Octa Journal of Biosciences
International peer-reviewed journal
Octa J. Biosci. Vol. 7(1):27-30

ISSN 2321 – 3663
Jan-June 2019

Octa Journal of Biosciences

journal homepage: www.sciencebeingjournal.com

Report of a petrified fossil species of *Saururaceocarpon cretaceousus* gen. et sp. nov. (Saururaceae) from the Maastritchian-Danian of central India

Deepak D. Ramteke, Vaishali D. Nagrale

Deccan Flora museum and Research Center, Sakoli, India. Dist- Bhandara. Maharashtra, India.441802

ARTICLE INFO

Received 22 Jan 2019
Revised 25 May 2019
Accepted 22 June 2019
Available online 30 June 2019

Keywords: Petrified, Saururaceocarpon, Maastrtchian-Danian, Deccan Intertrappean

Email: deeplifesc@gmail.com

ABSTRACT

Piperales today are a diverse, speciose group of early divergent angiosperms and are important for understanding early angiosperm evolution. Fossil samples were collected from the deccan Intertrappean Chert outcrop, located on the field of the Singpur locality, about 5 km east of Saunser India (19278, 21°36.958′N, 78°43.827′E) of Madhya Pradesh India. Chert blocks were cut into pieces and studied using the cellulose acetate peel technique The present fruit is well preserved cut in transverse plane. Rounded globular to triangle in shape measuring 2.5-3 mm in diameter. The fruit is unilocular and is differentiated into outer pericarp and seed. Present fossil specimen resembles with the family Saururaceae in having perisperm with starch grains, pericarp with protruberances, epicarp multilayered with wavy outgrowths, mesocarp single layered made of large square cells, seed with modest undulating outline and minute embryo. It shows close similarities with the fruits of family Saururaceae hence it is named as *Saururaceocarpon cretaceousus* gen. et sp. nov. The generic name is after the family and specific name is after the age of present specimen.

INTRODUCTION

Angiosperm-dominated floras of the Late Cretaceous are essential for understanding the evolutionary, ecological, and geographic relatioship of flowering plants. The Late Cretaceous–early Paleogene Deccan Intertrappean Beds of India contain angiosperm-dominated plant fossil assemblages known from multiple localities in central India. Number of fossil vegetative or reproductive remains have been reported from the Deccan Intertrappean beds of central India. Among these few capsular fruits have been reported such *Enigmocarpon parijai* (Sahni, 1943), Indocarpa intertrappea (Jain, 1964), *Harrisocarpon sahnii* (Chitaley and Nambudiri, 1973), *Sahniocarpon harrisii* (Chitaley and Patil, 1973), *Daberocarpon gerhardii* (Chitaley and Sheikh, 1973), *Deccanocarpon arnoldii* (Paradkar, 1975), *Enigmocarpon sahnii* (Chitaley and Kate, 1977), *Centrospermocarpon chitaleyi* (Sheikh and Khubalkar, 1979), *Euphorbiocarpon drypeteoides* (Mehrotra et al., 1983), *Grewia mohgaonse* (Paradkar and Dixit, 1984), *Oleaceocarpon nagpurensis* (Sheikh et al., 1986), *Duabangocarpon deccanii* (Kadoo and Kolhe, 2002), Chitaleocarpon intertrappea (Kapgate et al., 2006), *Portulacaceaeocarpon jamsavlii* (Meshram et al., 2011), *Tiliaceaeocarpon jamsavlii* (Meshram et al., 2013) and *Spinocarpon mohgaonse* (Kapgate, 2013).

During the Cretaceous period angiosperms underwent a rapid evolutionary radiation, first appearing in the fossil record around 140-66 million years ago and rising to geographic and ecological dominance in terrestrial ecosystems by the end of the Cretaceous in the parts of central India. (Ramteke D.D. 2017).

