

# Fossil Drupe Fruit Revealing Angiosperm Diversity from the Deccan Intertrappean Beds of Singhpur, Madhya Pradesh, India

Kapgate Ashwini V.<sup>1</sup> and Meshram Sanjay M.<sup>2</sup>

<sup>1</sup>Department of Botany, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

<sup>2</sup>Department of Botany, Manoharbhay Patel College, Sakoli

ashwinikapgate151@gmail.com and sanjaymeshram83@rediffmail.com

**Abstract:** : A well-preserved dicot fruit was collected from Singhpur (Lat 21.616095° N and Long 78.730775° E) in Chhindwara District, M.P. The fruit is elongated to ovoid or ellipsoidal with a distinct basal long stalk. The fossil fruit is unilocular and is characterized by the presence of bitegmic seed. The fruit is a drupe and dehiscent, not clearly seen. The fruit, though, shows some characteristics of the present-day families like Salvadoraceae, Rubiaceae, Urticaceae and Oleaceae. It has close affinities with the members of the family Oleaceae. It could not conclusively be traced to any particular genus, but it is broadly placed under Oleaceae.

**Keywords:** Drupe fruit, unilocular, single seeded, seed unitegmic, Oleaceae.

## I. INTRODUCTION

The present paper deals with the detailed study of new petrified dicotyledonous drupe fruit from Singhpur, Chhindwara Dist., M.P., India. Where many dicot and monocot fruits are found scattered mixed with black and brown cherts in the field. Enigmocarponsahnii (Chitaley and Kate, 1977), Indocarpaintertrappea (Jain, 1964); Harrisocarponsahnii (Chitaley and Nambudiri, 1973); Sahniocarpon harrisii (Chitaley and Patil, 1973; Nambudiri et al., 1987; Karekar, 1989; Duabangocarpondeccanii (Kadooand Kolhe, 2002); Lytherocarponmohgaoense (Kapgate et. al., 2003); Surangeocarponmohgaoense (Kapgate et. al., 2005); Euphorbiocarponmohgaoense (Bhowal and Sheikh, 2006); Chitaleyocarponintertrappea (Kapgate et. al., 2006); Pantocarpondeccanii (Kapgate et. al., 2007); Bicarpelarocarponsinghpurii (Bhowal and Sheikh, 2008); Lymnophyllocarponsurangeii (Kolhe et. al., 2009); Tiliaceocarponjamsavlii (Meshram et. al., 2013); Lagerstroemiocarpon harrisii (Kokate et. al., 2013). One spiny capsule or utricle type of fruit described as Spinocarponmohgaoense by Kapgate in 2013. The fruit described here is also a spiny. Cocos binoriensis (Srivastava and Srivastava, 2014); Unispermospinocarponkeriensis (Kapgate and Paliwal, 2016); Coffeocarpondeccanii (Dighe and Kokate, 2016); Premnocarponmohagaonii (Dighe and Kokate, 2016); Drupaceocarponsahnii (Nandeshwar et al., 2016); Tamaricaceocarponmohgaonse (Yadav, 2017); Aizoocarpondeccanii (Borkar et al., 2017); Spinouscarponmohganii (Nandeshwar and Zingare, 2018); Tamarixocarpondeccanii (Pandey, 2019); Leguminoceocarponsinghpurii (Meshram et al., 2020); Uniloculocarponcentrales (Bobade, 2021); Geraniocarponpatanii (Patil et al, 2023); Caryopseocarpondeccanensis (Patil, 2023); Triangulocarponpatanii (Nimgade, et al, 2025) Lufocarponintertrappea (Patil et al., 2026) The fruit elongated, oval in shape, stalked, unilocular, single seeded and capsular. But the fruit described here is quite different from aforesaid fruits hence formed the matter for present investigation.

## II. MATERIALS AND METHODS

The petrified unilocular fruit described as under was collected in the form of a black chert from the Deccan Intertrappean beds of Singhpur, M.P., India. The anatomical details were studied by etching the chart with hydrofluoric



acid and peel sections were prepared without grinding the material. The fruit appeared in a longitudinal plane. The important stages of the fruit were photographed and camera Lucida sketches were drawn.

