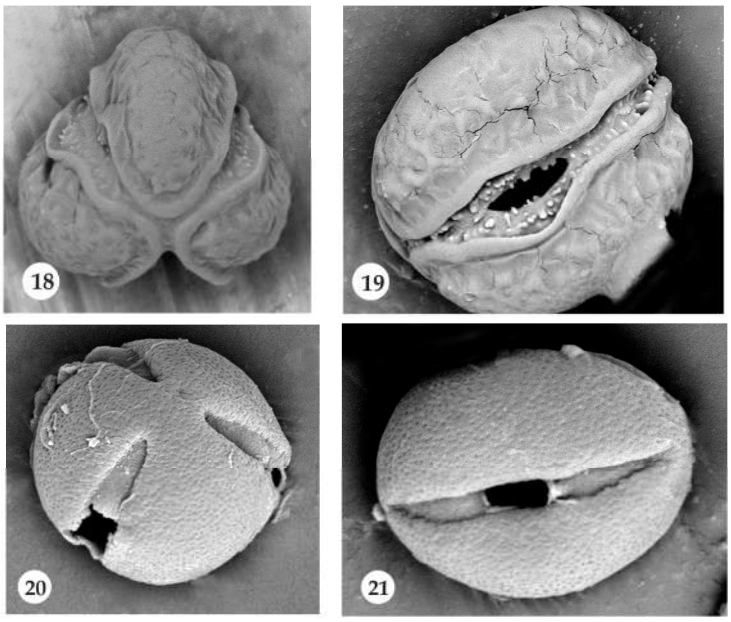
1-2. ***Barringtonia racemosa*- (1)Polar view showing 3-zonocolporate aperture (X=1000). (2) Equatorial view showing the lolongate endoaperture (X=1000). 3-4** ***Barringtonia acutangula*. (3) Polar view showing 3-zonocolporate aperture (X=1000).(4) Equatorial view showing the lolongate endoaperture (X=1000). 5-6.** ***Barringtonia asiatica*. (5)Polar view showing 3-zonocolporate aperture (X=1000). (6)Equatorial view showing the lolongate endoaperture (X=1000). 7-8.** ***Careya arborea*.(7)Polar view showing 3-zonoporate aperture (X=1000).(8)Equatorial view showing the lolongate aperture (X=1000). 9-10.** ***Couropita guainensis*:(9)Polar view showing 3-zonocolporate aperture (X=1000). (10) Equatorial view showing the lolongate endoaperture (X=1000).**



11-12. ***Barringtonia racemosa.* (11) Equatorial view showing the colpus and macroreticulate exine ornamentation. (12) Subequatorial view showing the syncolpate condition. 13-14.** ***Barringtonia acutangula*. (13) Equatorial view showing the colpus and macroreticulate exine ornamentation. (14) Subequatorial view showing the syncolpate condition. 15-16.** ***Barringtonia asiatica*. (15) Subequatorial view showing the lolongate endoaperture and syncolpate condition. (16) Equatorial view showing the marginal ridge (17) Magnified view showing the marginal disc and marginal groove and depressions on the exine surface.**

Barringtonia acutangula (L.) Gaertn.

It is a medium sized tree, conspicuous for its long pendent racemes of pink flowers, obovate leaves and angular fruits. For the present observation flower buds were procured from moothakunnam, Ernakulam district. Pollen grains are 3-zonocolpate, syncolpate; prolate in lateral view and 3-lobed in polar view; grain size range (49 - 56 × 35 - 38.5µm), $\overline{X}$ = (52.71 × 35.87µm), and σ = (2.38 x 1.54); exine 2.27µm thick; colpus narrow covering the whole polar diameter; polar ends



18-19. *Careya arborea*. (18) Polar view showing the syncolpate condition and marginal ridge. (19) Equatorial view showing the lolongate endoaperture, apertural verrucae and macroreiculate exine. 20-21. *Couropita guainensis*. (20) Polar view showing 3-zonocolporate aperture, lolongate endoaperture and granulate exine. (21) Equatorial showing long colpus and lolongate endoaperture.

forms the poalar cushions; mesocolpium bulged. Colpus submargin characterized by two to three rows of geometrically shaped depressions, which being triangular to circular, large or small or macroreticulate. (Figs. 3-4 & 13-14)

Barringtonia asiatica

This is a medium-sized ornamental tree with large white flowers, with pink stamens in racemes and large brownish-red fruits. Pollen material for the present study was collected from Ernakulam. Pollen grains 3-zonocolporate, syncolpate; prolate-spheroidal in lateral view and 3-lobed in polar view; endoaperture lolongate; marginal ridge or costae colpi prominent; marginal ridge bordered by a marginal groove on the mesocolpial side; polar cushions prominent grain size range (56 - 73.5 x 47.25 - 70µm), $\bar{X}$ = (67.72 x 60.44µm), and σ = (5.7 x 5.04µm); exine 1.75µm thick, exine surface uneven to reticulate (Figs. 5-6 & 15-17)

***Careya arborea*, Roxb.**

It is a large deciduous tree with yellowish-white flowers, large, obovate leaves and large, globular-fruits. For the present study material was collected from Muvattupuzha, Ernakulam district. Pollen grains 3-zonocolporate; syncolpate; spheroidal in lateral view and 3-lobed in polar view; grain size range (52.5 - 59.5 × 52.5- 59.5µm), $\bar{X}$ = 57.05 × 56.87µm, and σ = (2.59 x 2.45); exine 1.62µm thick; polar caps absent; colpus margin costate or marginal ridge present and is bordered on the mesocolpial side by marginal groove; colpus membrane bears two rows of gemmate-verrucose sculptural elements on either side of the endoaperture and these verrucae reduced to a single row towards the polar region; endoaperture, lolongate; exine surface, plated, plates of various sizes and shapes; general surface mildly plated or reticulate. (Figs. 7-8 & 18-19).