However, recently recognized unilocular capsular fossil fruits from the Deccan Intertrappean sedimentary sequences of Singpur near Saunser, Madhya Pradesh of central India related to family Saururaceae (Piperales) is taken for palaeobotanical investigation. Piperales today are a diverse, speciose group of early divergent angiosperms and are important for understanding early angiosperm evolution (Wanke et al., 2007). Piperales include the families Aristolochiaceae, Hydnoraceae, Lactoridaceae, Piperaceae, and Saururaceae. Saururaceae are a small family consisting of four genera and six extant species: Anemopsis californica Hook. Et Arnott, Gymnotheca chinensis Decaisne, G. involucrata Pei, Houttuynia cordata Thunb., Saururus cernuus L., and S. chinensis (Lour.) Baill. (Wu and Kubitzki, 1993). These herbaceous, rhizomatous plants tend to inhabit moist to wet environments (Wu and Kubitzki, 1993; Xia and Brach, 1999). Within Saururaceae, two species S. cernuus and A. californica are found in North America and four species S. chinensis, H. cordata, G. chinensis, and G. involucrata in eastern Asia (Rendle, 1959; Wu and Kubitzki, 1993). The family is likely monophyletic and is sister to Piperaceae in the order Piperales (Meng et al., 2003; Neinhuis et al., 2005); Smith and Stockey (2007). there are few fossils confidently assigned to the order, inhibiting a deeper understanding of evolutionary trends.

MATERIALS AND METHODS

Fossil samples were collected from the deccan Intertrappean Chert outcrop, located on the field of the Singpur locality, about 5 km east of Saunser India (19278, 21°36.958′N, 78°43.827′E) of Madhya Pradesh India. Chert blocks were cut into pieces and studied using the cellulose acetate peel technique (Joy et al., 1956) . Peels were mounted on microscope slides using DPX as a xylene-soluble mounting medium. Images were captured with a digital camera. Photographs were processed with Adobe Photoshop. Thus the fruit revealed details of morphology and anatomy through examination of fractured surface, serial sectioning and successive peels.

RESULTS

The present fruit is well preserved cut in transverse plane. Rounded globular to triangle in shape measuring 2.5-3 mm in diameter. The fruit is unilocular and is differentiated into outer pericarp and seed. Placentation is axile. The fruit wall is wavy in outline, multilayered with parenchymatous tissues. Capsules dehiscent apically valvular. Seeds scantily endospermic. Perisperm present containing starch grain. Seeds with starch. Embryo rudimentary at the time of seed release (Pl.1, fig.1). The detailed description of each part is given below.

Pericarp (Fruit wall)

The fruit wall or pericarp is well preserved provided with protruberances and differentiated into outer epicarp, middle mesocarp, and inner endocarp (Pl.1, figs.3, 4) It is thick, multilayered and measures 0.2-0.6 mm in thickness. Outer epicarp is multilayered measuring 160-550 m in thickness and is well preserved. The middle mesocarp is single layered with thin walled parenchymatous tissue. It measures 20-30 m thick. Inner endocarp is 10 m thick. The cells are parenchymatous (Pl.1, figs.4, 5, 6).

Epicarp

It is the outermost layer of the fruit and somewhat globose to triangular in appearance with wavy outgrowths. It is multicellular in thickness. The cells are polygonal and parenchymatous in nature (Pl.1, fig.3).

Mesocarp

It is uniform with single layer of large square cells. The cells are parenchymatous and measures 20-30 m thick (Pl.1, fig.5).

Endocarp

It is the innermost layer and well preserved. It measures 10 m in thickness, single layered and consist of transversly elongated parenchymatous cells.

Locule

The fruit is unilocular, somewhat oval and consist of single seed (Pl.1, fig.2. The diameter of locule is 1.9 × 2.4 mm.

Seed

Single large seed present in a locule. This is oval to elliptical in T.S. and slightly elongated in L.S., measures 1.7 x 2.2 mm in size. Bitegmic seed coat present. Outer testa is thin and inner tegmen is 1 to 2 layered with dark banded cells. Endospermic tissue present inside the seed lumen. Embryo not seen properly (Pl.2, fig.3). Outer surface of seed have elliptical imprints with modest undulating outline.