**Description:**

The fossil fruit is small, elongated and ovoid to ellipsoidal in outline, with a slightly tapering apex and a comparatively broader base. The fruit appears approximately symmetrical and shows a distinct outer fruit wall that is well preserved due to petrification. The surface is generally smooth to slightly ridged, with faint longitudinal markings. The fruit is apparently indehiscent or its mode of dehiscence is not clearly (it may be loculicidal dehiscence) recognizable from the preserved specimen. Internally, a prominent longitudinal structure is visible, suggesting the presence of a locule or septum, with an elongated central structure that may represent a preserved seed. The basal region appears to represent the point of attachment to the fruit stalk.

**Anatomical Character of the Fruit:****pericarp**

The pericarp is relatively thick, well-preserved, measuring approximately 2.375 mm in thickness, and is differentiated into three zones, namely, exocarp, mesocarp and endocarp. The mesocarp is the major portion with vascular bundles in it, while the endocarp is the part enclosing the locule and seed.

**Exocarp**

The exocarp is the outermost layer of the pericarp and is relatively thin, compact and well-preserved in the petrified fruit. It is made up of densely arranged polygonal to rectangular parenchymatous cells that form a continuous outer boundary. The cells are arranged in a single to few layers and have comparatively thick walls.

**Mesocarp**

The mesocarp is the middle and major portion of the pericarp and is relatively thick. It is mainly composed of parenchymatous cells that are polygonal to irregular in shape and arranged compactly to loosely. Vascular bundles are present in the mesocarp and are mainly longitudinally distributed. The cells have moderately thickened walls, and the mesocarp is well-preserved due to mineralization. It occupies the region between the exocarp and endocarp and makes the major bulk of the fruit wall.

**Endocarp**

The endocarp is the innermost layer of the pericarp that surrounds the locule or the seed chamber. This layer is fairly compact with thick cell walls, having polygonal to elongate cells arranged closely together. The cells have relatively thick walls compared to those in the mesocarp layer, thus making the endocarp quite rigid compared to the mesocarp. The inner surface of the endocarp is distinct and marks the boundary of the seed. The endocarp is well-preserved by petrification process, retaining its tissue arrangement.

**Locule**

The locule is the centrally located elongate structure that is surrounded by the endocarp and contains the seed. The locule appears relatively spacious, with the preserved seed occupying the central region.

**Seed morphology**

The seed is elongated to ovoid in shape and is triangular in form. The seed is enclosed in the locule and is about 9.25 mm long and 4.5 mm wide. The seed has a well developed seed coat (testa) which appears relatively thick and well preserved due to petrification. The seed surface is smooth in appearance and the outline of the seed is well defined. The seed is well centered within the locule and it appears that the seed is attached to the surrounding tissue through a short



funicular or placental region. Differentiation of seed parts such as the testa, tegmen, nucellus and embryo can be seen in well preserved specimens.

#### **Seed coat**

The seed coat makes up the outer covering of the seed and is well preserved in the petrified form. The seed coat is made up of closely packed thick walled cells, with a wall thickness of about 0.375 mm. The seed coat is differentiated into two main layers namely the outer testa and inner tegmen. The testa is relatively thick and compact made up of closely packed thick walled cells, while the tegmen layer is relatively thin and made smaller, more delicate cells. Both layers are well preserved.

#### **Stalk**

The stalk of the fruit is elongated and very noticeable, having developed from the basal part of the fruit. It is made up mostly of dense parenchymatous tissue with vascular bundles embedded in it, extending in a vertical direction toward the fruit. The stalk is about 24 mm long and 2.625 mm wide.

#### **Fruit Apex**

The fruit apex is gradually narrowing and rounded, representing a distinctive apex of the fruit. The surface of the apex is rather smooth, showing slight indentation or apex, with the pericarp extending evenly toward the apex.

### **III. DISCUSSION AND IDENTIFICATION**

The above described Fossil fruit is identified with help of following important details.

