A New Petrified Pentacarpellary Flower "Kapgateanthus Intertrappea" from the Deccan Intertrappean Beds of Mohgaonkalan, M. P. India.

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Abstract: The present paper deals with a new dicot fossil flower reported from the Deccan Intertrappean Beds of Mohgaonkalan, M.P., India. The present flower from its oblique transverse section appears to be the medium in size among the flowers reported from the Deccan Intertrappean series. It is 2.20 X 2.35 mm in diameter at middle and 1.50 X 1.65 mm in diameter towards basal region, globular in shape. Swollen at middle and tapering at its ends indicate its companulate shape. The flower is ebractiate and ebractiolate, actinomorphic, unisexual, pentamerous, polytepalous and hypogynous. Gynoecium is pentacarpellary, syncarpous with superior, pentalocular ovary. The fossil flower under consideration shows that it does not have any affinities to fossil specimens described so far from Deccan Intertrappean beds. As, the present flower shows no. of important character close to family Amborellaceae but not with the genus of same family in toto. Hence, the fossil flower kept under family Amborellaceae as a separate genus and it is named as *Kapgateanthus intertrappea* gen. et sp. nov. Affinities of the flower are discussed.

KEYWORDS:- Fossil, Late Cretaceous (Maastrichtian) dicot, unisexual pistillate flower, Amborellaceae; Deccan Intertrappean; Mohgaonkalan.

INTRODUCTION:-

Number of fossil flowers have been recovered from the black silicified cherts of Mohgaonkalan, Chhindwara District, Madhya Pradesh, India. Apart from monocot flowers, a number of dicot flowers namely ***Sahnianthus*** (Shukla, 1943 [29]; 1944[30]; Chitaley, 1955[2]); ***Sahnianthus parijai*** (Shukla, 1948[31]; Dwivedi and Shukla, 1958[12]; Paradkar & Senad, 1984[23]; Sakundarwar et al., 2012[26]); ***Sahnianthus dinecterium*** (Shukla, 1958[33]; Dayal, 1967[9]); ***Sahnipushpum*** (Shukla, 1950[32]); ***Sahnipushpum glandulosum*** (Prakash, 1955[24]); ***Sahnipushpum shukla*** (Verma, 1956[35]; Prakash & Jain, 1964[25]; Chitaley, 1964[3]; Ambwani et al., 2001[1]; Kapgate et al., 2011[17]); ***Chitaleypushpum mohgaoense*** (Paradkar, 1971[22]; Kokate et al., 2011[20]); ***Deccananthus savitrii*** (Chitaley & Kate, 1972[4]); ***Raoanthus intertrappea*** (Chitaley & Patel, 1975[5]); ***Flosfemia intertrappea*** (Kar et al., 2003[11]); ***Flosvirulis deccanensis*** (Kar et al., 2003[11]); ***Mohgaonthus deccanii*** (Dixit, 2003[10]); ***Chenopodioanthus mohgaoense*** (Kapgate et al., 2006[18]); ***Tetranplasandranthus deccanii*** (Kapgate et al., 2009[19]) are recorded. The present dicot fossil flower is distinct from all the known records because of strangely pentalcarpellary, pentalocular ovary and describe here with in detail.

MATERIAL AND METHOD:-

The specimen of this flower was collected from the Deccan Intertrappean beds of Mohgaonkalan, M.P., India. The specimen is cut and exposed in obliquely transverse for revealing xylotomical characters. Peel sections are taken after etching with hydrofluoric acid and thoroughly washed with water (Darrah, 1936[8]; Joy et al., 1956[16]; Stewart and Tylor, 19653[34]; Holmes and Lopez, 1986[14]; Kapgate et. al., 2011[17]).The peels were mounted in DPX mountant and photographed. The camera lucida sketches of the slides were drawn for detailed study of flower cut in transverse plane. Preservation is good, serial peel sections were taken to study anatomical details. The description is based on the study of both the surface of the specimen i.e. part and counterpart.