***Couropita guianensis*, Aublet.**

This is the cannon-ball tree which is a medium sized tree with large flowers which are cauliflorous and large spherical, indehiscent -fruits. The material for the present study was obtained from Kothamangalam, Ernakulam district. Pollen grains 3-zonocolporate; prolate-spheroidal in lateral view and triangular to circular in polar view; endoaperture, lolongate; colpus long with acute ends and surface smooth; grain size range (28 - 35 × 21- 28.0µm), $\bar{X}$= (30.62 × 25.79µm), and σ = (2.45 x 2.59); exine 1.75µm thick, exine surface granulate, granules minute. (Figs. 9-10 & 20-21).

DISCUSSION

Lecythidaceae is palynologically a heterogeneous group. All the five species studied in the present investigation is 3-zonoaperturate and shape of pollen grains differ from prolate, prolate- spheroidal to spheroidal. The pollen grains in all species of *Barringtonia* and *Careya arborea* are large in size. The three species of *Barringtonia* are 3-zonosyncolpate; two of them, *B.acutangula* and *B.racemosa* without clear endoaperture, while *B.asiatica* is 3-zonosyncolporate with lolongate endoaperture. In *Couropita guianensis* on the other hand the pollen grains are typically 3-zonocolporate and comparatively smaller in size.

The aperture in *Careya* is similar to that of *B.asiatica* but the apertural membrane bears two rows of gemmate-verrucose sculptural elements, flanking the underlying endoaperture and called apertural verrucae. *B.asiatica* also has apertural verrucae on the membrane but less conspicuous. The endoapertures bordered by prominent marginal ridges has been observed in *B.asiatica* and *Careya*. The marginal ridges are bordered on their mesocolpial side by marginal grooves. In the polar region the exine is much thickened and forms the so called polar cushions. The exine ornamentation in *Barringtonia* and *Careya* has been observed to be of the

macroreticulate type while this in *Couropita* is minutely-granulate. The pollen of Lecythidaceae studied can be divided into two main types, the first type including the species of *Barringtonia* and *Careya* and the second type consisting of *Couropita* which are described as the *Planconia* type and *Lecythis* type respectively by (Erdtman, 1952; Muller, 1972 & 1973). Lecythidacea is a family which was a subject of much controversy regarding its taxonomic position inter- and intrafamily relationships etc. The family was previously placed in Myrtaceae and then close to Myrtaceae based on the shared occurrence of separate petals, numerous stamens, and a syncarpous inferior ovary with axile placentation(Miers, 1874). However Lecythidaceae can be clearly distinguished from typical Myrtales taxa based on their alternate leaves, bitegmic and tenuinucellar ovules, lack of intraxylary phloem and vestured pits in wood and a series of embryological features (Prance & Mori, 1979). These marked differences lead Cronquist (1981) to the conclusion that Lecythidaceae must be removed from Myrtales and placed in a separate order close to Theales and Malvales. More recent morphological results (Tsou, 1994) and molecular sequence data (Morton *et al* ., 1997; Anderberg *et al* ., 2002; Schonenberger *et al* ., 2005) support the Theales link and place the family in the enlarged Ericales sensu APG (APG II, 2003). The syncolporate pollen grains of some members of Lecythidaceae, (the *Planconia* type) shows similarity to the similar condition in some of the Myrtaceous members. But the exine ornamentation, pollen shape thinner exine and other apertural features differ from Myrtaceae and do not indicate close relationships between the two families. Other than Myrtaceae the pollen does not have similarity to any other myrtallean members. The present study also justifies the separation of the family from Myrtales and its inclusion in a separate order as evidenced from earlier studies on morphology and molecular sequencing.

Conclusion

Lecythidaceae is much diverse regarding the pollen morphology. All the species presently studied have 3-zonoaperturate pollen grains but have different apertural structure showing syncolpate, syncolporate and colporate condition. The members of the family studied can be divided into two types based on the size of the pollen, apertural features and exine ornamentation. The first type including the three species of *Barringtonia* and *Careya* and the second type is *Couropita* comparable to the *Planconia* type and *Lecythis* type proposed by Erdtman(1952). The family has been much discussed regarding the taxonomic position and inter- and intra-family relationships. Even though the syncolporate condtion of the pollen grains in *Planconia* type bears a superficial similarity to that of some Myrtaceous members, the aperture structure and other details does not indicate any close relationship between the two families.

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