- The fruit is elongated to ovoid or ellipsoidal with a distinct basal stalk.
- The fruit apex is gradually tapering and broadly rounded, with a slightly distinct terminal region.
- The pericarp is well preserved and differentiated into exocarp, mesocarp and endocarp.
- The exocarp forms the outer compact protective layer.
- The mesocarp forms the major portion of the pericarp and contains prominent vascular bundles.
- The endocarp forms the innermost compact layer surrounding the locule.
- A distinct elongated locule is present within the fruit.
- Placentation is axile, with the ovules/seeds attached to the central axis of the locule.
- The seed is elongated to ovoid and enclosed within the locule.
- The seed coat is bitegmic differentiated into testa and tegmen.
- A distinct fruit stalk is present at the basal region and contains vascular tissue.

### **IV. DISCUSSION AND COMPARISON**

Mehrota et al. (1983) reported Euphorbiocarpon drypetoids to be the trilocular single-seeded indehiscent fruit, while the fruit is a unilocular single-seeded drupe fruit. Unispermospinocarpon keriensis (Kapgate and Paliwal, 2016) The fruit is oblong to elliptical, unilocular, single-seeded, dehiscent, and stalked, with a spiny mesocarp and basal placentation, while the seed is bitegmic and contains a poorly preserved dicot embryo, whereas the present fruit is unilocular and single-seeded but different in placentation and the pericarp is fleshy and smooth. Palmocarpon chandrapurens (Kapgate et al., 2017) the monocot palm fruit is a sessile, unilocular, single-seeded drupe, obovoid to slightly trigonous and quadrangular in shape, with a fruit wall differentiated into epicarp, fibrous mesocarp, and thick endocarp, while present fruit is different in anatomical character. Portulacaceocarpon ghatparacaii (Meshram et al., 2019) has a unilocular fruit with eight seeds, showing free-central placentation and circum-sessile dehiscence. The seeds are tetrahedral to elliptical, bitegmic, and contain a dicot embryo measuring about  $188 \times 90 \mu\text{m}$ , while the present fruit is unilocular but single seed, showing axial placentation. Leguminocarpon singhpurii (Meshram, 2020) has a dicotyledonous, unilocular, indehiscent fruit measuring about 3.2 mm in diameter. The fruit wall is 0.4 mm thick, differentiated into



epicarp, mesocarp, and hard-cell endocarp. It contains a single seed measuring  $1.1 \times 1.8$  mm, with an undifferentiated seed coat, whereas the present fruit is a drupe. *Myrtocarpon ganeshii* (Pundkaret al., 2020) is a fleshy, globose, unilocular, single-seeded drupe with three apical appendages. The pericarp consists of a thick-walled epicarp, parenchymatous mesocarp, and hard endocarp, while present fruit is drupe, fleshy pericarp but different in anatomy. *Gyrocarpus carponmohagaonii* (Niranjane and Dahegaonkar, 2025), the fruit is unilocular, dry, indehiscent, oval or semicircular with one large wing for dispersal, single-seeded, embryo not preserved, whereas present fruit elongated and ovoid to ellipsoidal in shape. *Triangulocarpon patanii* (Nimgadeet al., 2025): the fruit is triangular, unilocular, dicotyledonous, single-seeded, endospermic, and indehiscent with basal placentation, while the present drupe fruit is elongated fleshy pericarp and showing axial placentation. *Lufocarpon intertrappea* (Patil et al., 2026) is an elongated, oval, stalked, unilocular, single-seeded capsular fruit with lines of dehiscence and a hook-like apical beak, but the present fruit is an elongated, broad at base drupe.

It is clear from the above characters that the specimen is different from all the fossil fruit previously reported from Maharashtra and Madhya Pradesh.

#### **Comparison with modern families like :**

Salvadoraceae, Rubiaceae, Urticaceae and Oleaceae show one and more similar characters with the petrified fruit, but fruits of the above families are achene, drupe and nut.

