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Leaf, fruit and seed of *Cassia* L. (*Fabaceae*) from the Eocene sediments of Gurha, Bikaner District, Rajasthan, India

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ABSTRACT

Harsh R. & Shekhawat S. 2022. Leaf, fruit and seed of *Cassia* L. (*Fabaceae*) from the Eocene sediments of Gurha, Bikaner District, Rajasthan, India. Geophytology 51(1&2): 79–86.

The lignite deposits of Gurha lignite mine possess almost all plant groups either in form of spores and pollen or fragmented parts of vegetative and fertile organs. The present paper deals with the fossil leaf of *Cassia fistula* L. and leaf, fruit and seed of *Cassia angustifolia* Vahl (Family: *Fabaceae*). This is the first report of occurrence of three fossil parts of single species of *Cassia*. Palaeoecological conditions of this area during Eocene in Rajasthan are also discussed.

Keywords: Eocene, lignite, *Fabaceae, Cassia*, leaf, fruit, seed, Rajasthan, India.

INTRODUCTION

In western Rajasthan, lignite deposits are encountered at several places either in subsurface (about 20–30 m below the ground level) or in open-pit mines, e.g. Palana, Barsinghsar, Gurha, Giral, Matasukh, etc. Palynological studies of Bikaner-Nagaur Basin have been made by Singh and Dogra (1988), Kar (1995), Ambwani and Singh (1996), Kar and Sharma (2001), Tripathi et al. (2008) and Harsh and Shekhawat (2018, 2020). The occurrence of oil-bearing alga *Botryococcus braunii* Kütz. was reported for the first time in the lignite of Palana by Rao and Mishra (1949). Rao and Vimal (1950, 1952) and Sah and Kar (1974) described pollen and spores from Palana lignite. Harsh and Sharma (1992) studied a carbonized wood from Palana and identified its inorganic and organic contents. Tripathi et al. (1998) described plant microfossil from the lignite of Barsinghsar. These microfossils include algal filaments, fungal hyphae, sporangia, spores, cuticle, pollen grains as well as peculiar kind of seed and fructification.

MATERIAL AND METHOD

For the present study, more than 15 specimens of leaf impressions have been collected from over-burden of Gurha lignite mine (Lat. 27.5229^{o}N, Long. 72.52269^{0}E). It is situated about 70 km southwest of Bikaner city (Figure 1). There is a great variation in the size of leaves. It ranges from 0.8 × 3 cm to 15 × 21 cm. Mostly, leaves are greyish in colour. The leaf impressions were studied under the EISCO Stereo binocular microscope and compared with a large