Seed coat

The seed is bitegmic. The testa is made up of single layer of elongated cells measuring about 3 µm in thickness and almost crushed at places. The tegmen is two cells in thickness measuring about 14-18 µm.
Inner pulp In between pericarp and seeds few thin walled parenchymatous cells are preserved at places (Pl.1, fig.4); otherwise except for the seed and placenta no other tissue is preserved. These cells inside fruit measure about 3 × 4 µm in size.

Placenta

The placentation is marginal; the seed is attached with its funicles. Vascular supply is not seen (Pl.2, fig.3).

Embryo

Embryo appears to be made up of thin walled cells with single layer epidermis. It is minute and curved. Embryo measures about 75 × 56 µm in size. The embryo is dicotyledonous having two cotyledons, supplied with a placenta (Pl.2, fig.3). At the chalazal end of the seed is seen a dark structure of hypostase (Pl.2, fig.4). The undifferentiated cellular mass of thin walled parenchymatous cells is found.

RESULTS

From the detailed study and comparison of fossil fruits, it is clear that the present fossil fruit does not show any resemblance with earlier reported fossil fruits, but it shows resemblance with the living family as under.
Systematics
Order-Piperales
Family-Saururaceae
Genus-*Saururaceocarpon*
Species-*Saururaceocarpon cretaceousus*
Ramteke & Nagrale sp. nov.

It shows close similarities with the fruits of family Saururaceae hence it is named as *Saururaceocarpon cretaceousus* gen. et sp. nov. The generic name is after the family and specific name is after the age of present specimen.
Holotype- DDR/Ang.Fruit/Deposited in Deccan Flora museum and Research center, Sakoli, India.
Horizon- Deccan Intertrappean beds.
Locality- Singpur, Madhya Pradesh, India.
Age- Maastritchian–Danian.

DIAGNOSIS

Saururaceocarpon gen. nov.
Fruit is dicotyledonous, unilocular, dehiscent capsule with single seed in a locule, axile placentation, large perisperm.
Saururaceocarpon cretaceousus gen. et sp. nov.
Fruit is a unilocular capsule, obovate, measuring 2.5–3 mm in width. Fruit wall 0.2-0.6 mm thick, differentiated into epicarp, mesocarp and endocarp. Epicarp 160-550 m thick with wavy outgrowths, parenchymatous, polygonal cells; mesocarp uniform with single layer of large square cells, parenchymatous, measuring 20-30 m in thickness; endocarp single layered of transversly elongated parenchymatous cells measuring 10 m in thickness. Large single seed, 1.7 x 2.2 mm in size with undulating outline, bitegmic. Embryo measures 75 × 56 µm in size, endospermic nucleus, dicot embryo, hypostase at chalazal end.

Saururaceocarpon cretaceousus **gen. et sp. nov**.
Explanation of Plate 1 (fig.1)

1. Specimen 1 in transverse plane.
2. Specimen 2 in longitudinal plane showing dehiscence and embryo.
3. Magnified view of specimen 1.
4. Magnified view Pericarp showing epicarp (ep), mesocarp (me), endocarp (en) and seed coat (sc).
5. Mesocarp showing large squarish cells.
6. Layer of epicarp with starch.

Saururaceocarpon cretaceousus **gen. et sp. nov**.
Explanation of Plate 2

1. Extant member of Saururaceae Saururus.
2. Transverse section of living Saururus species.
3. Magnified view of seed showing embryo (emb) and placenta (pl).
4. Magnified view of seed hypostase (hy).