The fruit of Salvadoraceae is small, fleshy and berry-like or drupe-like. It is usually globose or ovoid, with a soft and juicy pericarp. It generally contains one seed surrounded by fleshy pulp. These characters are reflected in the living genera and species like *Salvadora persica* and *Salvadora oleoides*, but the present fruit is elongated to ovoid or ellipsoidal in shape; therefore, it is different.

The fruit in the family Rubiaceae is variable and may be a berry, capsule, drupe, or schizocarp. It can be either fleshy or dry, depending on the genus. The fruit usually develops from an inferior ovary and may contain one to many seeds. In some members, the fruit is fleshy and animal-dispersed, while dry fruits may split open to release the seeds. These characters are reflected in the living genera like *Gardenia*, *Mitragyna*, *Pavetta*, *Hedyotis*, and *Spermacoce*, but present fruit morphologically different.

In Urticaceae, the fruit is a small, fleshy drupe which is mostly one-seeded and indehiscent. It arises from the superior ovary and may have the persistent perianth enclosing it. The seed is usually small and non-endospermic with straight or curved embryo. These features are seen in the living genera of *Dendrocnide*, *Laportea* and *Debregeasia* while the present fruit is drupe but does not share any similarity with them.

The fruits of Oleaceae are varied; there are fleshy drupes (olives), berries (jasmine), dry capsules (lilacs), winged samaras (ash trees) and many more but all of these arise from a superior, two-carpelled ovary containing one to four seeds. These features are reflected in the living genera and species like *Schreberaswietenoides*, *Jasminum auriculatum* and *Olea paniculata*.

*Schreberaswietenoides* has a large pear-shaped fruit that is a wooden capsule which is around 5 to 7 cm long having a rough and speckled surface. It is a dry dehiscent fruit which splits up into two thick valves to allow some pendulous, winged seeds adapted for wind dispersal, but the present fruit being examined does not match these characteristics.

*Jasminum auriculatum* has a very small globose fruit which can be found in pairs or lobules which contain either one or two seeds. The size of the fruit is about 5 to 8 mm in diameter having a smooth skin and glossy dark color, but the present fruit is not like that.

*Olea paniculata* has a small ovoid fleshy drupe fruit which is around 1 to 1.5 cm long. This is hanging in loose clusters which consist of a single hard woody seed and a thin layer of oily pulp; this is the most resembled fruit of the present one.



Table 1.1: Comparison with Living Families

| Character           | Salvadoraceae            | Rubiaceae                           | Urticaceae                          | Oleaceae                      | Present Fruit                 |
|---------------------|--------------------------|-------------------------------------|-------------------------------------|-------------------------------|-------------------------------|
| <b>Fruit type</b>   | Berry or drupe           | Berry, capsule, drupe or schizocarp | Achene / utricle                    | Capsule, berry or drupe       | Drupe                         |
| <b>Fruit shape</b>  | Globose, ovoid or oblong | Globose, ovoid or variable          | Ovoid / ellipsoid, often compressed | Ovoid, ellipsoid or elongated | Ovoid, ellipsoid or elongated |
| <b>Fruit size</b>   | Small to medium          | Small to medium                     | Very small                          | Small to medium               | Small to medium               |
| <b>Locules</b>      | 1–2                      | Usually 2                           | 1                                   | Usually 2                     | 1                             |
| <b>Seeds</b>        | 1–several                | Few to many                         | Usually 1                           | Usually 1–4                   | 1                             |
| <b>Seed nature</b>  | Usually endospermic      | Usually endospermic                 | Usually non-endospermic             | Usually non-endospermic       |                               |
| <b>Placentation</b> | Axile                    | Axile                               | Basal                               | Axile                         | Axile                         |