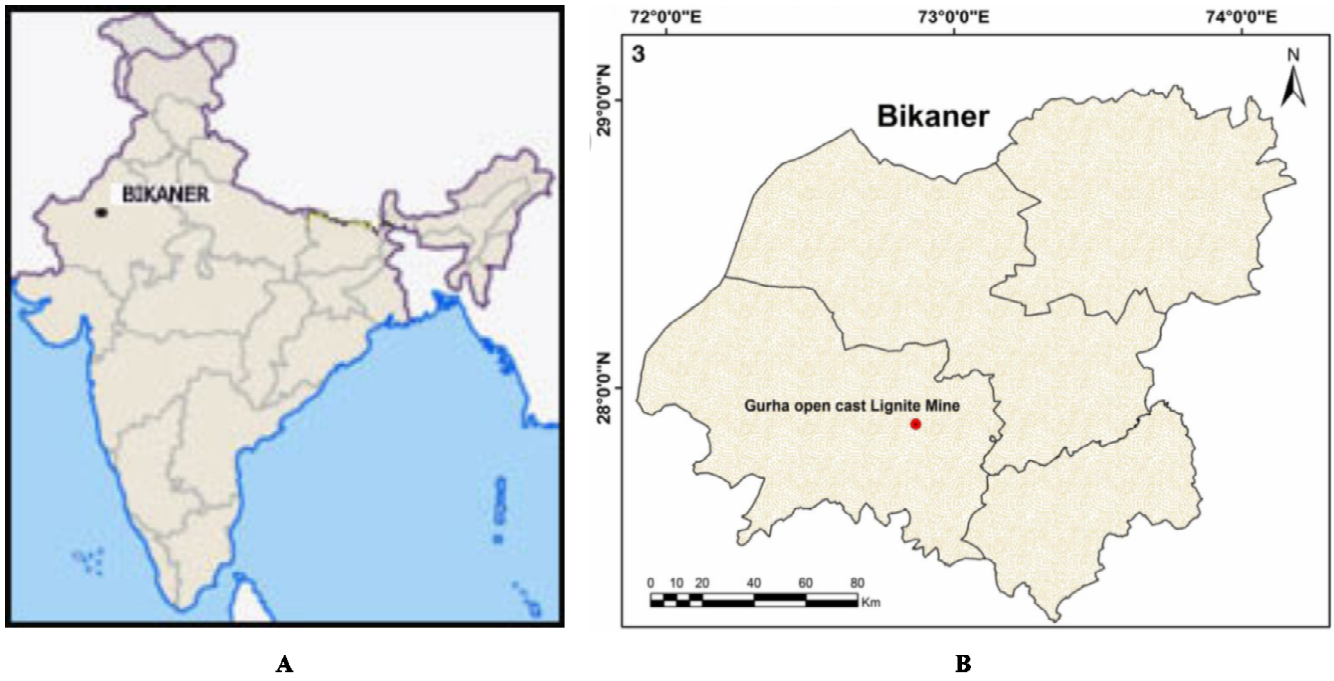

Figure 1. A. Map of India showing location of Bikaner. **B.** Map of Bikaner District showing location of the Gurha open-pit lignite mine.

number of modern leaves from the herbarium sheets available in the herbarium of Botanical Survey of India (B.S.I.), Jodhpur and herbarium of Dungar Post-Graduate College Bikaner. Almost all the specimens were found to resemble with the modern leaves quite closely. The photograph of the comparable modern leaves showing similar morphological characters were also taken at the same magnification and put along with those of fossils leaves (Figures 2, 3).

The photographs of the leaf impressions, showing morphological characters, were taken by Canon 1100d DSLR camera. The microscopic structure of the surface (cuticle and stomata) of impressions were, also studied using transparent peels (e.g. Fevicol, Quick Fix) and mounted on slide for microscopic study. For identifying these leaves, parameters suggested by Hickey (1973, 1979), Dilcher (1974), Melville (1976), Ash et al. (1999) and LAWG (1999) were followed and compared with published papers (Dickinson et al. 1987, Agarwal 1991, 2002, Ambwani 1991).

DESCRIPTION

Phylum: *Tracheophyta* Kenrick & Crane

Class: *Magnoliopsida* Cronquist et al.

Order: *Fabales* Bromhead

Family: *Fabaceae* Lindley

Genus: *Cassia* L.

Cassia fistula L. 1753

Figure 2.1–6

Material: The present specimens are well-preserved leaf impression. There is no trace of any cuticle preserved on the impression.

Number of specimens: Two (Specimen no. 6 and 20, M.S. Government Girls College, Bikaner, India).

Figure 2. *Cassia fistula* L. **1.** Fossil leaves showing shape, size and venation pattern, ×0.7. **2.** Modern leaves showing resemblance in similar shape, size and venation pattern, ×0.7. **3.** Hand diagram of fossil leaves showing clear pattern of venation up to tertiary level, ×0.7. **4.** Fossil leaves showing shape, size and venation pattern, ×0.9. **5.** Modern leaves showing resemblance in similar shape, size and venation pattern, ×0.9. **6.** Hand diagram of fossil leaves showing clear pattern of venation up to tertiary level, ×0.9.