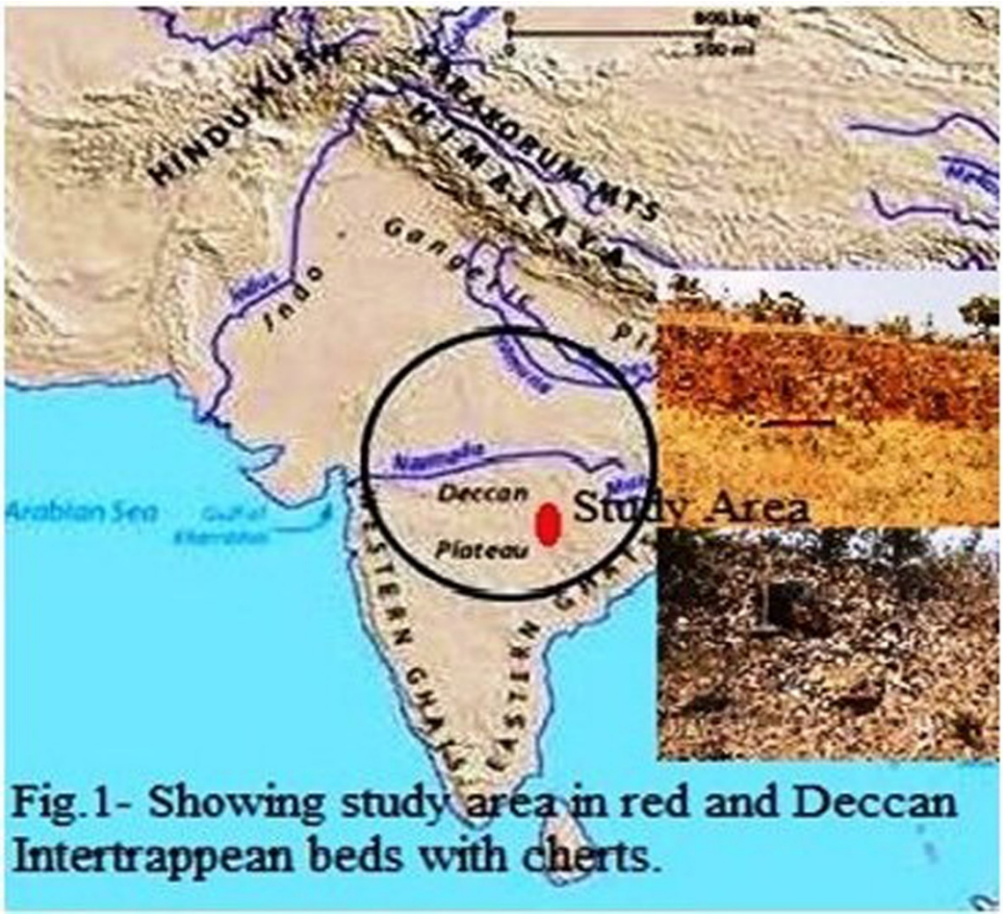

Fig.1- Showing study area in red and Deccan Intertrappean beds with cherts.

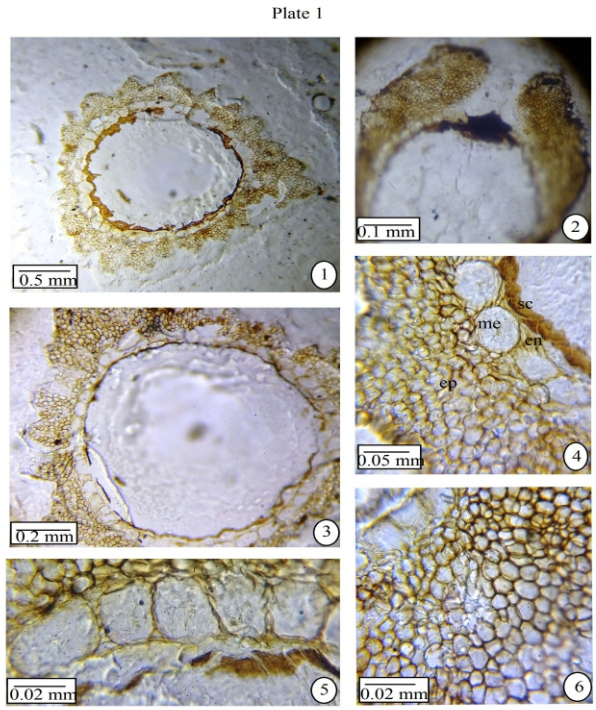

Fig .2: Extant member of *Saururaceae Saururus*.

