Chenopodianthus, a fossil flower genus from the Deccan Intertrappean Beds of India

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Chenopodianthus mohgaoense gen. et sp. nov., a fossil flower showing close affinity with the genus *Chenopodium* of the family Chenopodiaceae is reported for the first time from Deccan Intertrappean exposures of Mohgaon Kalan, Madhya Pradesh.

Key - words – Fossil, Deccan trap, Late Cretaceous, Mohgaon Kalan, Dicot flower, Chenopodiaceae.

INTRODUCTION

The Deccan Intertrappean flora of Mohgaon Kalan occupies a unique position in the palaeovegetational history of India. The fossils are embedded in the lacustrine and fluviatile sediments, deposited between the successive lava flows. The fossil flora is represented by variety of well preserved woods, leaves, fruits, flowers belonging to all major groups of plants (Bande et al., 1988, Bande & Chandra 1990).

Many fossil dicot flowers such as *Sahnianthus parijai* (Shukla 1944; Chitaley 1955; Dayal 1967); *Sahnipushpum shuklai* (Verma 1956; Prakash, 1956; Prakash & Jain 1963; Chitaley 1964); *Sahnianthus dinecterium* (Shukla 1958); *Deccananhus savitrii* (Chitaley & Kate 1972); *Chitaleypushpum mohgaoense* (Paradkar 1971); *Raoanthus intertrappea* (Chitaley & Patel 1973); *Flosfemina intertrappea and Flosvirulis deccanensis* (Kar et al., 2003) have been recorded form the intertrappean beds of Mohgaon Kalan (22°1' N : 79°11'30" E), Chhindwara District, Madhya Pradesh. However, the present dicot fossil flower is distinct from all the known records.

Material : Well preserved specimen of polytepalous flower with pollen grains and bilocular ovary has been recovered from Deccan Intertrappean beds of Mohgaon Kalan.

SYSTEMATIC DESCRIPTION

Family – Chenopodiaceae

Genus –*Chenopodianthus* gen. nov.

Chenopodianthus mohgaoense sp. nov.

Plate 1, Figs. 1-4 ; Plate 2, Figs. 1-7;
Text figs. 1-15

Description : The flower is small, sessile, bracteolate, hermaphrodite, actinomorphic, pentamerous (except in gynoecium), polytepalous, cyclic, hypogynous flower (Pl.1, Fig. 2; Text fig. 1-6). It is 1.66 mm broad at apical region, 1.55 mm broad at middle and 1.22 mm broad at basal region. Thus the flower is tubular (Pl.1, Figs. 1, 2; Text fig. 1-6).

Bracteole : Bracteoles are two in number, each is attached almost at the base of the flower and more or less completely covered to the perianth lobes. (Pl. 1, Figs. 1, 2; Text fig. 6). It is ovate to concave in shape, broad in the middle and acute at its apex, 1.60 to 1.70 mm broad and 100 to 110 µm thick, consists of thin walled parenchymatous cells (Pl. 2, Figs. 1, 4; Text fig. 9).

Perianth : Perianth consists of five, free, uniseriate tepals which are spirally arranged. The tepals are somewhat equal in size and arranged at equal distance from the centre of the flower showing actinomorphic nature. Two tepals are internal, two are external and one is partly external and partly internal showing

quincuntial aestivation (Pl. 2, Fig. 1, Text fig. 1, 4). Each tepal is ovate to concave, oblonge-lanceolate in shape, broad in the middle and acute at apex. It is 1 to 1.1 mm broad and 111 to 115 μm thick, made up of 2 to 3 layered, thin walled hexagonal parenchymatous cells bounded by single layered epidermis. At central region the tepals are multilayered and show few vascular elements (Text fig. 9). Thickness of the tepals from base to apex is constant.

