

POLLEN MORPHOLOGY AND PHYLOGENY OF INDIAN EBENACEAE

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ABSTRACT

Pollen morphology of twenty four species belonging to *Diospyros* and *Euclea* distributed in India has been investigated. Besides, the affinities of Ebenaceae with Styracaceae, Symplocaceae and Sapotaceae, the palynology has also provided the clues as to the merging of the above two genera.

INTRODUCTION

Three genera, viz., *Diospyros*, *Euclea* and *Lissocarpus* together constitute the family Ebenaceae. The total strength of the family is marked by about five hundred plant species distributed in tropics throughout the world (CLARK, 1882). SANTAPAU AND HENRY (1973) have reported forty four species of the genus *Diospyros* from India. The members are mostly trees but rarely shrubs. The systematic treatment of this family was first given by ENGLER (1912) who placed it under Ebenales along with Sapotaceae, Symplocaceae and Styracaceae for the sympetalous nature in common. HUTCHINSON (1967) also treated this family under Ebenales but together with Sapotaceae and Sarcospermaceae. WETTSTEIN (1935), however, followed Engler's combination of families but treated them under Diospyrales.

The palynological information of Ebenaceae is very scanty and scattered. SELLING (1946) studied the palynology of *Diospyros ferra* sub sp. *sandwicensis* and found tricolporate, prolate, prolate-spheroidal with minutely granular texture. ERDTMAN (1952) has reviewed the palynological literature and found that the pollen grains are 3-colporate with obscure (sub-reticulate) pattern in both *Diospyros* and *Maba*. IKUSE (1956) observed 3-colporate with fine reticulate pattern in *Diospyros kaki* var. *domestica*. GUINET (1962) has studied the pollen grains of *Diospyros chloroxylon* Roxb. and reported that in prolate (Longiaxe) grains the Os is lolongate whereas, in the oblate (Breviaxe) grains the Os is lalongate. BONNEFILLE (1971), while studying the arborescent species of Ethiopian montane forest, has described the pollen of *Euclea kellan* Hochst. as tricolporate and subtriangular.

MATERIAL AND METHOD

The polliniferous material for present study was procured from Herbarium of Forest Research Institute, Dehradun (DD). The method of acetolysis and terminology used here is in accordance with ERDTMAN (1943, 1952). The abbreviation used here for the above herbarium has been taken from the Index Herbariorum (1954). The pollen diagnoses were carried out under optical microscope (Olympus microscope with a highest magnification of 100×15). The size measurements are based on random selection of 20-50 pollen grains per species.

We acknowledge our sincere thanks to the Director, Forest Research Institute, Dehra Dun for according permission to collect polliniferous material from the herbarium.

DESCRIPTION OF POLLEN GRAINS

Ebenaceae is characterized by 3-colporate, sub-prolate, prolate and prolate-spheroidal pollen grains. Amb sub-circular, sub-triangular and triangular. The position of aperture

is generally angular. Colpi are mostly long, thin and Ora are lalongate with irregular margins. The sexine is largely comprised of obscure pattern. Exine is tenuimarginate.

Diospyros bourdilloni Brandis (Pl. 1, Figs. 9-10)

(Ranger, sheet no. 94016, DD)

Pollen grains 3-colporate, sub-prolate ($37.2 \times 32.3 \mu\text{m}$), range $36.0-40.0 \times 27.0-35.0 \mu\text{m}$. Amb \pm triangular. Colpi membrane \pm psilate. Apocolpium diameter about $5.0 \mu\text{m}$ and mesocolpium distance about $15.0 \mu\text{m}$. Ora lalongate, thin, small ($1.5 \times 6.0 \mu\text{m}$) and membrane psilate. Exine about $1.5 \mu\text{m}$ thick. Sexine thinner than nexine. Nexine \pm two times thicker than sexine. Sexine pattern obscure.

Diospyros brandisiana Kurz (Pl. 1, Fig. 8)

(Sukoc, sheet no. 55068, DD)

Pollen grains 3-colporate, prolate ($46.0 \times 32.5 \mu\text{m}$). Amb triangular. Colpi long, thin, running from pole to pole. Apocolpium diameter about $2.5 \mu\text{m}$ and mesocolpium distance about $17.5 \mu\text{m}$. Ora lalongate. Exine about $2.0 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern obscure.

Diospyros candolleana Thw. (Pl. 1, Fig. 11)

(Braganza, sheet no. 598/110685, DD)

Pollen grains 3-colporate, sub-prolate ($36.3 \times 30.0 \mu\text{m}$), range $35.0-38.0 \times 25.0-32.5 \mu\text{m}$. Angulo-aperturate. Amb triangular. Colpi long, thin, running from pole to pole, membrane psilate. Apocolpium indistinct and mesocolpium distance about $12.0 \mu\text{m}$. Ora lalongate, small. Exine about $1.5 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern obscure.