DESCRIPTION:- Flower morphology:-

The present flower from its oblique transverse serial sections appears to be the medieum in size form amongst the known flowers reported from the Deccan Intertrappean series. It is 1.20 X 1.25 mm in diameter at apical region, 2.20 X 2.35 mm in diameter at middle and 1.50 X 1.65 mm in diameter towards basal region, globular in shape (Text Figs.4,5; Plate-Ia, Figs. 3-6). Swollen at middle and tapering at its ends indicate its companulate shape. The flower is ebractiate and ebractiolate, actinomorphic, unisexual, pentamerous, polytepalous and hypogynous. The perianth are five in numbers. Gynoecium is

pentacarpellary, syncarpous with superior, pentalocular ovary. Each locule contains two ovules in it with parietal-septate placentation. Ovary wall is hairy and pentangular (Text Fig. 9; Plate- Ib Fig.18).

Pedicel:-

Pentangular, 0.4 mm thick, consists of thin walled, rounded to hexagonal cells of parenchyma and cental vascular tissues (Text Fig.7; Plate-Ia Fig.12).

Thalamus:-

The floral parts based on the thalamus, because the section cut obliquely transversed the diameter of thalamus section is not possible to measure properly. It is made up of thick walled parenchymatous hexagonal ground tissue bounded by single layered epidermis, numerous vascular bundles are seen in the tissue of thalamus (Text Fig. 6; Plate-Ia Figs.9-11). It might be vascular tissue of floral parts.

Bracts & Bractioles:- Is not observed.

Perianth:-

Perianth consists of five tepal members, free, uniseriate, arranged in one whorl showing polytepalous condition of the flower, somewhat equal in size and arranged at the equal distance; from the centre of the flower giving actinomorphic appearance, aestivation is valvate type. (Text Figs.1-5; Plate-Ia, Figs.1-11). Each lobe is swollen at middle and tapering at its ends and folded inwards measuring 1.45 to 1.65 mm broad and 160 µm thick and is made up of 1 to 2 layered thin walled parenchymatous cells bounded by epidermis. At central region the perianth lobes are multilayered somewhat bigger cells of parenchyma with few vascular elements, broad and thick at the base (Text Fig.8; Plate-Ib Fig.13).

Androecium:-

Serial peel sections were taken from both part and counterpart. After observing and studying both the surfaces of the specimen i.e. part and counterpart there is no observation of androecieum.

Gynoecium:-

Gynoecieum is sessile, hairy consisting of style, stigma and ovary. Ovary is pentacarpellary, pentalocular, matured, superior, pentangular in shape measuring 0.90 to 1.00 mm in diameter (Text Fig.9; Plate-Ib Fig.18). Cellular details of ovary wall, central axis, septa, funicle are clearly visible. The ovary wall measures 30 µm in thickness made up of 1 to 3 layered parenchyma tissue. The outer single layered epidermis of the ovary wall consists of hairy outgrowths, hairs are long in size measures 60 µm in length (Text Fig.9; Plate-Ib Fig.18). Pentalocular ovary consists of each locule is equal in size, elongated to oval, angular in shape and measures 380 to 420 µm in length and 240 to 260 µm in thickness and consisting of two ovule in each locule. Septum is thin, 300 to 340 µm in length and 20 µm in thickness and made up of thin walled parenchymatous cells having vascular elements, separating the five locules giving pentalocular nature to the ovary (Text Fig.6; Plate Ib Fig.18). The axis of the placenta is a circularr about 0.11 mm in diameter, consisting of a parenchymatous pith and a cortex region (Text Fig.9; Plate Ib Fig.18).As seen in a transverse section through the ovary, the two ovules in each locules occurs. The ovules are attached by a small placenta to the central axis of the flower indicating the axile placentation (Text Fig.9; Plate Ib Fig.18,19). Each ovule measures 200 to 220 X 65 to 70 µm in size and mature. (placentation (Text Fig.9; Plate Ib Fig.18,19)..The pentangular single short style arises from the ovary. It is pentangular in cross section, 0.55 mm in diameter (Plate Ia Figs.5,6). Style is short, pentangular and solid with centrally placed compact cells and vascular tissues. Single style is terminated by a five free stigma having expanded flanges, single stima measures 0.22 mm in size, made up of thick walled parenchymatous cells (Plate Ia Figs.2,3).

FLO. FORMULA:- Ebrl, Ebr□□□□□□□□□□□□P$_5$□A$_0$□G$_{(5)}$ ♀

DISCUSSION:-

As evident from the above description, the present flower shows following important characters-

- The present fossil flower characterized by medium in size and campanulate and folded inwards at both the end.
- Perianth lobes are five, polytepalous, pentamerous in single whorl, actinomorphic, valvate aestivation.
- Stamens are not observed giving unisexual female flower appearance.
- Gynoecium with pentacarpellary, pentalocular, syncarpous, superior ovary.
- Stigma having expanded flanges; style single, pentangular, short and solid.
- Ovary is pentalocular, pentangular with two ovule in each locule showing axile placentation and long hairs are present on ovary wall.