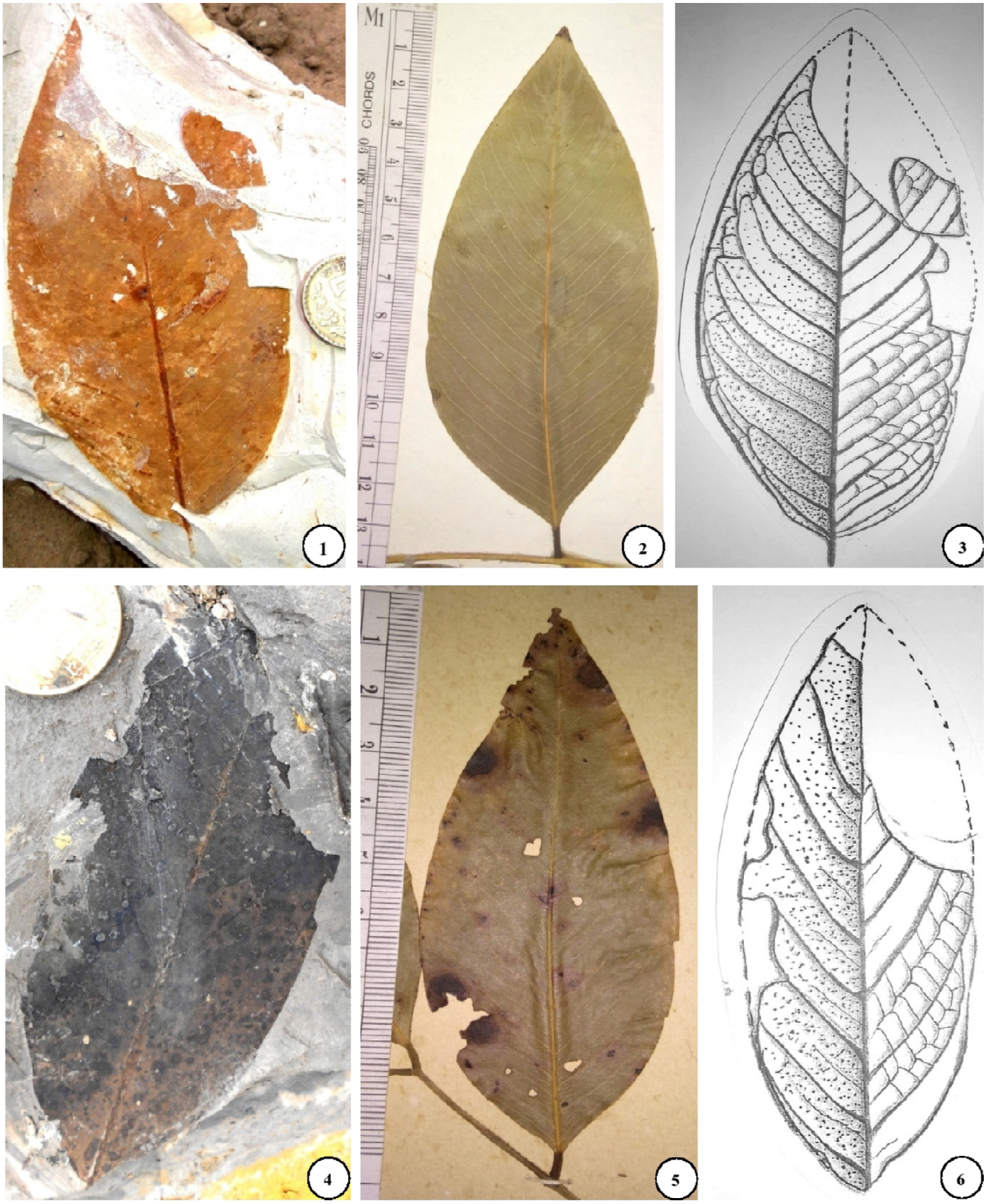

Figure 2

Description (leaf): Leaves symmetrical, narrow elliptical, preserved size 12.5 × 6.2 cm and 10.4 × 4.1 cm (L/W ratio 3:1), microphyll/mesophyll (one side area 15–30 cm^2), apex broken, base obtuse, margin entire, petiole 0.6 cm long and normal, venation pinnate, semi-craspedodromous type, primary vein (1°) single, prominent, stout, straight, secondary veins (2°) about 10 to 12 pairs, with nearly right angle of divergence, angles gradually decreasing towards apex, uniformly curved up, closely spaced, 0.6 to 1.2 cm apart from each other, alternate to opposite, inter secondary veins present and simple, tertiary vein (3°) fine.

Location and age: Gurha, Bikaner District, Rajasthan, Eocene.

Modern affinity and comparison: The important characters of the fossil leaves such as narrow elliptical shape, craspedodromous venation and closely spaced secondary's with nearly right angle of divergence indicates their close affinity with the modern leaves of *Cassia* of the family *Fabaceae.* Leaf was compared with a number of species of modern leaves of *Cassia* (like *Cassia fistula*, *Cassia angustifolia, Cassia holosericea, Cassia absus, Cassia obtusifolia, Cassia occidentalis* and *Cassia tora*). Comparison was also made with the published paper of fossil of *Cassia* spp. *Cassia antiqua* **(**Awasthi & Lakhanpal 1990), *Cassia siwalica* **(**Prasad 1994a), *Cassia* cf. *C. fistula* Linn. (Prasad 1994b), *Cassia dayalii* **(**Mathur et al. 1996), *Cassia praesophora* **(**Agarwal 2002), Dwivedi et al. (2006). Critical examination and comparison with above leaves indicates that the leaf of *Cassia fistula* L. (BSI Jodhpur sheet no. 14203 and 38470) show closest resemblance with the fossils hence leaf is identified as *Cassia fistula* L. The modern taxon *Cassia fistula* with which the fossil show close affinity, is a medium-sized, deciduous trees, with yellowish or greenish-grey bark. Leaves 20–45 cm long; leaflets 4–8 pairs, 8–20 × 3.0–8.5 cm, ovate or elliptic-ovate, glabrous above, glabrescent beneath. Flowers in axillary, pendulous, lax racemes, yellow. Pods 35–40 cm long, dark blackish-brown. Seeds ovate or ellipsoidal, glabrous.