Diospyros chloroxylon Roxb. (Pl. 3, Figs. 7-8)

(H. H. Haines, sheet no. 20933, DD)

Pollen grains 3-colporate, prolate-spheroidal ($32.5 \times 25.0 \mu\text{m}$). Anguloaperturate. Amb sub-triangular. Colpi long, thin, running almost from pole to pole and membrane ornamented (granulate). Maximum width of colpus is about $1.5 \mu\text{m}$. Apocolpium $3.0 \mu\text{m}$ and mesocolpium about $12.0 \mu\text{m}$. Ora lalongate $2.5 \times 10.0 \mu\text{m}$, membrane granulate. Exine about $2.0 \mu\text{m}$ thick. Sexines slightly thinner than nexine. Sexine pattern granulate.

Diospyros cordifolia Roxb. (Pl. 1, Figs. 6-7)

(R. N. Singh, sheet no. 112562, DD)

Pollen grains 3-colporate, prolate ($40.5 \times 28.5 \mu\text{m}$), range $35.0-42.5 \times 25.0-32.5 \mu\text{m}$. Parasyncolpate. Colpi long, membrane psilate. Apocolpium diameter about $6.0 \mu\text{m}$ and mesocolpium distance about $12.0 \mu\text{m}$. Ora lalongate. Exine about $1.5 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern \pm obscure.

Diospyros crumenata Thw.

(Parkinson, sheet no. 166/16182, DD)

Pollen grains 3-colporate, prolate ($45.0 \times 37.5 \mu\text{m}$). Colpi long, running from pole to pole with psilate membrane. Ora more or less circular. Exine about $2.0 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern \pm obscure.

Diospyros densiflora Wall. (Plate 3, Figs. 1-2)

(Sukoe, sheet no. 91897, DD)

Pollen grains 3-colporate, prolate ($35.2 \times 23.0 \mu\text{m}$), range $32.5-37.5 \times 20.0-27.5 \mu\text{m}$. Amb sub-triangular. Colpi long, thin, running almost from pole to pole. Colpi margins slightly uneven and membrane ornamented. Maximum width of colpus about $3.0 \mu\text{m}$. Apocolpium diameter about $6.0 \mu\text{m}$ and mesocolpium distance about $16.0 \mu\text{m}$. Ora equatorially elongated ($3.0 \times 11.0 \mu\text{m}$), membrane ornamented. Exine thickness about $2.0 \mu\text{m}$. Sexine thinner than nexine. Sexine pattern \pm obscure.

Diospyros ebenum Koen. (Plate 3, Figs. 9-10)

(Sheet no. 13047, DD)

Pollen grains 3-colporate, sub-prolate ($32.0 \times 24.0 \mu\text{m}$). Colpi long, thin, running from pole to pole with psilate membrane. Ora lalongate with psilate membrane. Exine about $2.0 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern obscure.

Diospyros ehretioides Wall. (Pl. 1, Figs. 4-5)

(C. B. Smales, sheet no. 4326, DD)

Pollen grains 3-colporate, sub-prolate ($40.0 \times 33.5 \mu\text{m}$), range $37.5-45.0 \times 30.0-37.5 \mu\text{m}$. Amb sub-circular. Colpi long, thin running from pole to pole. Colpi membrane uneven and ornamented. Apocolpium diameter not distinct and mesocolpium distance about $18.0 \mu\text{m}$. Ora lalongate ($3.7 \times 7.0 \mu\text{m}$) with irregular margins, membrane psilate. Exine about $2.0 \mu\text{m}$ thick. Sexine pattern obscure.

Diospyros excsulpta Buch.—Ham. (Pl. 2, Figs. 3-4)

Syn. *D. tomentosa* Roxb.

(Mayat, sheet no. 23707, DD)

Pollen grains 3-colporate, sub-prolate ($43.1 \times 35.8 \mu\text{m}$), range $40.0-50.0 \times 30.0-42.0 \mu\text{m}$. Amb sub-circular. Colpi long, running from pole to pole. Maximum width of colpus about $2.0 \mu\text{m}$. Ora lalongate, membrane indistinct. Exine about $1.5 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern obscure.

Diospyros fasciculosa Muell. (Pl. 3, Figs. 18-19)

Syn. *Maba fasciculosa* Muell. ex Benth.

(B. L. Gupta, sheet no. 39985, DD)

Pollen grains 3-colporate, sub-prolate ($35.5 \times 27.0 \mu\text{m}$), range $32.5-37.5 \times 25.0-27.5 \mu\text{m}$. Anguloaperturate. Amb \pm triangular. Colpi long, streaky, margins wavy and membrane ornamented. Apocolpium not distinct. Mesocolpium about $12.0 \mu\text{m}$. Ora lalongate ($4.5 \times 8.0 \mu\text{m}$), membrane ornamented. Exine about $2.0 \mu\text{m}$ thick. Sexine as thick as nexine. Sexine pattern obscure.