From the above characters it is clear that the flower is pentacarpellary, pentalocular, actinomorphic, pentamerous, unisexual female flower and hypogynous in nature. Perianth lobes are five, polytepalous, folded inwards at both end, valvate, pentamerous character of flower shows its dicotyledonous nature. Ovary is pentangular, hairy and fully mature, pentalocular with two ovules in each locule but there is no observation of male character i.e. androecieum indicating its unisexual female flower.

IDENTIFICATION:-

The present flower under consideration is compared with reported dicot flowers of the Deccan Intertrappean beds of India and the flowers of modern angiospermic taxa.

Comparison with reported dicot flowers-

The present flower is compared with the reported fossil flowers such as with *Sahanianthus* (Shukla, 1943[29]; 1944[30]; Chitaley, 1955[2]) *Sahanianthus parijai* (Paradkar and Senad, 1984[23]); *Sahanianthus dinecterium* (Shukla, 1958[33]; Dayal, 1967[9]); *Sahanipushpum* (Shukla, 1950[32]); *Sahanipushpum shuklai* (Verma, 1956[35]; Prakash & Jain, 1963[25]; Chitaley, 1964[3]; Ambwani et al., 2001[1]; Kapgate et. al., 2011[17]); *Sahanipushpum glandulosum* (Prakash, 1955[24]); *Chitaleypushpum mohgaoense* (Paradkar,1971[22]; Kokate et. al., 2011[20]); *Deccananthus savitrii* (Chitaley & Kate, 1972[4]); *Raoanthus intertrappea* (Chitaley & Patel, 1973[5]); *Mohgaonthus deccanii* (Dixit, 2003[10]); *Chenopodioanthus mohgaoense* (Kapgate et al., 2006[18]); *Tetranplasandranthus deccanii* (Kapgate et al., 2009[19]) all this reported flowers are separated from present flower because present flower is unisexual female flower but the reported flowers are bisexual in nature. It is also compared with unisexual flowers *Flosvirulis deccanensis* (Kar et al., 2003[11]); & *Flosfemia intertrappea* (Kar et al., 2003[11]); *Flosvirulis deccanensis* (Kar et al., 2003[11]); is unisexual male flower while the present flower is unisexual female flower. While *Flosfemia intertrappea* (Kar et al., 2003[11]); differs from present in having unisexual female flower with unilocular many seeded ovary but the present flower with pentalocular,with two seed in each locule. Thus the present flower is totally different from the reported fossil flowers.

Comparison with flowers of modern angiospermic taxa-

The most striking features of the fossil flowers described here are ebractiate and ebractiolate unisexual female flower, pentacarpellary, pentalocular, polytepalous with 5 tepal members, actininomorphic, hypogynous, ovary hairy, two ovules in each locule with axiles placentation. These features were of great help in assessing its affinities with modern families and finally assigning it a family to which it shows closest resemblances.

A critical study of the flower of dicotyledonous living families revealed that the character of present fossil flower collectively indicates its affinities with the family Amborellaceae, Fagaceae, Anacardiaceae, Euphorbiaceae, Sapindaceae, Cornaceae, (Cook, 1958[6]; Hooker, 1961[15]; Saldanha & Nicolson, 1978[27]; Mathew, 1981[21]).

The above families shows closer resemblances with the present specimen in unisexual nature of flower, polytepalous condition, gynoecieum syncarpous. Out of these families, fossil seeds shared most of the important characters with family Amborellaceae comprises the single genus Amborella but not in toto.

- **Fagaceae:-** The characters shared by these are; unisexual, polytepalous, actinomorphic, gynoecieum syncarpous, two ovules per locule (G - *Quercus*). But differs in having perianth number, ovary inferior, tetralocular, placentation axile, hairs are absent on ovary wall, the special character is the flower is involucerate, the involuceral bracts often fused forming a cupule (e.g. acorncap).

- **Anacardiaceae:-** The characters shared by these are; unisexual, polytepalous with 5 tepal members, actinomorphic, gynoecieum syncarpous with superior ovary (G - *Rhus*). But differs in having trilocular nature of ovary, hairs are absent on ovary wall and single ovule per locule.