Table 1.2: Comparison of Genera and Species of the Family Oleaceae

| Family                 | Oleaceae                     |                             |                        |                                       |
|------------------------|------------------------------|-----------------------------|------------------------|---------------------------------------|
| <b>Genus / Species</b> | <i>Schreberaswietenoides</i> | <i>Jasminum auriculatum</i> | <i>Olea paniculata</i> | <b>Present Fruit</b>                  |
| <b>Fruit type</b>      | Berry                        | Berry                       | Drupe                  | <b>Drupe</b>                          |
| <b>Fruit shape</b>     | Globose / ovoid              | Globose / ovoid             | Ovoid / ellipsoid      | <b>Elongated to ovoid/ellipsoidal</b> |
| <b>Fruit size</b>      | Large                        | Small                       | Small to medium        | <b>Medium</b>                         |
| <b>Locules</b>         | 2                            | 2                           | 1                      | <b>1</b>                              |
| <b>Seeds</b>           | Several                      | 1–several                   | 1                      | <b>1</b>                              |
| <b>Placentation</b>    | Axile                        | Axile                       | Axile                  | <b>Axile</b>                          |

#### Etymology:

It is clear from the comparison that the present fossil shares characters entirely and shows maximum resemblance to these genera. Because it exhibits close affinities with the family Oleaceae, it is named *Olea paniculataeocarponsinghpurii* gen. et sp. nov. The generic name indicates its resemblance to the living genus *Olea*, specifically the species *Olea paniculata*, while the specific epithet is given after the locality, Singhpur, from where the fossil specimen was collected.



**Diagnosis:*****Olea paniculataeocarpon***

Petrified fruit, elongated to ovoid/ellipsoidal, with a gradually tapering to broadly rounded apex and short basal stalk. Pericarp relatively thick, differentiated into exocarp, mesocarp and endocarp; mesocarp forming the major portion and containing vascular strands, while endocarp forms the compact inner boundary of the locule. Locule elongated and containing an ovoid to elongated seed. Seed coat distinctly differentiated into testa and tegmen. Placentation presently indeterminate.

***Olea paniculataeocarpon* singhpurii**

Fossil fruit is unilocular with a single-seed, ellipsoid to ovoid in shape, with well-developed basal stalk, having size dimensions of 22.5 mm length 7.5 mm breadth. The fruit pericarp is smooth on outer surface, and it is 2.375 mm thick, consisting of exocarp, mesocarp, and endocarp; exocarp is thin-walled polygonal to rectangular parenchymatous cells, mesocarp is loosely arranged polygonal to irregular parenchymatous cells with vascular strands, and endocarp is closely packed polygonal to elongated thick-walled cells. The single locule is centrally placed and contains one seed. The seed is obovate to triangular in shape, having dimensions of 9.25 mm in length, which is differentiated into testa and tegmen; testa is made up of polygonal cells with sinuous walls, and tegmen is formed of several longitudinal fibrous layers. The seed cavity is surrounded by elongated thick-walled cells and is provided with curved vascular supply; the embryo is dicotyledonous and exalbuminous, having central lysigenous cavity made up of thin-walled parenchymatous cells.

Holotype : AVK/ANG. Dico. F2/ Deposited in the Department of Botany, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur.

Horizon : Deccan Intertrappean Series of India.

Locality :Singhpur, M.P., India.