Cassia angustifolia Vahl 1790

Figure 3.1–9

Material: The present specimens are well-preserved leaf impression, fruit and seed. There is no trace of any cuticle preserved on the impression.

Number of specimens: Three (Specimen no. 19, 19a and 101, M.S. Government Girls College, Bikaner, India).

Description: Leaflet: Symmetrical, narrow elliptical, preserved size 3.1 × 0.9 cm (L/W ratio 3:1), nanophyll (one side area 1.16 cm^2), apex obtuse and base acute, margin entire, petiole 0.2 cm long, venation pinnate craspedodromous type, primary vein (1°) single, prominent, massive, straight, secondary veins (2°) 9 pairs visible, angle of divergence about 45°, moderately acute, 0.3 to 0.5 cm apart from each other, uniformly curved up, usually alternate, unbranched, inter-secondary veins present, simple, tertiary veins (3°) fine. **Fruit:** Oblong shaped, preservation size 2.8 × 0.8 cm size, lomentum (8 constrictions). **Seed:** Oval shaped preservation size 0.8 × 0.4 at base and 0.8 × 0.5 at apex.

Location and age: Gurha, Bikaner District, Rajasthan, Eocene.

Modern affinity and comparison: The important characters of the fossil leaflet such as narrow elliptical shape, craspedodromous venation and closely spaced secondary veins with 45° angle of divergence indicates their close affinity with the modern leaves of

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Figure 3. *Cassia angustifolia* Vahl **1.** Fossil leaflet showing shape, size and venation pattern, ×1.9. **2.** Modern leaflet showing similar shape, size and venation pattern, ×1.5. **3.** Hand diagram of fossil leaflet showing clear pattern of venation up to tertiary level, ×1.5. **4.** Fossil fruit showing shape, size and 7–8 constrictions, ×1.6. **5.** Modern fruit showing similar shape and size with marking of seed within it, ×2.2. **6.** Hand diagram of fossil fruit showing shape, size and 7–8 constrictions, ×2.2. **7.** Fossil seed showing shape and size, ×3. **8.** Modern seed showing similar shape and size, ×3.2. **9.** Hand diagram of fossil seed showing shape and size, ×3.2.