- **Euphorbiaceae :-** The characters shared by these are; unisexual, polytepalous, actinomorphic, gynoecieum syncarpous with superior ovary (G - *Jatropa,* G - *Cnidoscolus*). But differs in having trilocular nature of ovary, placentation is apical-axile; single ovule per locule.

- **Sapindaceae:-** The characters shared by these are; unisexual, polytepalous, gynoecieum syncarpous with superior ovary (G -*Dodonaea*, G - *Acer*), actinomorphic (G - *Acer*). But differs in having bilocular ovary, symmetry zygomorphic (G - *Dodonaea*), hairs are absent on ovary wall and single ovule per locule, placentation apical-axile.

- **Cornaceae:-** The characters shared by these are; unisexual, polytepalous, pentacarpellary, actinomorphic, gynoecieum syncarpous with superior ovary (G - *Toricellia*) . But differs in having biseriate nature of perianth, because both calyx and corolla present hairs are absent on ovary wall and single ovule per locule, placentation marginal.

- **Amborellaceae:-** The characters shared by these families show closer resemblances with the present specimen in almost all the features such as unisexual, polytepalous with 5-8 perianth members in single whorl, 5-6 locular, actinomorphic, gynoecieum syncarpous with superior ovary, stigma having expanded flanges; placentation is parietal, pistils that are apically open (G - *Amborella*) except the absence of hairs on ovary wall and single ovule in each locule; stigma is directly attached on the top of ovary {there is no intermediate style, staminode 1-3 (rarely zero)}.

Thus, in general plan the fossil flower resembles the family Amborellaceae (Hooker, 1961[15]) in having polytepalous perianth members in single whorl, pentacarpellary, pentalocular, unisexual, gynoecieum syncarpous with superior ovary, placentation marginal. When compared with the single genus *Amborella* comprises from Amborellaceae family the fossil flower does not correlate in toto because the ovary have no hairs on ovary wall and single ovule per locule but in present specimen hairs are present on ovary wall and two ovules per locule.

Thus from above discussion it is clear that; - the fossil flower under consideration shows that it does not have any affinities to fossil specimens described so far from Deccan Intertrappean beds. As, the present flower shows no. of important character close to family Amborellaceae but not with the genus of same family in toto. Hence, the fossil flower kept under family Amborellaceae as a separate genus and it is named as ***Kapgateanthus intertrappea*** gen. et sp. nov. Generic epithet is given after an eminent paleobotanist Dashrath Kapgate, while the specific epithet is after Deccan Intertrapean beds from where the fossil specimen was collected.

DIAGNOSIS:-

Kapgateanthus gen nov.

The flower is pentacarpellary, pentalocular, polytepalous, actinomorphic, pentamerous, unisexual female flower and hypogynous in nature. Perianth lobes are five folded inwards. Pentamerous character of flower shows its dicotyledonous nature. Ovary pentangular, pentalocular, two seeds in each locule with axile placentation, ovary wall hairy.

Kapgateanthus intertrappea gen. et. sp. nov.

The present flower from its oblique transverse section appears to be the medieum in size among the flowers reported from the Deccan Intertrappean series. It is 1.20 X 1.25 mm in diameter at apical region, 2.20 X 2.35 mm in diameter at middle and 1.50 X 1.65 mm in diameter towards basal region, globular in shape. Swollen at middle and tapering at its ends indicate its companulate shape. The flower is ebractiate and ebractiolate, actinomorphic, unisexual, pentamerous, polytepalous and hypogynous. The perianth lobes are five in numbers arranged in single whorl i.e. uniseriate. The single whorl contains five

members may be termed as tepals. Stamens are not observed, so the flower is unisexual female flower. Gynoecium is pentacarpellary, syncarpous with superior, pentalocular ovary. Each locule contains two ovule in it with axile placentation. Ovary wall is hairy and pentangular consist of long hairs on ovary wall.

Holotype:- PAP/ Ang / Dflr-1. / Deposited at Botany Dept.