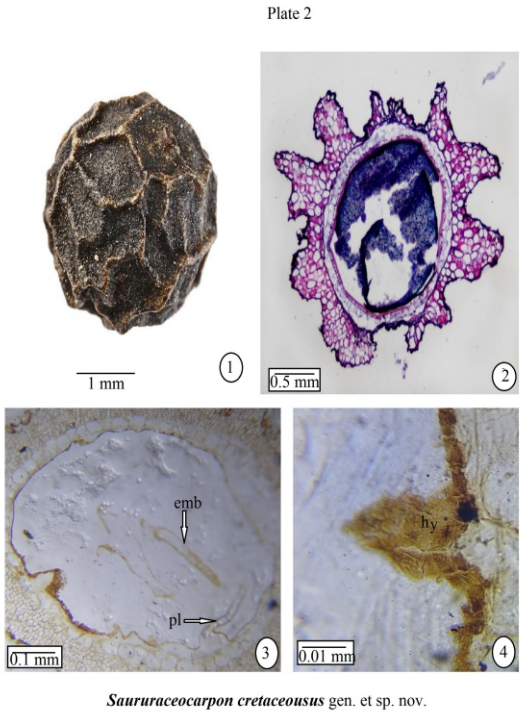

Fig .3: Extant member of *Saururaceae Saururus*.

DISCUSSION

The above described specimen revealed following important details for its identification.

- Fruit is unilocular, dehiscent and ovate.
- Fruit wall is multilayered and fleshy.
- Single seeded.
- Perisperm with starch grains.
- Mesocarp single layered made of large square cells.
- Seed with modest undulating outline.
- Seed coat is thick and differentiated into testa and tegmen.
- Embryo minute, dicotyledonous.
- Nuclear endosperm.

From these characters it is evident that the described fruit was formed from unicarpellary, syncarpous, superior ovary with axile placentation, having single ovule in a locule. Nature of the fruit appears capsular due to fleshy pericarp and dehiscence (Corner, 1976).

Comparison with fossil fruits

The previously described capsular fossil fruits from the Deccan Intertrappean beds of India are differing from the present fruit in number of characters. Mehrotra et al., (1983) reported *Euphorbiocarpon drypetoid*s, the trilocular single seeded fruit while the present fruit is unilocular single seeded. *Wingospermocarpon mohgaonse* (Sheikh and Kapgate, 1984) is unilocular fruit but differs from present fruit in having winged seed. *Portulacaceaeocarpon jamsavlii* (Meshram et al., 2011) is unilocular but differs in having triangular, multiseeded fruit. *Spinocarpon mohgaoense* (Kapgate, 2013) is a spiny fruit having two locules with two erect mucronate beak but the present fruit is unilocular single seeded therefore it is totally different. *Lagerstroemiocarpon harisi*i (Kokate, 2013) differs in having hexagonal fruit with single seed in each locule. *Tiliaceaeocarpon jamsavli*i (Meshram et al., 2013) is unilocular fruit but differs in having hexagonal, ovate indehiscent fruit measuring 3-4 mm in size, hard woody projection on fruit wall, thin walled *parenchymatous mesocarp*, unitegmic seed, nonendospermic.

Comparison with the modern taxa

For assigning the fossil seed to proper family, it was also compared with living genera of modern monocot families. The available literature was thoroughly searched for the anatomical and embryological characters (Corner, 1976; Esau 1979; Fahn 1982) and Angiosperm Phylogeny Group (APG) (2003, 2016). The present fossil fruit is compared with the modern families like Amaranthaceae, Aristolochiaceae, Celastraceae, Dilleniaceae, Flacourtaceae, Pedaliaceae, Papaveraceae, Saururaceae, Zygophyllaceae showing characters like unilocular, single seeded, capsular fruit, seed coat not multiplicative, valvular dehiscence, embryo small

Family Amaranthaceae differs in having the medium size, unilocular fruit, hard pericarp, single seed with elongated spines. Aristolochiaceae fruit differs in having hexagonal, more or less cylindrical, longitudinal dehiscence, multiseeded, triangular seed, seed with leather like endothecium. Celastraceae differs in having seeds completely enveloped in a large brigh aril, large cotyledons embedded in a fleshy endosperm. Dilleniaceae differs in having conspicuous funicular aril closely united with the testa. Flacourtiaceae differs in having endosperm in quantity, embryo with a small root, large flat cotyledons and hard seed coat. Pedaliaceae differs in having fruit with wings, thorns or hooks. Papaveraceae differs in having dehiscence by four to six valves at the apex, long narrow fruit, seed bear an appendage of the raphe. Family Zygophyllaceae differs in having septicidal nature of fruits with membranous testa, loculicidal dehiscence.