Diospyros foliolosa Wall. (Pl. 3, Figs. 14-16)

(Sheet no. 13048, DD)

Pollen grains 3-colporate, prolate-spheroidal ($40.0 \times 35.0 \mu\text{m}$), sub-prolate ($40.0 \times 30.0 \mu\text{m}$). Anguloaperturate. Amb triangular. Colpi long, thin, running almost from pole to pole with granulate membrane and uneven margins. Maximum width of colpus about $2.5 \mu\text{m}$. Apocolpium diameter about $4.0 \mu\text{m}$ and mesocolpium distance about $12.0 \mu\text{m}$. Ora lalongate ($2.5 \times 10.0 \mu\text{m}$), rarely dumb-bell shaped with psilate membrane. Exine about $2.0 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern \pm obscure.

Diospyros glandulosa Lace (Pl. 1, Figs. 1-3)

(M. B. Raizada, sheet no. 74172, DD)

Pollen grains 3-colporate, sub-prolate ($40.0 \times 30.2 \mu\text{m}$), range $38.0--42.0 \times 28.0--32.0 \mu\text{m}$. Angulo-aperturate. Amb sub-triangular. Colpi long, thin and running almost from pole to pole. Maximum colpus width about $3.0 \mu\text{m}$ and mesocolpium about $18.0 \mu\text{m}$. Ora lalongate ($3.5 \times 10.5 \mu\text{m}$), membrane psilate. Exine about $2.5 \mu\text{m}$ thick. Sexine slightly thinner than nexine. Sexine pattern obscure.

Diospyros lotus Linn. (Pl. 3, Figs. 11-13)

(Sheet no. 16357, DD)

Pollen grains 3-colporate and rarely 4-colporate, prolate. Colpi long, thin, running from pole to pole, with psilate membrane. Ora not distinct. Exine about $2.0 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern obscure to granulate.

Diospyros marmorata Parker (Pl. 2, Figs. 10-12)

(Kirat Ram, sheet no. 65725, DD)

Pollen grains 3-colporate, sub-prolate ($34.7--26.2 \mu\text{m}$), range $32.5--37.5 \times 25.0--30.0 \mu\text{m}$. Amb sub-triangular. Colpi long, thin, running from pole to pole. Maximum width of colpus about $3.0 \mu\text{m}$, membrane psilate. Ora lalongate ($2.5 \times 8.0 \mu\text{m}$), membrane psilate. Exine about $2.0 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern obscure.

Diospyros melanoxyton Roxb. (Pl. 2, Figs. 7-8)

(Donald, sheet no. 31870, DD)

Pollen grains 3-colporate, sub-prolate ($43.7 \times 34.9 \mu\text{m}$), rarely prolate-spheroidal ($42.5 \times 37.5 \mu\text{m}$). Angulo-aperturate. Amb sub-circular. Colpi long, thin, running from pole to pole. Maximum width of colpus about $1.5 \mu\text{m}$. Colpi membrane ornamented. Apocolpium diameter not distinct, mesocolpium distance about $16.6 \mu\text{m}$. Ora lalongate ($2.5 \times 10.0 \mu\text{m}$), with psilate membrane. Exine about $2.0 \mu\text{m}$ thick but thicker at the equator ($3.0 \mu\text{m}$). Sexine slightly thinner than nexine. Sexine pattern obscure.

Diospyros montana Roxb. (Pl. 1, Fig. 12 ; Pl. 2, Figs. 5-6)

(Syn. *D. bracteata* Roxb.)

(Ba Pe, sheet no. 46292, DD)

Pollen grains 3-colporate, sub-prolate ($38.3 \times 31.5 \mu\text{m}$), range $30.0--42.0 \times 25.0--34.0 \mu\text{m}$. Anguloaperturate. Amb triangular. Colpi long, thin, running from pole to pole, membrane psilate. Apocolpium diameter not distinct and mesocolpium distance about $20.0 \mu\text{m}$. Ora lalongate, small ($1.5 \times 5.0 \mu\text{m}$), membrane psilate. Exine about $2.0 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern obscure.

Diospyros nigrescens (Dalz.) Saldhanha (Pl. 3, Fig. 20)

(Syn. *Maba nigrescens* Dalz.)

(N. L. Bor., sheet no. 81376, DD)

Pollen grains 3-colporate, prolate-spheroidal ($35.0 \times 34.0 \mu\text{m}$). Colpi long, streaky with psilate membrane. Ora lalongate, margins irregular and membrane psilate. Sexine as thick as nexine. Sexine pattern obscure.