Androecium : Stamens are five, free, equal in size and length, arranged as 2+2+1 arrangement. Two pairs of stamens are covered by two opposite perianth lobes and one stamen is covered by third perianth lobe (antiphyllous) (Pl. 2, Fig. 1; Text fig. 1). Attachment of the filament to the anther is basifixed. Each filament measures 166 μm thick, made up of 3 to 4 layers of thick walled parenchymatous cells. Single vascular bundle is seen at the central tissue of each filament (Pl. 2, Fig. 1, 3; Text fig. 11). Each anther is large, rectangular in shape, 200 to 228 μm broad and 85 μm in wide. It is bilobed with two distinct loculi and two pollen sacs (Pl. 2, Fig. 3; Text fig. 12). Each anther is made up of thin walled parenchymatous hexagonal cells. Each locule is semicircular, 100 to 140 μm thick, joined by a thick connective tissue in which few vascular elements are seen (Pl. 2, Fig. 3; Text fig. 12). Pollen sacs are filled with free, isolated pollen grains, rounded to triangular in polar view while elongated to oval in equatorial view, 28 to 30 μm in size (Pl. 2, Figs. 5, 6). Pollen grains are tricolpate and psilate (Pl. 2, Figs. 5, 6). Exine is thick without any ornamentation. (Pl. 2, Figs. 5, 6; Text fig. 13). The anther wall shows longitudinal dehiscence.

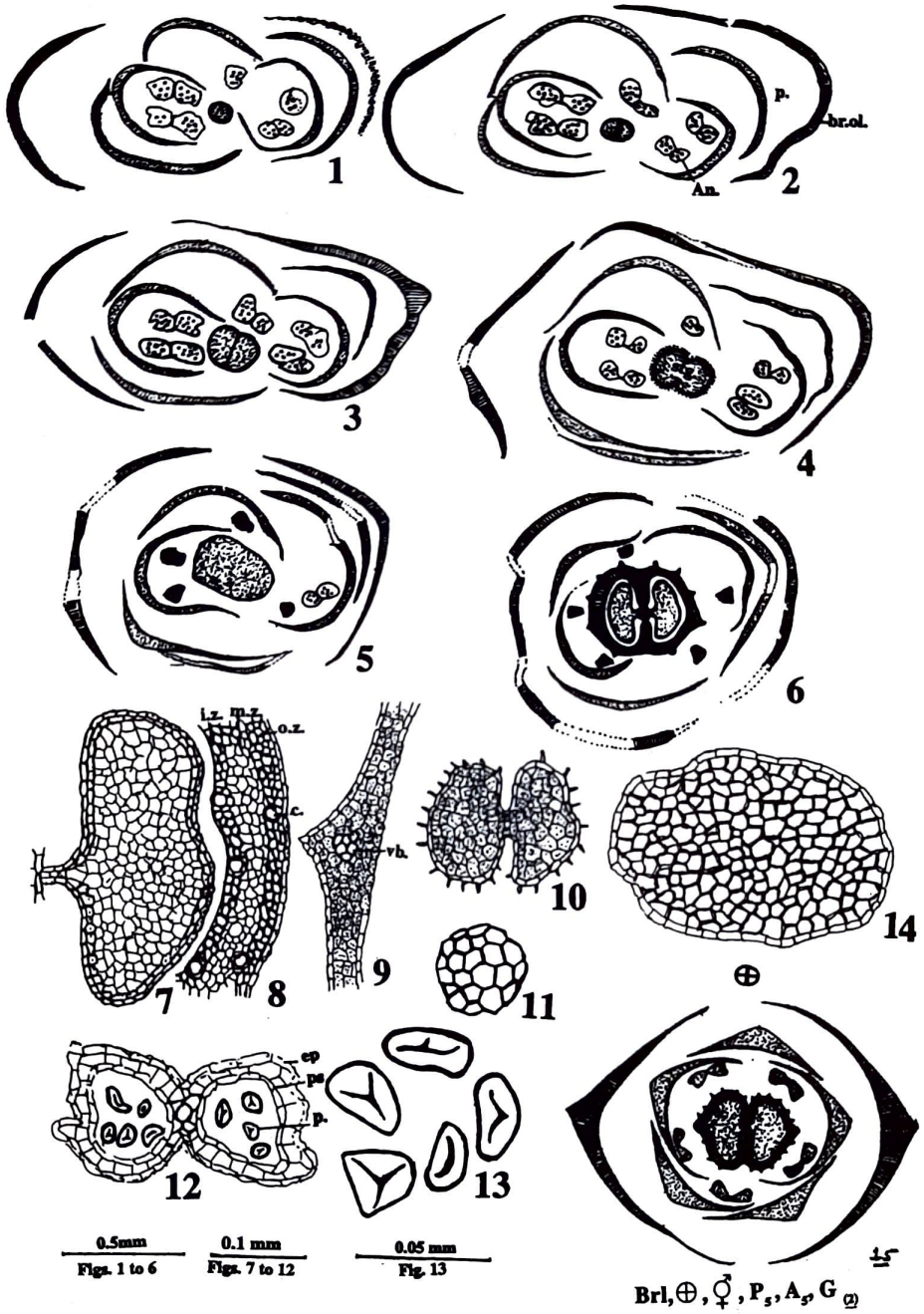
Gynoecium : Gynoecium is sessile, hairy consisting of style, stigma and ovary. Ovary is bicarpellary, bilocular syncarpous, superior, rounded to globular in shape, 500 to 600 μm in diameter (Pl. 1, Fig. 4; Text fig. 6). Ovary wall is 60 to 70 μm thick, made up of three zones - outer, middle and inner. Outer zone is with thick tissue of parenchyma, middle zone is with thin tissue of parenchyma and inner zone is with stony fibrous tissue. Few vascular elements are seen in the inner zone of the ovary wall (Pl. 2, Fig. 2; Text figs. 6, 8). Small spiny projections are given out through the outer zone of the ovary wall. (Pl. 1, Fig. 3; Text fig. 6). Septum is broad, 57 to 60 μm thick consists of fibrous tissue having vascular elements (Pl. 2, Fig. 2; Text fig. 6). Each locule is elongated to oval in shape, 170 to 180 μm in breadth and 328 to 357 μm in length. Single orthotropus ovule is present in each locule, 310 to 320 μm in length and 140 to 142 μm in breadth. It is attached to the septum by a small placenta showing an axile placentation (Pl. 2, Fig. 2; Text fig. 6). Lumen of the ovule is filled up by parenchymatous tissue of nucellus (Pl. 2, Figs. 2, 7; Text fig. 7). Stigma is bifid, 222 x 230 μm in size, made up of thick walled parenchymatous cells. Numerous tiny hairs are given out through epidermal layer of the stigma (Pl. 1, Fig. 2; Text fig. 10). Style is short, circular and flat at terminal portion, 166 to 170 μm in size and solid with centrally placed compact cells and vascular tissue (Text fig. 14).