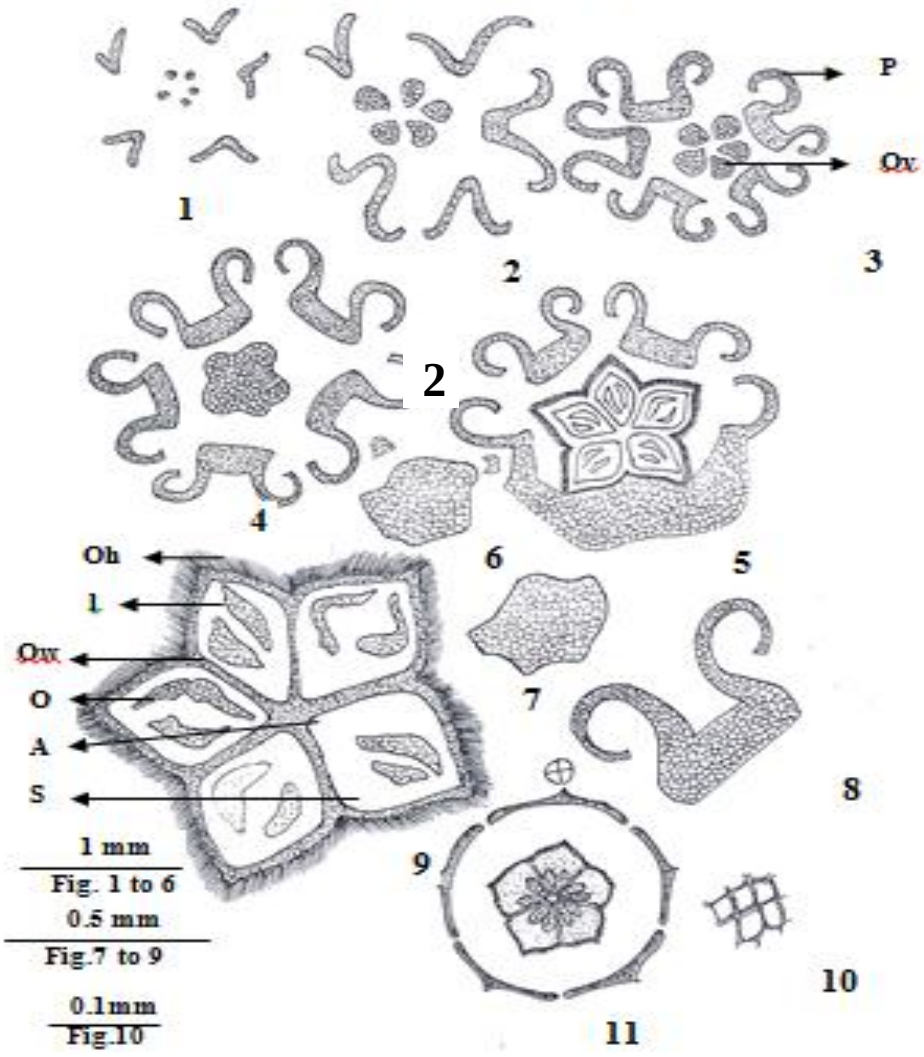
J.M. Patel College, Bhandara, M.S. India.

Horizone:- Deccan Intertrappean Series of India.

Locality:- Mohgaonkalan (M. P.)

Age :- Late Cretaceous (Maastrichtian)

Text Figs. 1 to 11



Kapgateanthus intertrappea gen. et. sp. nov.

• EXPLANATION OF TEXT FIGURES 1 to 11•

Figs.1-5 -Various stages of basal portion of Flower cut in obliquely transverse section exposed on fossiliferous chert showilng polytepalous perianth lobe (P) {fig.1-5} and pentalocular ovary (Ov) {fig.5}.

Fig.6 - T.S. of basal portion of flower showing thalamus.

Fig.7 - T.S. of basal portion of flower showing pentangular pedicel.