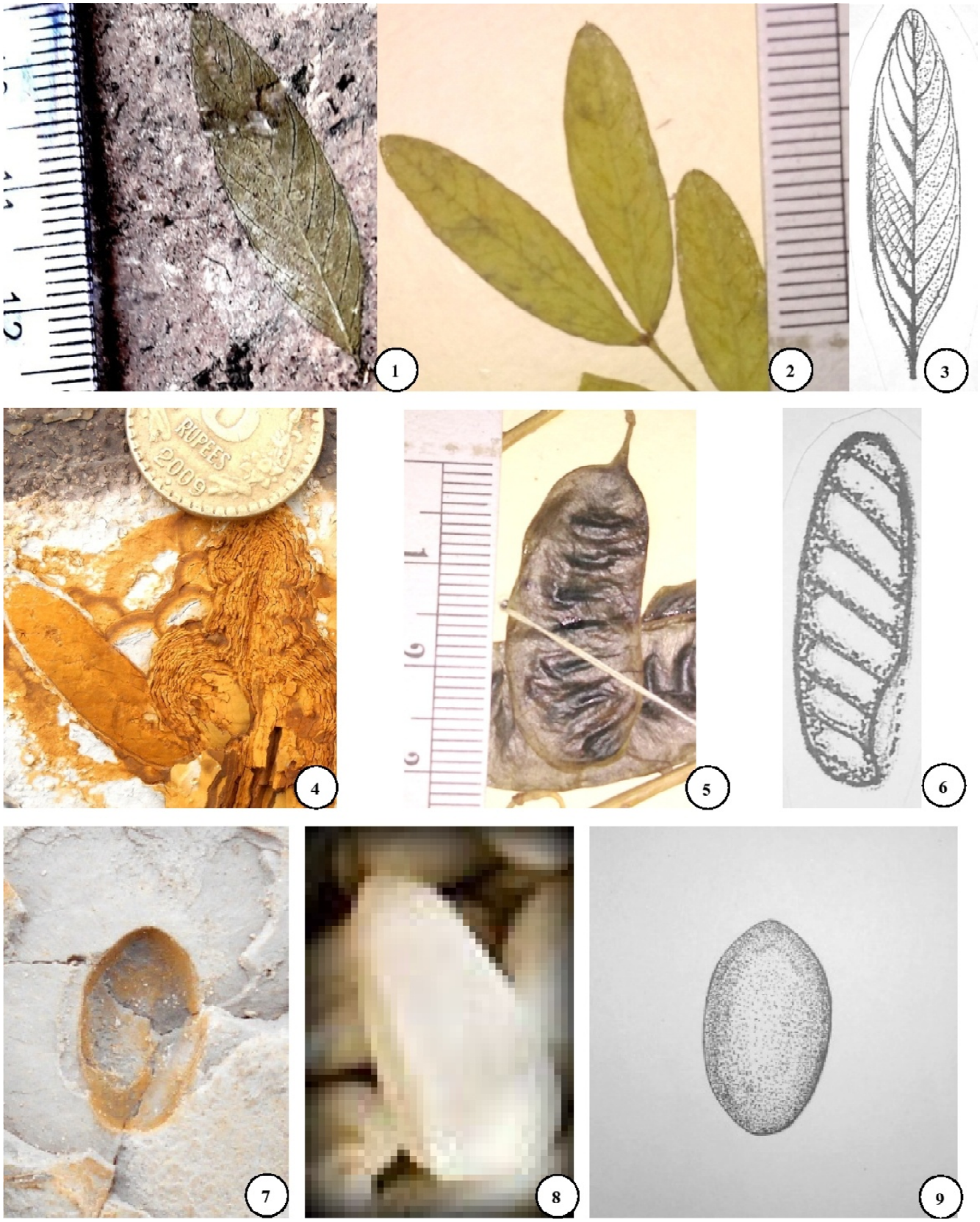

Figure 3

Cassia of family *Fabaceae.* Leaf was compared with a number of species of modern leaves of *Cassia* like *Cassia fistula*, *Cassia angustifolia, Cassia holosericea, Cassia absus, Cassia obtusifolia, Cassia occidentalis* and *Cassia tora*). Comparison was also made with the published paper of fossil of *Cassia* spp. *Cassia antiqua* (Awasthi & Lakhanpal 1990), *Cassia siwalica* (Prasad 1994a), *Cassia* cf. *C. fistula* L. (Prasad 1994b), *Cassia dayalii* (Mathur et al. 1996), *Cassia praesophora* (Agarwal 2002), Dwivedi et al. (2006). A Critical examination and comparison with above leaves indicates that the leaves of *Cassia angustifolia* (Botanical Survey of India, Jodhpur, Sheet No. 28386 and 28387) show closest resemblance with the fossils. The present leaf impression is identical to *Cassia angustifolia* described from opposite Kendriya Vidyalaya (AF) no. 1, Jodhpur, Rajasthan, India hence leaf is identified as *Cassia angustifolia.* The modern taxon *Cassia angustifolia*, with which the fossil show close affinity, is a shrubby plant that reaches 0.5–1 m, rarely two meters in height with a branched, pale-green erect stem and long spreading branches bearing four or five pairs of leaves. These leaves form complex, feathery, mutual pairs. The leaflets vary from 4 to 6 pairs, fully edged, with a sharp top. The midribs are equally divided at the base of the leaflets. Its legume fruit are oblong, compressed and flat and contain about six seeds.

PALAEOECOLOGY

From the fossil plant data available from the Tertiary sediments of Rajasthan, it is evident that the plants show vide variations in their habitat. Extinct remains of *Cocos, Mesua, Garcinia* at Kapurdi and palm pollen, e.g. *Barringtonia*, *Rhizophora*, etc. suggest the existence of marine conditions in this area. Occurrence of fossils of marine fish and echinoderm supports to this hypothesis. However, the plant megafossils discovered, i.e. broad and large sized leaves of dicot plants from Barmer, *Mangiferoxylon* and *Glutoxylon* from Jaisalmer and the present collection of dicot leaves, described in this paper, favour presence of warm and humid climate, but certainly not of marine conditions in the western shelf of Rajasthan.

RESULT

It is postulated that during the Tertiary Period, there were low-land as well as high-land areas. In the former, probably the sea intruded quite far in the land making gulf like structure. The low-land areas had plants like Cocos, *Mesua, Garcinia, Rhizophora*, etc. On the other hand, in the high-land areas, although the climatic conditions were humid and warm, there had been no effect of the 'sea gulf'. As a result, broad and large sized fossil leaves are found in some of the Eocene localities in the western shelf of Rajasthan. However, more investigations are required in this connection.

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