Floral formula : Brl, ⊕, , P_5, A_5, $G_{(2)}$ (Text fig. 15)

COMPARISON AND DISCUSSION

The diagnostic features exhibited by the present fossil flower are small size (1.66 to 1.22 mm), quincuncial aestivation, antiphyllous stamen, tricolpate pollen grains, hairy gynoecium, bicarpellary bilocular ovary, bifid stigma, axile placentation and orthotropous ovule. Comparative features of present fossil flower with the known record of fossil flowers are shown in Table 1. All the fossil forms described earlier are multicarpellary gamopetalous in nature whearas present fossil flower is bicarpellary and polypetalous in nature.

A study of living families revealed that, the characters collectively indicate its affinity with the families such as Convolvulaceae, Apocynaceae, Nectaginaceae, Chenopodiaceae and Amarantaceae (Gamble, 1957; Saldanha & Nicolson, 1978; Mathew, 1981). *Chenopodium* of the family Chenopodiaceae shows closer resemblances with the present specimen in having minute size (2 mm across) of the flower, bracteolate, actinomorphic, hermaphrodite, pentamerous, polypetalous, perianth-5, staments-5, bicarpellary, syncarpous, superior pistil with single ovule



EXPLANATION OF TEXT FIGURES, 1-15

1. T.S. flower showing polypetalous perianth lobes, anthers and bifid stigma. Slid no. 4.
2. Terminal portion of the T.S. flower showing bracteole (br. ol.), perianth (p.), anther lobes (An.) and stigma. Slide no. 8.
3. T.S. flower showing prominent bracteoles, quincuncial aestivation of perianth lobes and stigma. Slide no. 14.
4. T.S. flower showing hairy, bifid stigma and 2+2+1 arragement of the anther. Slide no. 22.
5. T.S. middle portion of the flower showing filaments, style and perianth lobes. Slide no. 30.
6. T.S. basal portion of the flower showing bilocular ovary with two ovules and spiny ovary wall. Slide no. 42.
7. Single ovule with its details. Slide no. 45.
8. Wall of the ovary showing inner (i.z.) and outer thick tissue (o.z.) and middle soft tissue (m.z.). Slide no. 42.
9. Single perianth lobe with its tissue and vasculature (vb.) Slide no. 10.
10. T.S. bifid stigma showing its spiny nature. Slide no. 8.
11. Part of filament showing peripheral tissue and central V.B. Slide no. 30.
12. Bilobed anther showing anther wall (ep.), pollen sac (p.s.) and isolated pollen grain (p.). Slide no. 14.
13. Tri-colpate and psilate pollen grains. Slide no. 4.
14. T.S. of stony style with its tissue. Slide no. 35.
15. Floral diagramm of the flower. Slide no. 42.

PLATE–1

Chenopodianthus mohgaoense gen. et sp. nov.

1 Terminal portion of the flower exposed on fossiliferous chert. x 80. Slide no. 4.

2 Terminal portion of the flower showing bifid stigma, five anthers and perianth lobes. x 80. Slide no. 8.

3 Middle portion of the flower showing bilocular ovary with spines. x 80. Slide no. 15.

4 Basal portion of the flower showing filaments and bilocular ovary with distinct ovules. x 80. Slide no. 26.

Table 1 : Comparison of known fossil flowers with *Chenopodianthus mohgaoense*

Characters	*Sahnianthus pariijai & Sahnianthus dinecterium*	*Sahnipusnpum shuklai*	*Chitaleypushpum mohgaoense*
Bract	Present	Absent	Not seen
Bracteole	Present	Absent	Present
Stalk	Present	Absent	Present
Breadth	1.3 to 2.0 mm in the middle 2.5 to 3.0 mm at the base	2.5 to 2.0 mm	2.5 mm throughout, 1.2 mm at the base
Symmetry	Actinomorphic	Actinomorphic	Actinomorphic
Perianth	One whorl; 6-8, united upper, 1/3 free, valvate aestivation. Two whorls in (*S. dinecterium*)	One whorl, quadrangular	One whorl, 7 united, tips free, valvate aestivation.
Shape	Globular	Tubular	Tubular
Nectary glands	Present at the base of the ovary.	Present on the ovary wall.	Absent
Sex	Hermaphrodite	Hermaphrodite	Hermaphrodite
Androecium	8-12 inflexed in bud.	4	7 curved inward
Stamens	alternate & opposite to the perianth lobes.	–	alternate & opposite to the perianth lobes.
Filament	Filament of different lengths, connective situated at 1/3 distance from the tip of the anther.	–	Short, same length, attached at 1/3 distance on the anther.
Anther	Oblong, dorsifixed, 0.75-1 mm long	–	Dorsifixed 0.7 mm long
Pollen grains	40 μm in diameter, psilate tricolphate, spherical to oval.	15-19 x 25-27 μm oblate	12.15 x 19 μm, tricolporate, psilate
Dehiscence	Lateral & longitudinal	Undehisced	Longitudinal
Gynoecium	Stalked	Sessile	Sessile
Ovary position	Superior	Superior	Superior
Size	0.9 mm diameter	–	0.7 mm diameter
Shape	Circular	Circular	Pentangular
Loculi	6-12 locular	4-5 locular	5 locular
Placentation	Axile	Basal	Axile
Ovules	Numerous, 2 rows in each locule	Single	Arranged in 2 rows
Style	Simple long chambered	Chambered	Simple, chambered
Stigma	Capitate, papillose	Discoidal	Simple