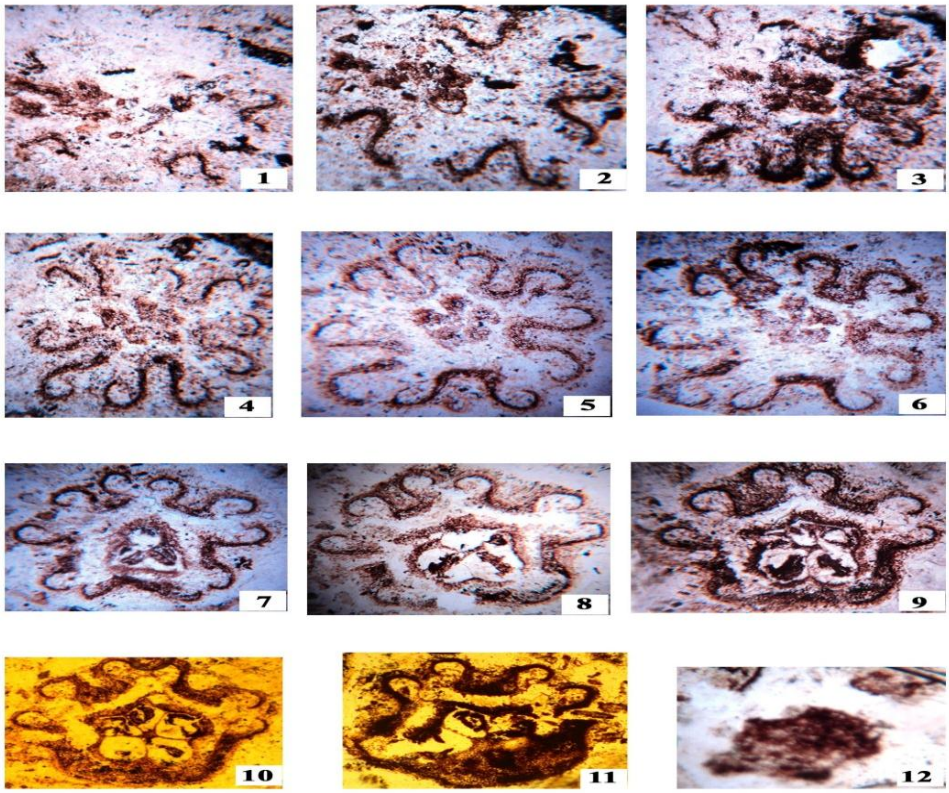
Fig.8 - Single perianth lobe with its tissue and vasculature.

Fig.9 - T.S. of pentalocular ovary showing with its detail showing ovary wall (Ow), two ovule in each locule (O); ovary wall with hairs (Oh); locule (l), central axis (A), septa (S) & attachment of ovule with axile placentation (p).

Fig.10 - Hexagonal cells of thalamus.

Fig.11 - Floral diagram of flower.

PLATE – I a

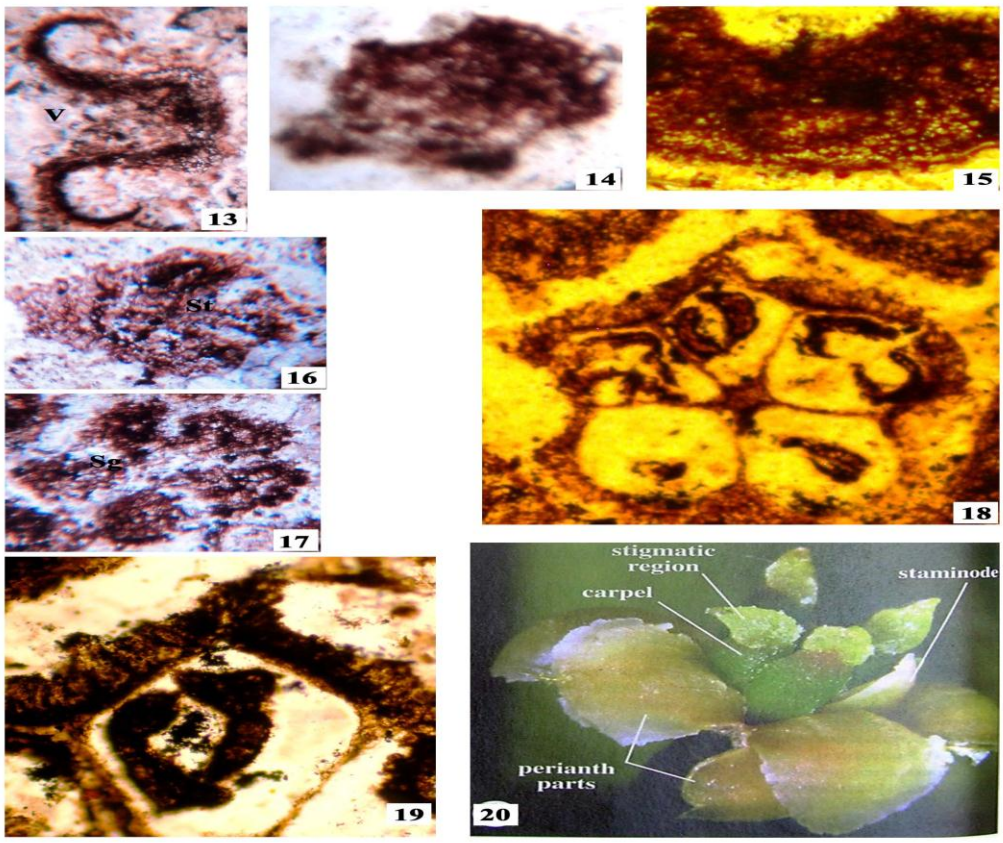


Kapgateanthus intertrappea gen. et. sp. nov.