Present fossil specimen resembles with the family Saururaceae in having perisperm with starch grains, pericarp with protruberances, epicarp multilayered with wavy outgrowths, mesocarp single layered made of large square cells, seed with modest undulating outline and minute embryo (Pl.2, figs.1, 2).

Fig.1 : Specimen 1 in transverse plane.

Disclosure statement: No potential conflict of interest was reported by the author.

Financial and proprietary interest: Nil

Financial support: Nil

REFERENCES

1. Angiosperm Phylogeny Group (APG) (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnean Society 141: 399-436.
2. Angiosperm Phylogeny Group (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181 (1): 1-20.
3. Bobade M.B. and Kokate P.S. (2013). A new petrified dicotyledonous capsular fruit from the Deccan Intertrappean beds of Mohgaonkalan (M.P.) India. The Botanique 17 (1-2): 100-105.
4. Bhowal M. and Sheikh M.T. (2006). A petrified dicot fruit, Euphorbioceocorpon singhpurii, fron the Intertrappean beds of Singhpur, Madhya Pradesh.
5. Chitaley S.D. and Nambudiri E.M.V. (1973). Harrisocarpon sahnii gen. et sp. nov. from the Deccan Intertrappean beds of Mohgaonkalan, India. Geophytology 3: 36-41.
6. Chitaley S.D. and Sheikh M.T. (1973). Ten locular petrified fruit from the Deccan Intertrappean Series of India. Palaeobotanist, 20 (3): 297-299.
7. Chitaley S.D. and Patil G.V. (1973). Sahniocarpon harrisii gen. et sp. nov. from the Deccan Intertrappean beds of India. Palaeobotanist, Silver Jubilee Vol. (29): 288-292.
8. Chitaley S.D. and Kate V. R. (1977). Enigmocarpon sahnii sp. nov. from the Deccan Intertrappean beds of Mohgaonkalan, India. Rev. Paleobot. and Palynol. 23: 389-398.
9. Corner E.J.H. (1976). The Seeds of Dicotyledons. Vol. I and II Cambridge Uni. Press. London.
10. Esau K. (1979). Anatomy of seed plants. John Wiley and Sons.Inc.New York, 355.
11. Fahn A. (1982). Plant Anatomy 3rd Edi. Pergamon Press, New York, 211.
12. Jain R.K. (1964). Indocarpa intertrappea gen. et sp. nov. A new dicotyledonous fruit from the Deccan Intertrappean series of India. Ann. Bot. 125 (1): 26-33.
13. Joy et al. (1956). A rapid cellulose peel technique in palaeobotany. Annals of Botany (N.S.), 20: 635-637.
14. Kadoo L.A. and Kolhe P.D. (2002). A new capsular fruit Dubangacarpon deccanii from Intertrappean bed of Mohgaonkalan, Madhya Pradesh. Gond. Geo. Mag. 17 (1): 39-46.