Characters	*Deccanthus savitrii*	*Raoanthus intertrapea*	*Chenopodianthus mohgaoense* **(Present flower)**
Bract	Absent	Absent	Absent
Bracteole	–	Absent	Present
Stalk	Present	Absent	Not clearly preserved
Breadth	3.5 mm at the middle	2 mm at middle 2.25 mm towards the base	1.66 mm broad at the tip & 1.22 mm at the base.
Symmetry	–	Zygomorphic	Actinomorphic
Perianth	Arranged in two whorls, 3+3	One whorl, 9, united, tips free, valvate aestivation	One whorl, 5, polytepalous, quincuncial aestivation
Shape	–	Tubular	Tubular
Nectary glands	Absent	Absent	Absent
Sex	Hermaphrodite	Hermaphrodite	Hermaphrodite
Androecium	6 in two whorls	–	5, polytepalous
Stamens	alternate to the perianth lobes.	9 in one whorl, aposite to perianth	5 in one whorl, opposite & alternate
Filament	3 short, 3 long	Heterostamenous	Equal in length, free.
Anther	Dorsifixed, 750-800 μm long	1.00 μm broad	large, rectangular, 200-228 μm broad
Pollen grains	20-15 μm, peroblate trichotomosulcate.	13-16 um trizono colporate, psilate	28 to 30 μm, triangular, tri-colpate & psilate
Dehiscence	Undehisced	Undehisced	Longitudinal
Gynoecium	With small stalk	Sessile	Sessile
Ovary position	Superior	Semi superior	Superior
Size	1.5 mm broad, 1.18 mm long	1 mm in diameter	500-600 μm in diameter
Shape	–	Angular	hairy, rounded, oval
Loculi	3 locular	7 locular	2 locular
Placentation	–	–	Axile
Ovules	Not seen	Not seen	1 ovule in each locule
Style	Solid	Chambered	Short & solid
Stigma	Simple	Simple	Bifid & hairy.

