

# The Origin and Diversification of Plant Family Dipterocarpaceae

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## Abstract

The Dipterocarpaceae plant family, that shows a disjunct distribution in Gondwanan continents and Southeast Asia, is a dominant constituent of the tropical rain forests of Southeast Asia. The high species diversity of Dipterocarpaceae in SE Asian rain forests suggests its origin from SE Asia. However, its fossil history is much younger, from Oligocene, from the region. Based on the pollen fossil records from the late Cretaceous-early Paleogene sedimentary sequences of Indian subcontinent and the contemporaneous distribution of its extant taxa, evolutionary history of Dipterocarpaceae has been traced. The study suggests a West Gondwanan origin for this family. Present study also provides first evidence of Dipterocarpaceae genus *Vateriopsis* (endemic in Seychelles) type fossil pollen record from the late Cretaceous and early Palaeogene sedimentary sequences of western Indian margin.

## Keywords

Fossil, *Vateriopsis*, Pollen, Cretaceous, Dipterocarpaceae

## 1. Introduction

Dipterocarpaceae, an economically important arborescent family distributed in SE Asian tropical regions, is important for the production of timber, camphor and resins. There exist a lot of opinions about its systematic classification [1]. The family is subdivided into three subfamilies: 1) Monotoideae, restricted to Africa, Madagascar and South America; 2) Pakaraimoideae, endemic to South America; 3) Dipterocarpoideae, distributed in SE Asia [2]. Except the two genera, *Pseudomonotes* and *Marquesia*, the representatives of Monotoideae distributed across Africa and Madagascar cultivate in seasonally dry forests. Whereas

members of Pakaraimoideae and Dipterocarpoideae subfamilies prefer lowland rain forest. It has been found that various species of Dipterocarpoideae have the adaptability to seasonally wet and aseasonal perhumid tropical regions of SE Asia [1]. Due to more plasticity in the climatic adaptive nature, members of Dipterocarpoideae exhibit greater species diversity compared to the other two subfamilies. The family is disseminated across continents following a strict disjunct distribution pattern which raises a question of its place and time of origin. Dipterocarpoideae clade dominates in SE Asia and almost 80% of its diversity has been found to occur in wet forest of SE Asia particularly in Western Malaysia (Borneo), and hence SE Asia was considered to be its centre of origin [3]. There are two plausible hypotheses proposed for the evolutionary history and biogeography of the family Dipterocarpaceae. One hypothesis supports a SE Asian origin (Into India hypothesis). The other suggests a Gondwanan origin (Out of India hypothesis) [3]. In the present study, we are trying to assess both biogeographic hypotheses based on fossil data.

## 2. Material and Method

Studied samples were collected from three sites: 1) Late Cretaceous infratrappean bore core samples from Yeotmal region, Maharashtra; 2) Late Cretaceous intertrappean samples from Gowmukh area, Madhya Pradesh; 3) Early Palaeogene (Danian) samples from Gurha lignite mine, Bikaner region, Rajasthan. For comparison purposes, extant flower buds of *Vateriopsis* collected from Seychelles were acetolysed for pollen study and the extant pollen were compared with the fossil palynomorphs.

## 3. Results

The current study finds the presence of *Vateriopsis* type pollen fossil from the Upper Cretaceous and Lower Palaeogene deposits of intertrappeans of central India and Bikaner Basin, Rajasthan, India, respectively. This study also documents the variety of *Dipterocarpus* type pollen fossils from the Upper Cretaceous of infratrappeans and intertrappeans of Maharashtra and Madhya Pradesh, central India, and the Lower Paleogene of Bikaner Basin, Rajasthan, western India.

## 4. Discussion and Conclusion

The Late Cretaceous *Vateriopsis* and *Dipterocarpus* type fossil pollen records suggest the Out of India hypothesis. *Dipterocarpus* type fossil pollen is recovered from the Indian Upper Cretaceous, the time when Indo-Seychelles plate was in surficial contact with Africa [4]. The distance between Asia and India during the Late Cretaceous was too large and could not facilitate the dispersal of the family. The presence of *Vateriopsis* type fossil pollen in Indian Lower Paleogene is the time just before the separation of Indo-Greater Somalasia from Seychelles [4]. The present distribution of *Vateriopsis* in Seychelles suggests its migration from

India. Moreover, the presence of possible *Dipterocarpus* fossils from Africa [1] [5], a continent where only Monotes is found in the present day, also strongly indicates the diversification of the family on Gondwanan landmass. Our consent of Out of India hypothesis for Dipterocarpaceae dispersal in SE Asia is much more strengthened by the presence of polycadinene resin in the Upper Eocene of Myanmar which was a part of Indian plate before its collision to Asia [6]. This suggests that the family might have migrated to Asia after the contact between India and Asia was established.

Furthermore the sharing of ectomycorrhizal symbiotic relation between Dipterocarpaceae and Sarcolaenaceae, a family endemic to Madagascar in present time, signifies that both families share a common ancestor [7]. The previously stated fact and the only Miocene fossil record of Sarcolaenaceae from Africa [8] imply that the diversification of the families should have occurred on the Gondwana landmass before the separation of Madagascar from India-Seychelles block.

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### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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