• EXPLANATION OF PLATE-I a FIGURES 1 to 12 •

Figs. 1-12 - Various stages of Flower cut in obliquely transverse section exposed on fossiliferous chert showing pedicel {fig.12}; polytepalous perianth lobe {fig.2-11} and pentalocular ovary {figs.9,10}, style {figs.5,6} and stigma {figs.2,3}.

PLATE – I b



Kapgateanthus intertrappea gen. et. sp. nov.

• EXPLANATION OF PLATE-I b FIGURES 13 to 20 •

Fig. 13. - Single perianth lobe showing tissues and central vasculature magnified.

Fig. 14. - Pedicel of flower showing tissues and vasculature.

Fig. 15. - Cells of thalamus magnified.

Fig. 16. - Enlarged view of pentangular style in T.S. with its tissue.

Fig. 17. - Enlarged view of five free stigma in T.S. with its tissue.

Fig. 18. - Enlarged view of pentalocular ovary in T.S. showing five fused locules by septa with two ovule in each locule with axile placentation and central axis; ovary showing hairs on ovary wall.

Fig. 19. - Magnified ovary wall with its detail showing hairs on ovary wall; two

ovule in each locule.

Fig. 20. - Living genus Amborella trichopoda (Courtesy of Sandra K. Flayd.).

REFERENCES :-

[1]Ambwani K., Kar R.K. & Ashok Sahni (2001). Reinvestigation on Sahnipushpam Shukla from the Deccan Intertrappean sediments of Madhya Pradesh, India. **Ameghiniana** 38(4): 393–398.

[2]Chitaley, S.D. (1955). Further contribution to the knowledge of Sahnianthus. **J.Ind. Bot. Soc.** 34 (2):121-129.

[3]Chitaley, S.D. (1964). Further observation in Sahnipushpam. **J.Ind. Bot. Soc. XLIII**: 69-74.

[4]Chitaley, S.D. and Kate V. R. (1972). On a new petrified flower Deccananthus savitrii gen. et sp. Nov. from the Deccan Intertrappean beds of India. **Paleobotanist,** 21 (3): 317 – 320.

[5]Chitaley, S.D. and Patel M. Z. (1975). Raoanthus intertrappea a new petrified flower from India. **Palaeontographica,** 153(B): 141 – 149.

[6]Cooke C.I.E. (1958). **The flora of Precidency of Bombay, Vol. I & III.** Bot. Surv. India, Calcutta. (Reprint 1967).

[7]Corner E.J.H. (1976). **The seeds of Dicotyledons**, Vols. I, II.Cambridge Uni. Press, London.

[8]Darrh H.C. (1936). **A Peel Method in Palaeobotany.** Harward Uni. Bot. Nus. Leaflet 4: 69-85.

[9]Dayal L.R. (1967). Critical remarks of Sahnianthus dinectrianum Shukla. **Palaeobotanist**, 15(3):316–317.

[10]Dixit, V.P. (2003). "Mohgaoanthus deccanii" A new petrified flower from Mohgaonkalan, M.P. India. **Botanique**12:36-45.

[11]Kar R.K, Ambwani K, Sahni A & Sharma P. (2003). Unisexual flowers from the Deccan Intertrappean Beds of Madhya Pradesh, India. **Paleobotanist** 52 (1-3): 73-79.

[12]Dwivedi J. N. & Shukla R.K. (1958). On the pollen grains and pollination in Sahnianthus parijai Shukla from the Intertrappean beds of India. **Jour. Paleont. Soc. India,** 3: 105–108.

[13]Gamble T.S. (1957). **Flora of Presidency of Madras**. **Bot. Surv. India**, Calcutta.

[14]Holmes, J & Lopez, J (1986). The disappearing peel technique: an improved method for studying permineralized plant tissue. **Palaeontology** 29: 66-70.