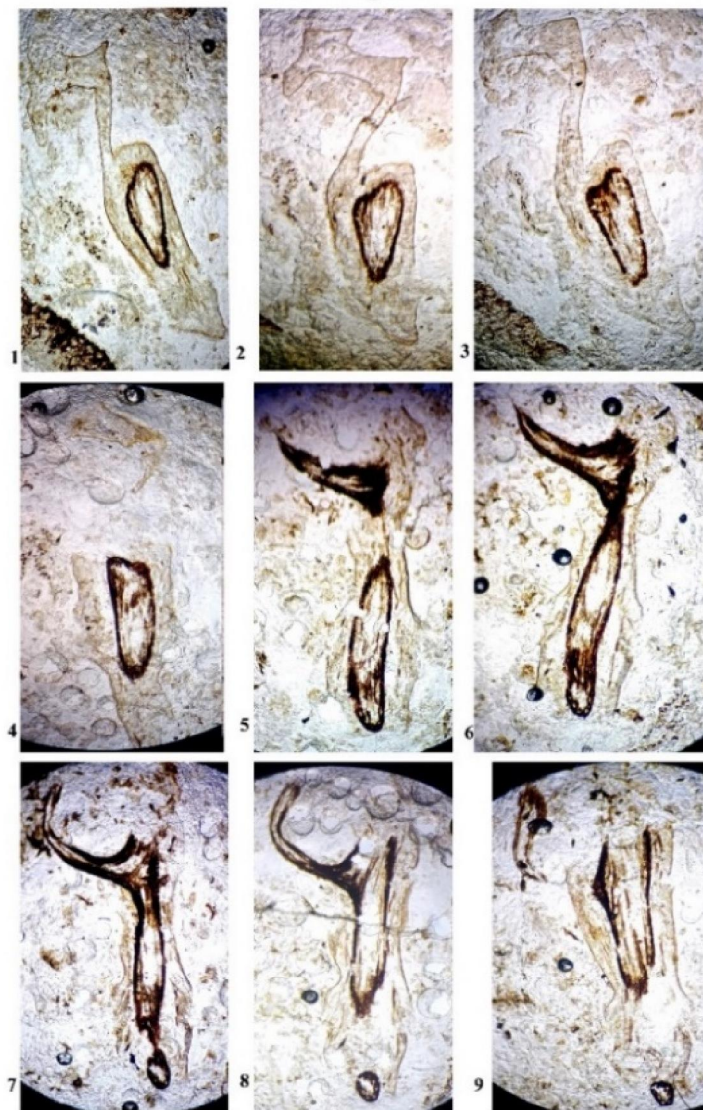
Age :? Uppermost Cretaceous.

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Plate 1 Figs. 1-9

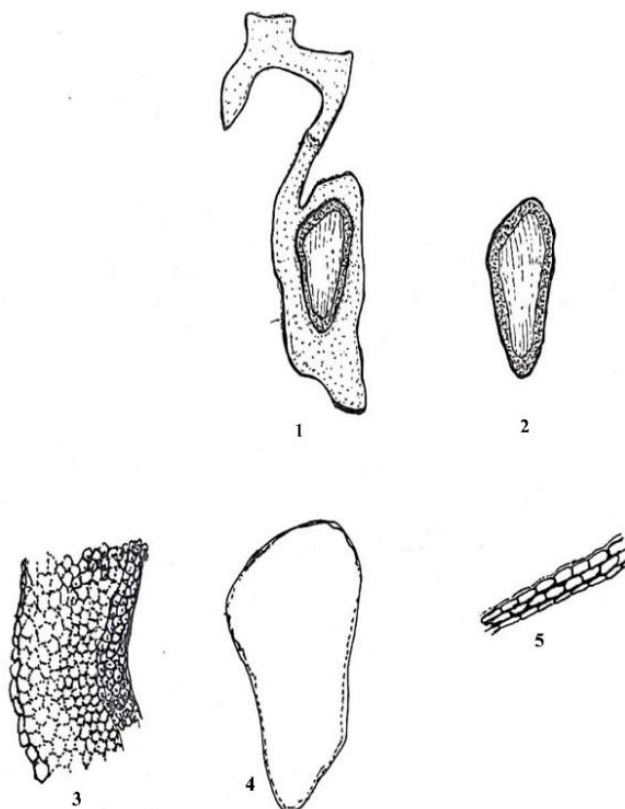


**EXPLANATION OF PLATE 1 FIGS. 1 - 9**

Figs. 1-9: Serial section of the fruit showing different stages of the fruit cut in the longitudinal section. (100X); Fig. 1: Fruit Shows stalk attachment. (100X); Fig. 2: Shows dehiscence. (100X); Figs. 5,6: Shows seed elongation. (100X).



**Text Figs. 1-5**



**EXPLANATION OF TEXT FIGS. 1-5:**

**Fig. 1:** Complete drupe fruit; **Fig. 2:** Seed; **Fig. 3:** Cellular details of fruit wall is differentiated into epicarp, mesocarp and endocarp; **Fig. 4:** Locule; **Fig. 5:** Seed Coat



Fossilsfruit compared with living member

*Olea paniculata*

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