



## **A Coconut Fruit Fossil (*Cocos L.*) from the Giral Lignite Mine of Akli Formation in Western Rajasthan, India**

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### **ABSTRACT**

The palm fruit fossil *Cocos L.* (Arecaceae) from Giral lignite mines of the Akli Formation of the Barmer Basin is reported here for the first time. It is assessed to be of Late Paleocene - Early Eocene age. This fruit fossil is close to the species *Cocos sahnii*, which is today a broad seaside component that flourishes in wet conditions. Its essence reflects the surrounding seaside conditions during the depositional era in contrast to the arid and semi-arid climates. Coconut is a very significant food plant with both household and commercial value.

**Keywords:** Akli Formation, Arecaceae, Barmer Basin, *Cocos L.*, Giral Lignite mines, Palm fruit fossil.

### **INTRODUCTION**

Since little research has been done on the floral fossil in Rajasthan (Lakhanpal and Bose, 1951; Guleria, 1996). Some authors have collected megafossils residue of plants. The first lignite in this basin was firstly reported by Oldham (1886) who conducted the systematic mapping. Earlier, Siddiqui and Bahl (1965) examined the lignite-containing Akli Formation. There are two members in this formation. First is the Giral-Thumbli lignite member at the bottom of the Akli Formation and second is the Akli bentonite member in the top region of the Akli Formation (DasGupta, 1974; Sisodia and Singh, 2000). The Giral Lignite Mine of the Akli Formation is composed of lignite, sandstones and shales from the lagoonal, delta-front environments, whereas the upper layer is consisting of shallow marine bentonite soils. The lignite seams are related to lignitic clays, lignites, clays and siltstones that range in color from dark grey to dark brown. Carbonaceous soils and lignitic soils are found both horizontally and vertically in these lignite seams. The Barmer Basin is the latest tertiary reservoir of fossil fruits collected from the Kapurdi Formation. Lamelibranchs, Ostracods, Foraminifera, Echinoids and are the common fossils found in the formation (DasGupta, 1977), while Lakhanpal and Bose (1951) reported some plant megafossils of the Calophyllaceae and Clusiaceae families. Kaul (1951)

uncovered the impression of a characteristic item (endocarp) which he named '*Cocos sahnii*', after *Cocos nucifera L.* from comparable aggregate, be that as it may, he didn't give any disclosure, understanding, or holotype number of the fossil. The fruit name mentioned by Kaul is not acceptable under the nomenclature standards (McNeil *et al.*, 2006). The Arecoideae subfamily has been related to the *Cocos L.* family, and as a result, the only recognized species, *Cocos L.*, is widely distributed in forests and probably an everyday existence in poor island and seaside conditions.

The wild-type coconut has long precocious natural products with a thick husk and short liquid endosperm, which were rapidly introduced and dispersed by ocean currents, although the trained coconut (*Niuvai-type*) has a high fluid endosperm content and it has a thin husk. The last one was developed because of the determination of the *Nukafa* under development and scarcity by the people (Harries, 1978). The Thar Desert and Aravalli Range are two of the most prominent geographical characteristics of Rajasthan. Rajasthan's climate is dry to subhumid, with annual rainfall ranging from 10-40 cm in the west of the Aravalli Range. The coconut, or *Cocos nucifera L.*, is a very significant food plant with both household and commercial value. The origin and dispersion of the genus is a controversial issue among biogeographers

and palaeobotanists due to the importance of coconuts in culture, environment, and agriculture (Harries, 1992; Gunn *et al.*, 2011). *Cocos nucifera* L. is the only known species of the genus *Cocos* L. belonging to the same family Arecaceae. This species can be found in all tropical and subtropical areas between 23° north and south of the equator and flourishes in warm, humid environments. It can also survive in temperatures up to 21°C for a short time. *Cocos*'s dispersion and cultivation history are intricately linked to the history of human activity in the tropics. The Indian and Pacific basins are further supported by fossil evidence from the Paleocene with longer existence of coconut or coconut-like species (Rigby, 1995; Shukla *et al.*, 2012).

The genus was previously thought to have originated in South America (Colombia) around the Middle-Late Paleocene, based on fossil data (Gomez-Navarro *et al.*, 2009). Later, Couvreur *et al.*, (2011) combined the Colombian fossil record (Gomez-Navarro *et al.*, 2009) and molecular phylogenetic analyses to derive a 54.8 Ma date for the stem node of the sub-tribe Attaleinae, tribe Cocoseae, to which *Cocos* belongs. The fossil fruit of *Cocos* L., also known as the coconut, is a very significant food plant with both domestic and economic importance.