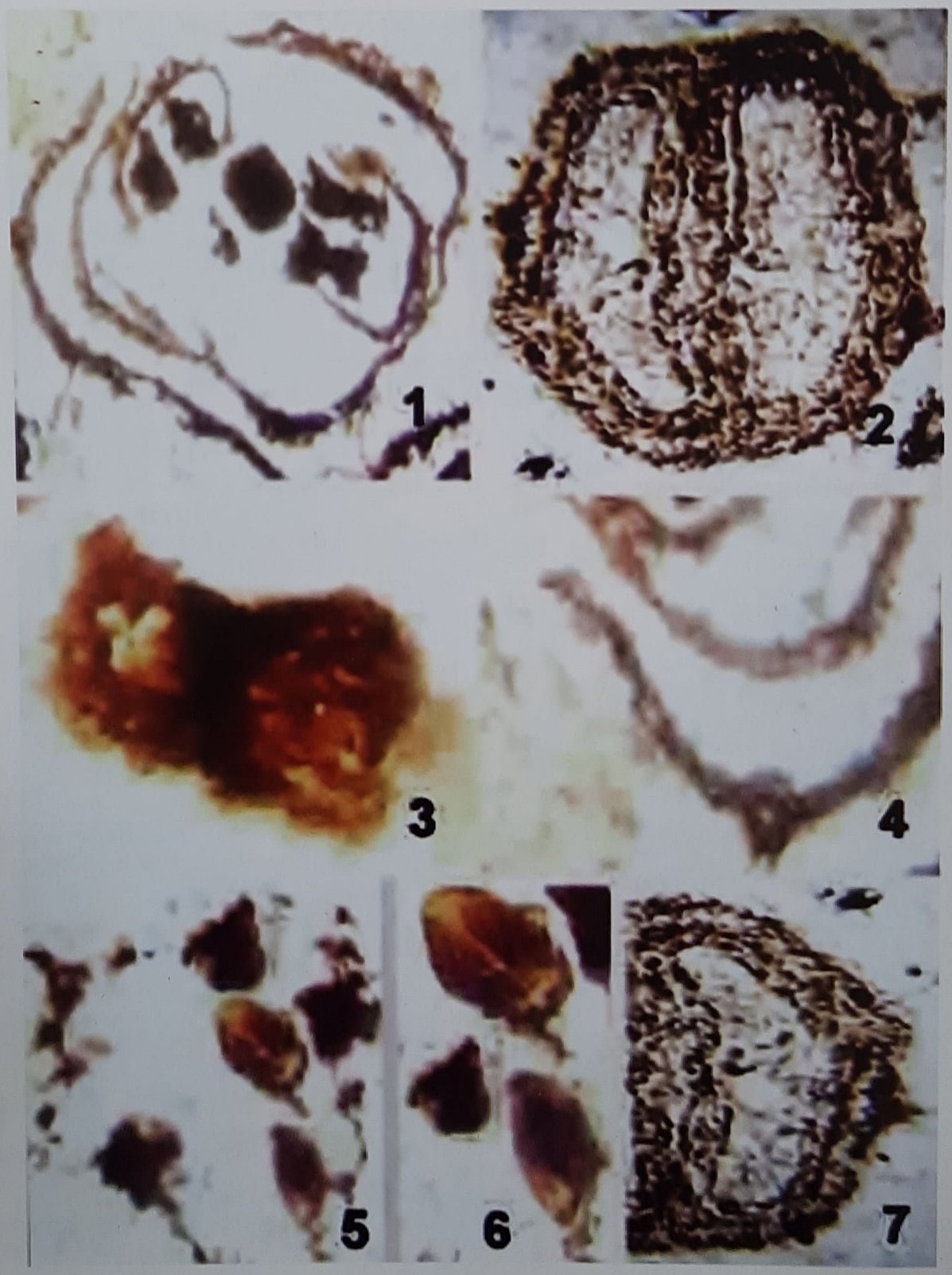


PLATE-2

1 Terminal portion of the flower showing bifid stigma, 2+2+1 arragement of the anthers and quincuncial aestivation of the flower. x 90. Slide no. 10.

2 Basal portion of the ovary showing three layers of ovary wall with its vasculature, two ovules with tissue of nucellus and filament. x 190. Slide no.30.

3 Single bilobed anther with connective, pollen grains and anther wall. x 250. Slide no. 20.

4 Tissue of the perianth. x 190. Slide no. 9.

5 Pollen sac with mature pollen grains. x 400. Slide no. 22.

6 Tricolpate and psilate pollen grains. x 400. Slide no. 24.

7 Ovary wall with its details and ovules on axile placentation. x 350. Slide no. 35.

in each locule, but *Chenopodium* differs from fossil flower in having unilocular ovary, spirally arranged anthers, polyporate pollen grains and campylotropous ovule with basal placentation. Fossil flower shows bilocular ovary, 2+2+1 arrangement of the anthers, tricolpate pollen grains and orthotropous ovule with an axile placentation. The fossil is described as *Chenopodianthus mohgaoense* gen. et sp. nov. indicating its resemblance with the family Chenopodiaceae. The generic epithet represents the family Chenopodiaceae and specific epithet represents the locality name.

DIAGNOSIS

Chenopodianthus gen. nov.

The flower is sessile, bracteolate, hermaphrodite, pentamerous, polypetalous, hypogynous, actinomorphic with bicarpellary, syncarpous ovary.

Chenopodianthus mohgaoense gen. et sp. nov.