15. Kapgate V.D., Kapgate D.K. and Sheikh M.T. (2006). First record of seven locular dicot fruit from Deccan Intertrappean Beds of Mohgaonkalan, Chhindwara district Madhya Pradesh. Gond. Geol. Magz. 21 (2): 109-114.
16. Kapgate D.K. (2013). Spinocarpon mohgaonse gen. et sp. nov. A permineralized spiny fruit from Deccan Intertrappean beds of Mohgaonkalan, M.P., India. Geophytology 43 (1): 51-56.
17. Kokate P.S. (2013). A petrified capsular fruit Lagerstroemiocarpon harisii gen. et sp. nov. Geophytology 43(1): 57-62.
18. Mehrotra R.C., Prakash U. and Bande M.B. (1983). Euphorbiocarpon drypteoides a new Euphorbiaceous fruit from Deccan Intertrappean beds of Mandla Distt. M.P. Geophytology 13 (1): 127-133.
19. Meng S.W., Chen Z.D., Wu D.Z., and Liang H.X. (2002). Phylogeny of Saururaceae based on mitochondrial matR gene sequence data. Journal of Plant Research 115: 71-76.
20. Meng S.W., Douglas A.W., Li D.Z., Chen Z.D., Liang H.X., and Yang J.B. (2003). Phylogeny of Saururaceae based on morphology and five regions from three plant genomes. Annals of the Missouri Botanical Garden 90: 592-602.
21. Meshram S.M., Narkhede S.D. and Bhowal M. (2011). The taxonomic identification of unilocular angiospermic fruit from new locality Jamsavl, M.P. India. Bionanofrontear, 4(2): 344-346.
22. Meshram S.M., Narkhede S.D. and Bhowal M. (2013). A new petrified unilocular fruit from the Deccan Intertrappean Beds of Jamsavli M.P. India. Int. J. of Life Sciences, Vol.1 (3): 221-225.
23. Neinhuis C., Wanke S., Hilu K.W., Muller K. and Borsch T (2005). Phylogeny of Aristolochiaceae based on parsimony, likelihood and Bayesian analyses of trnL-trnF sequences. Plant Systematics and Evolution 250: 7-26.
24. Paradkar S.A. (1975). Deccanocarpon arnoldii gen. et sp. nov. A new dicotyledonous fruit from the Deccan Intertrappean series of India. The Botanique, 6 (1): 5-10.
25. Ramteke D.D. (2017). Investigation of late cretaceous ossil flora from the Deccan Intertrappean sedimentary beds of central India. Ph.D. Thesis Nagpur university Nagpur.
26. Rendle A. B. (1956). Classification of flowering plants, Vol. II, Cambridge Uni. press. London.
27. Sahni B. (1943). Indian silicified plants-2, Enigmocarpon parijaii, a silicified fruit from the Deccan, with a review of the fossil history of the Lythraceae. Proc. Ind. Acad. Sci. 17B (3): 59-96.
28. Sheikh M.T. and Khubalkar, N.V. (1979). Centrospermocarpon chitaleyi gen.et sp. nov., A new petrified fruit from the Intertrappean beds of Mohgaonkalan, M. P., India. The Botanique, Vol.10 (1-4): 23-40.
29. Sheikh M.T. and Kapgate, D.K. (1984).A fossil capsule with winged seeds from the Deccan Intertrappean Beds of India.Current Science 5 (12): 656-657.
30. Sheikh M.T., Kapgate, D.K., Juneja, C.D. and Gupta, R.G. (1986). A petrified bilocular fruit from the Intertrappean beds of India. Proc. Special Indian Geophytological Conf.-Pune: 157-159.
31. Smith S.Y. and Stocky, R.A. (2007). Establishing a fossil record of perianthless piperales: Saururus tuckerae Sp. Nov. (Saururaceae) from the middle Eocene prinstone cherts. American journal of Botany 94(10): 1642-1657. 2007.
32. Wanke S., Jaramillo M.A., Borsch T., Samain D. Quandt and Neinhuis C. (2007). Evolution of Piperales: matK gene and trnK intron sequence data reveal lineage specific resolution contrast. Molecular Phylogenetics and Evolution 42: 477-497.
33. Wu C.H., and Kubitzki K. (1993). Saururaceae. In K. Kubitzki, J. G. Rohwer, and V. Bittrich [eds.], The families and genera of vascular plants, vol. II. Flowering plants. Dicotyledons: magnoliid, hamamelid and caryophyllid families, 586–588. Springer-Verlag, Berlin, Germany.
34. Xia N and Brach A.R. (1999). Saururaceae. In Z. Y. Wu and P. H. Raven [eds.], Flora of China, vol. 4 (Cycadaceae through Fagaceae), 108–109. Science Press, Beijing, China and Missouri Botanical Garden Press, St. Louis, Missouri, USA.