## MATERIALS AND METHODS

### 1. Study Area

The fossils of the plant were discovered from the Giral



Fig. 1. Map of the study area showing plant fossil locality.

Lignite mine in the Thumbli area of the Barmer district of Rajasthan. The mine is located near Thumbli village in Barmer district (Latitude 26°03'N, Longitude 71°16'E). The Akli Formation, which ages from the Late Paleocene to the Early Eocene, and lignite are obtained from this mine. This lignite mine is located about 40 km near the North-West side of Barmer city and 14 km away from the Bhadkha village, located on the Barmer-Jaisalmer Highway (NH- 68) (Fig. 1).

### 2. Sampling Methods

The lignite seam deposition occurred from top to bottom in mines and plant fossils are found in the bottom surface of thick lignite deposition. Coconut fruit fossils are found in carbonaceous clay between lignite seam 5 and 6 of the Giral lignite mine. A deep fossilized layer lies between these two seams, where the present fossil fruit was found. The mesocarp impression of coconut fruit was found here printed on the surface of the lignite. It is an example of a natural product, which has been preserved. About 1 specimen of fruit print was obtained from Giral Lignite Mine, Thumbli area of Akli Formation, Barmer District, Rajasthan, India. The material consists of a single piece that is 12 cm long and has a width of 9 cm. This is the first-time record of a plant megafossil in the mine. It was damaged due to several fractures during excavation. The fruit fossil was a single sample of material, photographed before it was removed from the surface of the rock (Fig. 2).

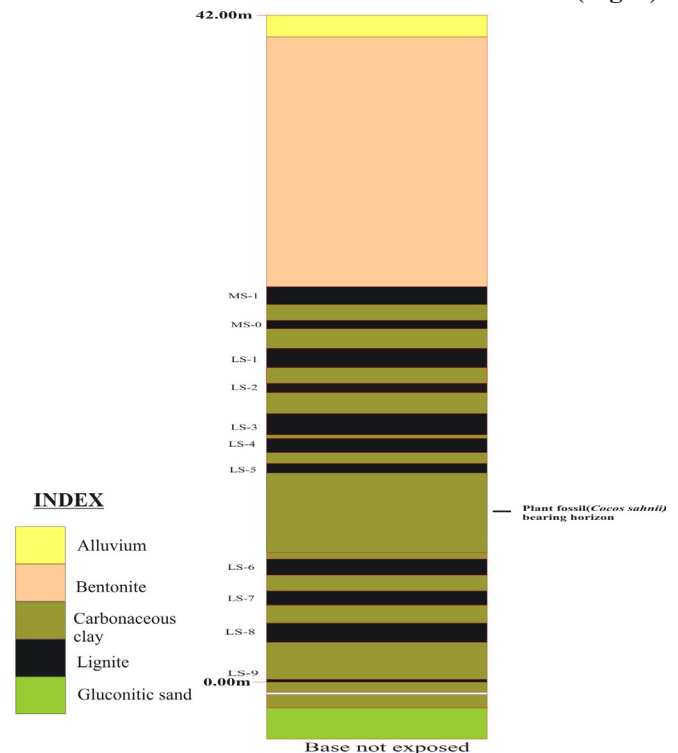
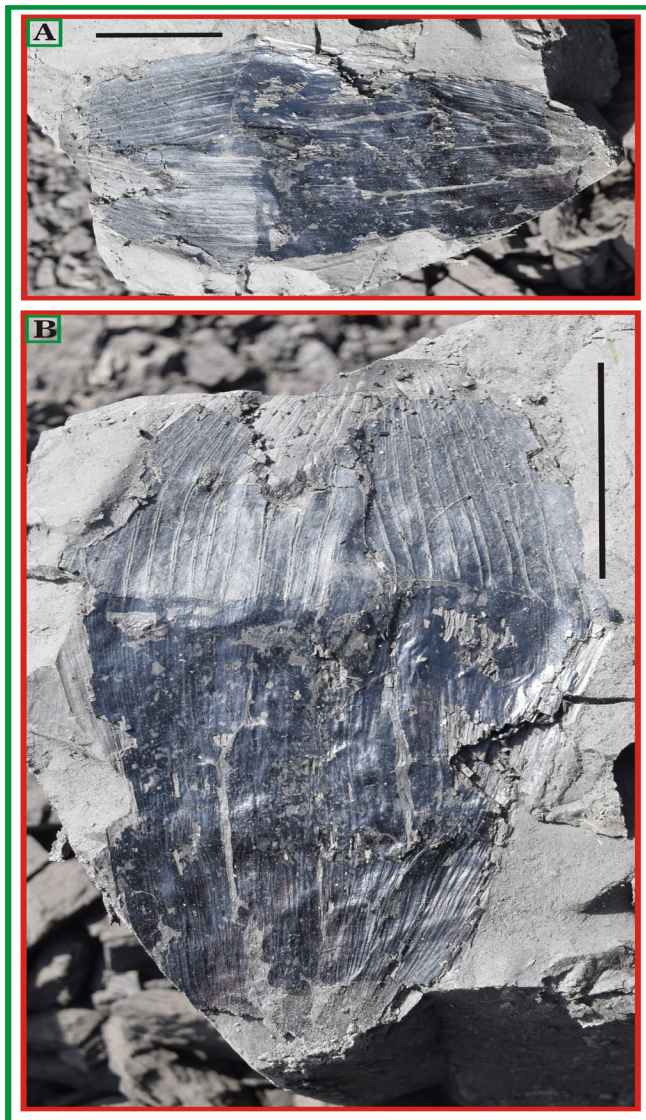