[15]Hooker J.D. (1961). **The Flora of British India Vol. II & III.** L.Recev. & Co. England.

[16]Joy K.W., Willis A. J., & Lacey W.S. (1956). A **rapid cellulose peel technique in Palaeobotany.** Annals of Botany (N.S.) 20: 635-637.

[17]Kapgate Dashrath, NilamberAwasthi, Steven Manchester&ShyamlaChitaley (2011). Inflorescence and flowers of SahnipushpumShukla from Deccan Intertrappean beds of India. **Acta Palaeobotanica** 51(2): 207-227.

[18]V.D. Kapgate, D. K. Kapgate and M. T. Sheikh (2006). "Chenopodianthus"a fossil flower genus from the Deccan Intertrappean Beds of India. **Geophytology**, 36 (1&2): 27-34.

[19]Kapgate, V. D., Kapgate, D. K. & Sheikh M. T. (2009): Araliaceous fossil flower from Deccan Intertrappean Beds of Madhya Pradesh, India. **Palaeobotanist**, 58(1-3): 67-74.

[20]Kokate P. S, Patil G.V., Upadhye E.V. and Sarate O. S. (2011). Further observation to the knowledge of Chitaleypushpam mohgaonse Paradkar. **Palaeobotanist** 60(2) : 345-353.

[21]Mathew, K.M. (1981). **The Flora of the Tamilnadu Carnatic. Part- I & II.** The Rapinat Herbarium – Tiruchirapalli.

[22]Paradkar, S.A. (1971). Chitaleypushpam mohgaonse gen. et sp. nov. from the Deccan Intertrappean beds of India. **Palaeobotanist,** 20 (3): 334-338.

[23]Paradkar, S.A. and Senad V.A. (1984). Sahnianthus parijai Shukla reinvestigated: 138-146 in Tiwari R.S. et al. (Editor) Proc. 5th Indian geophytol. Conf. Lucknow, 1983. Special publ. **Palaeobotanical society**, Lucknow.

[24]Prakash, U. (1955). On the structure and affinities of Sahnipushpum glandulosum sp. nov. from the Deccan Intertrappean series. **Palaeobot.** 4: 91-100.

[25]Prakash, U. and Jain R. K. (1964). Further observation on Sahnipushpam shukla. **Palaeobotanist** 12 (2): 128-138.

[26]Sakundarwar, R.S. & Puranik S.D. (2012). Further observation on the structure & affinities Sahnianthus parijai from Deccan Intertrappean cherts of M.K. **Botanique,** 16(1) : 74-79.

[27]Saldanha C. J. & Nicolson D.H. (1978). **Flora of Hassan Distt. Karnataka,** India. Amerada Publishing Co., New York: 923.

[28]Shukla, R.K. (1958). Sahnianthus dinectrianumsp. nov. A new species of the petrified flower Sahnianthus from the Eocene beds of the Deccan. **Jour. Paleont.Soc. India**, 3: 114 -118.

[29]Shukla, V.B. (1943). Sahnianthus in Palaeobotany in India IV. **J. Ind. Bot. Soc**. 22: 181.

[30]Shukla, V.B. (1944). On Sahnianthus a new petrified flower from Intertrappean beds of Mohgaonkalan and its relation with fruit Enigmocarpon parijaii Sahni from the same locality. **Proc. Nat. Acad. Sci. India** 14: 1-39.

[31]Shukla, V.B. (1948). A new angiosperm flower and gymnosperm ovule from Mohgaonkalan, Paleobotany in India. VI. **Jour. Ind. Bot. Soc.,** 26: 259.

[32]Shukla V.B. (1950). Sahnipushpam gen. nov.and other plant remains from the Deccan Intertrapps. Paleobotany in India. VII. **Jour. Ind. Bot. Soc.,** 29(1): 29.

[33]Shukla, V.B. (1958). Sahnianthus dinectrianum sp. nov. a new species of petrified flower Sahnianthus from Eocene beds of Deccan. **J. palaeont soc. India** 3: 114-118.

[34]Stewart W.W. & Taylor T.N. (1965). The peel technique. In handed B. s. book of Palaeontological Technique, **Kummel & D. Raup.** San Francisco. 224-232.

[35]Verma J.K. (1956). On a new petrified flower Sahnipushpam shuklai sp. nov.from the Deccan Intertrappean beds of M.K, in the Deccan.**Jour. Paleont. Soci. India,** 1: 131–141.