Diospyros nigricans Wall. (Plate 3, Fig. 17)

(U. Kanjilal, sheet no. 19594, DD)

Pollen grains 3-colporate, prolate-spheroidal ($31.5 \times 27.5 \mu\text{m}$), range $30.0-34.0 \times 25.0-30.0 \mu\text{m}$. Amb \pm circular. Colpi long, thin, running from pole to pole with psilate membrane. Maximum width of colpus about $1.5 \mu\text{m}$. Ora lalongate ($2.0 \times 6.0 \mu\text{m}$) with psilate membrane. Exine about $1.5 \mu\text{m}$ thick. Sexine as thick as nexine. Sexine pattern psilate.

Diospyros nilagirica Bedd. (Pl. 3, Figs. 5-6)

(Bourdellon, sheet no. 6867, DD)

Pollen grains 3-colporate, sub-prolate ($35.0 \times 28.0 \mu\text{m}$). Amb sub-circular. Colpi long, thin, running from pole to pole, margins uneven with psilate membrane. Maximum width of colpus about $1.5 \mu\text{m}$. Mesocolpium $16.0 \mu\text{m}$. Ora lalongate with psilate membrane. Exine about $2.0 \mu\text{m}$ thick. Sexine as thick as nexine. Sexine pattern psilate.

Diospyros pyrrocarpa Miq. (Pl. 2, Fig. 9)

(Parkinson, sheet no. 16542, DD)

Pollen grains 3-colporate, sub-prolate ($45.0 \times 38.7 \mu\text{m}$) range $37.5-45.0 \times 25.0-35.0 \mu\text{m}$. Colpi long, thin (streaky), about $1.0 \mu\text{m}$ in width, membrane psilate. Apocolpium diameter about $6.0 \mu\text{m}$ and mesocolpium about $17.0 \mu\text{m}$. Ora lalongate ($2.5 \times 10.0 \mu\text{m}$) with psilate membrane. Exine about $2.5 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern obscure to psilate.

Diospyros sylvatica Roxb. (Pl. 3, Figs. 3-4)

(H. H. Haines, sheet no. 20928, DD)

Pollen grain 3-colporate, prolate-spheroidal ($30.5 \times 28.5 \mu\text{m}$), range $30.0-32.5 \times 27.5-30.0 \mu\text{m}$. Amb sub-circular. Colpi thin, long, running from pole to pole, membrane ornamented (granulate). Maximum width of colpus about $1.5 \mu\text{m}$ thick. Exine about $2.0 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern psilate to obscure.

Diospyros wallichii King & Gamble (Pl. 2, Figs. 1-2)

(Sukoe, sheet no. 55067, DD)

Pollen grains 3-colporate, sub-prolate ($46.2 \times 37.2 \mu\text{m}$), range $42.5-50.0 \times 32.5-40.0 \mu\text{m}$. Anguloaperturate. Amb triangular. Colpi long, thin, running from pole to pole, membrane ornamented. Maximum width of colpus about $3.0 \mu\text{m}$. Apocolpium not distinct, mesocolpium distance about $20.0 \mu\text{m}$. Ora lalongate ($4.0 \times 8.0 \mu\text{m}$), membrane psilate. Exine about $2.0 \mu\text{m}$ thick. Sexine thinner than nexine. Sexine pattern obscure to granulate.

Euclea undulata Thunb.

(M. B. Raizada sheet no. 74464, DD)

Pollen grains 3-colporate, prolate-spheroidal ($22.5 \times 20.5 \mu\text{m}$). Colpi long, thin, running from pole to pole, margins wavy with psilate membrane. Ora lalongate, membrane psilate. Exine about $2.0 \mu\text{m}$ thick. Sexine as thick as nexine. Sexine pattern psilate.

DISCUSSION AND CONCLUSION

The palynological studies of Ebenaceae has revealed that it is a stenopalynous family. The chief type of aperture met within this family is 3-colporate with long, thin colpus and lalongate os. Sexine pattern varies from psilate to obscure and rarely granulate.

There is no major palynological difference between *Diospyros* and *Euclea*. Ebenaceae, being a stenopalynous family, the palynological diversification stops at the family level. Thus palynology offers an indirect support to the merger of these genera.

Pollen morphology does provide positive clues as to the affinities of Ebenaceae with Styracaceae, Symplocaceae and Sapotaceae. Nevertheless, Symplocaceae differs from Ebenaceae in having brevicolpate condition whereas, Sapotaceae differs in having additional apertural types (GUPTA & SHARMA, 1977 ; SHARMA & GUPTA, 1978). The close palynological relationship amongst four families supports ENGLER's (1912) classification grouping them under Ebenales.

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All magnifications $\times 1000$

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PLATE III

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