Fig.2. Lithostratigraphy of Akli Formation at Giral Lignite mine, Thumbli section.



**Fig. 3. A & B** *cocos sahnii* Kaul (1951). (A). lateral view of fossil fruit *cocos sahnii* in oval shape (B) Vertical view of the *cocos sahnii* fossil fruit that is showing the shape, size, and longitudinal fibers. (Scale bar= 3cm)

### SYSTEMATIC PALAEOLOGY

**Family:** Arecaceae (Schultz Sch., 1832)

**Tribe:** Cocoseae (Mart, 1837)

**Genus:** *Cocos* L.

**Species:** *Cocos sahnii* Kaul (1951) (**Fig-3. a & b**), (**Fig-4.**)

**Type material:** *Holotype*. JNVU/DZ/PL/AF: - 163

**Horizon:** Akli Formation.

**Type locality:** Giral lignite mine of Thumbli area, Akli Formation, Barmer Basin, Rajasthan.

**Age:** Late Paleocene - Early Eocene

**Description:** A *Cocos* is a drupe, the preserved length and width were 12 cm and 9 cm, respectively. The top



**Fig. 4.** Field photograph of *cocos sahnii* fossil fruit found in coal layer of Giral Lignite mine of Akli Formation of Barmer basin.

appeared sharp; oval-shaped, asymmetrical. The surface was partially covered with fibrous mesocarp markings. The enhancement in the center of the fruit forming the endosperm was not retained.

### RESULTS AND DISCUSSION

The ancient fruit shares similar traits to the genus *Cocos* in the Arecaceae family. Description of *Cocos* and *Cocos*-like fruits from diverse horizons in India and overseas as well as morphological information have been given (Shukla *et al.*, 2012). A new *Cocos* species, *C. binoriensis*, was recently identified from Maastrichtian, Danian Deccan Intertrappian deposits in central India (Srivastava and Srivastava, 2014). The fossil fruit was matched to previously reported fossils and was found to be similar to *Cocos sahnii*, which was discovered in the early Eocene of Rajasthan (Shukla *et al.*, 2012). The only difference between our fossils and other known species is their size. The size of fossils of *Cocos zeylandica* (Berry, 1926) and *C. intertrapensis* (Patil and Upadhyay, 1984) is lesser than our fossil. However, fossils of *C. nucifera* (Rigby, 1995), *C. nucifera*-like fruit (Tripathi *et al.*, 1999), *C. pentii* (Mishra, 2004), cf. *Cocos* sp. (Gómez-Navarro *et al.*, 2009), *Cocos sahnii* (Shukla *et al.*, 2012) and *C. binoriensis* (Srivastava and Srivastava, 2014) were having greatest size than our fossil (**Table-1**). It grows well in the wet climate, with an average annual rainfall of 1500–2500 mm and an average annual temperature of 21–30°C (Chan and Alevich, 2006). The coastal region of Southeast Asia