The flower is 1.66 to 1.22 mm in size, bracteoles are ovate to concave in shape. Perianth lobes are five, uniseriate, ovate to oblong-lanceolate, 1 to 1.1 mm broad and 111 to 115 μm thick, polypetalous in nature with quincuntial aestivation. Stamens five, polyandrous, antiphyllous arranged in 2+2+1 manner; anthers are basifixed, bilobed dehisced by longitudinal dehiscence, pollen grains are isolaled, 28 x 30 μm in size, tricolpate, psilate, ± circular. Gynoecium sessile and hairy; style short circular and terminal; stigma is bifid, hairy, 222 to 230 μm in size; ovary is bicarpellary, syncarpous and superior, rounded to globular in shape, 500 to 600 μm in diameter; septum is broad, 57 to 60 μm thick, each locule is elongated, oval in shape, bears single ovule with an axile placentation; ovules are 310 to 320 μm in length and 140 to 142 μm in breadth.

Distribution : The genus *Chenopodium* of the family Chenopodiaceae consists of about 150 species. Seven species are found in India, they occur in Rajasthan and most characteristically in the saline Sambhar Lake region. (Santapau & Henry, 1972). *C. album,* a weed occurring chiefly in cultivated ground, is very common in the Deccan (Cook, 1906).

Holotype : VDK / Ang. (Fl) - Sl. No. 1 to 65

Repository : Botany Department, J. M. Patel College, Bhandara.

Locality : Mohgaon Kalan, Chhindwara District, Madhya Pradesh.

Horizon : Deccan Intertrappean beds.

Age : Late Cretaceous – Early Eocene

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