(Malaysia, Indonesia, the Philippines) and Melanesia is inhabited by *Cocos nucifera* (Harries, 1990, 1992). Fossil of coconut fruits found in lignite mines in the early Eocene indicates that coastal conditions existed in and around Surat during the early Eocene, rather than the current dry to the semi-arid environment (Merh, 1995). The origin of coconut has been controversial for a long time, and the new world and old-world origins of the coconut genus have been proposed. At a time when the commercial value of the coconut supported the notion of bringing it to Southern California, the classification argument was taken to extremes based on similarities (Cook, 1910), between coccoid palms belonging to Central and South America (Martius, 1823–50). Here report for the first time of the palm fruit fossil of *Cocos* L. from Giral Lignite mines that has a resemblance with the *Cocos nucifera* of the family Arecaceae reported from the early Eocene sediments of Gujrat.

## CONCLUSION

We report for the first time the plant fossil of *Cocos Sahnii* L. (Arecaceae) similar to *Cocos nucifera* that is found in the Giral lignite mine near Thumbli village of Akli Formation in Barmer District of Rajasthan. *Cocos nucifera* fruit finds in the present time in all countries in the coastal area of the ocean. It has paleoclimatology and palaeoecology importance. This revealed the presence of evergreen species at the site and proposed that the environment in Rajasthan was extravagant, permitting these evergreen taxa to flourish. Coconut (*Cocos nucifera* L.) is a very significant food plant with both household and commercial values. The onset and dispersion of diversity is a questionable issue among biogeographers and paleontologists in light of the importance of coconuts in culture, climate, and cultivation.

**Table 1. Comparison of *Cocos sahnii* (Kaul) with the previously described fossil fruits of *Cocos* (modified after Shukla et al., 2012).**

Characters	<i>Cocos zeylandic-a</i> , Berry (1926)	<i>Cocos intertrapp-eansis</i> , Patil and Upadhye (1984)	<i>Cocos nucifera</i> , Rigby (1995)	<i>Cocos nucifera</i> like fruit Tripathi et al. (1999)	<i>Cocos pantii</i> , Mishra (2004)	<i>cf. Cocos sp.</i> , Gomez-Navarro et al. (2009)	<i>Cocos sahnii.</i> , Shukla et al. (2012)	<i>Cocos binoriensis</i> , Srivastava and Srivastava (2014)	<i>Cocos sahnii</i> , (present fossil)
Locality	New Zealand	Madhya Pradesh, India	Australia	Madhya Pradesh, India	Amarkantak, India	Northern Colombia, South America	Rajasthan, India	Madhya Pradesh, India	Rajasthan, India
Geological time	Pliocene	Upper Cretaceous	Pliocene	Tertiary	Tertiary	Middle-Late Paleocene	Early Eocene	Maastrichtian - Danian	Late Paleocene-Early Eocene
Epicarp	Not preserved	Present, 135 µm thick	Not preserved	Present, 5–2 mm wide	Present with fine longitudinal striations	Not preserved	Not preserved	preserved	Not preserved
Mesocarp	Fibrous	Fibrous, 1–2 mm thick	Not preserved	Fibrous, 2–5 mm thick	Fibrous, 2–5 mm thick	Not preserved	Fibrous	Fibrous	Fibrous
Shape	Prolate spheroid	Oval	?	Ovoid	Oval	Ovoid, asymmetric	Ovoid, asymmetric	Ovoid shaped	Oval shaped
Apex	?	?	?	?	?	Acute with stigmatic remains	Acute	?	Acute
Maximum width (mm)	25–30	50	95	60–100	80–130	150	58	100	90
Maximum length (mm)	3–5 cm	0	100	130	100–150	250	117	117	120
Endocarp	Preserved	Preserved	Preserved	Preserved	Preserved	Not preserved	Preserved	Preserved	Preserved
Longitudinal ridges	?	?	?	Preserved	3-Preserved	1 preserved	2 preserved	2 Preserved	2 Preserved
Eyes	3	3 (?)	3	?	?	Not preserved	2	?	Not visible

## Abbreviations

JNVU: Jai Narain Vyas University; DZ: Department of Zoology; PL: Palaeontology Lab; AF: Akli Formation.

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## Conflict of Interest

The authors declare that they have no conflict of interest.

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