On the Indian origin of *Ocimum* (Lamiaceae): a palynological approach

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Hexacolpate pollen grains recovered from a bore hole core no K 12, drilled by the MECL at Kuchuan-Tilnia area, Bikaner District, Rajasthan closely resemble the extant pollen of *Ocimum* spp. by their size range, shape, pluricolumellate reticulation and presence of columella in laminas. The palynological assemblage from where these grains were recovered indicates an Early Eocene age. Since this is the oldest record of fossil *Ocimum* pollen known so far it is postulated that the genus *Ocimum* originated in India.

**Key-words**—Palynology, *Ocimum*, Origin, Early Eocene (India).

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THE family Lamiaceae (Labiatae) consists of about 180 genera and 3500 species. It is mostly concentrated in the Mediterranean region but according to Willis (1973) some groups have localised distribution in Australia, Tasmania, India, etc. Some of the genera of Lamiaceae like *Mentha* and *Lycopus* are marshy plants, some are climbers (*Stenogyne*). Most of them are herbs, but few like *Hyptis* are small trees; while *Gomphostemma* excels in the rain forest.

Mukerjee (1940) remarked that of the Indian Lamiaceae, the most common genera are *Leucas*, *Nepeta*, *Plectranthus*, *Pogostemon*, *Salvia*, *Scutellaria* and *Gomphostemma*. *Ocimum* is a small genus and only 9 species are found in India. Of which, three are exotic. All the species of *Ocimum* have hexacolpate pollen grains. Polycolpate pollen are common in the Early Tertiary sediments of India and reported by many a palynologists. Sahni, Sitholey and Puri (1947) were the first to report a polycolpate pollen from the Early Miocene sediments of Assam. Rao and Vimal (1950, 1952), Bose (1952), Vimal (1952, 1953) and many others described various types of polycolpate grains from different Tertiary sediments of India (see Saxena, 1982). These pollen are accommodated in more than 30 genera. Saxena (1982) observed that a number of these genera were proposed on minor differences, while in others pollen having distinguishing characters were clubbed together into one genus.

At present polycolpate pollen are found in a number of families, viz., Bruniceae, Chloranthaceae, Ctenolophonaceae, Didiereaceae, Euphorbiaceae, Lamiaceae, Papaveraceae, Pedaliaceae, Polygalaceae, Saxifragaceae, Scrophulariaceae, etc. It leads to a logical assumption that the fossil polycolpate pollen were also produced by diverse families. These groups of plants are, however, difficult to
identify by studying the pollen alone in the dispersed condition, because in most of the cases they are devoid of any special morphological feature.

The pollen of *Ctenolophon* of the family Ctenolophonaceae is an exception. It has ring like, occasionally branched exinal thickenings, one in each apocolpium and are inter connected by meridional thickenings. By this character it could be traced from Maestrichtian to present day. According to Muller (1981), many of the polycolpate pollen described by Baksi (1962), Mathur (1966), Sah and Dutta (1968, 1974), Venkatachala and Kar (1969), Venkatachala and Rawat (1972), Rawat et al. (1977) could be accommodated in *Ctenolophon parvifolius* type. The parentage of rest of the polycolpate pollen could not be definitively ascertained.

The present study deals with a type of hexacolpate pollen recovered from a bore core (no. K 12) drilled by the MECL at Kuchaur-Benia area, about 30 km south west of Bikaner on Bikaner-Nagaur road, Rajasthan. The area covered by alluvium is also presently investigated by the Geological Survey of India for lignite exploration. The thickness of the lignite is about 1-2 m thick and is roughly found 80 m below the surface. In all, 10 samples from the bore core no. K 12 were collected at the depth of 134 m, 125 m, 122 m, 121 m, 98 m, 97 m, 95 m, 90 m, 85 m and 80 m, respectively. The lithology of the bore hole core and location of samples are provided in Text-figures 1 and 2. All the samples yielded spores and pollen grains. The palyno-assemblage is dominated by the angiospermic pollen; the pteridophytic spores are rare and the gymnospermic pollen are absent. The common taxa are *Neocouperipollis kutchensis* Venkatachala & Kar 1969, *Tricolpites reticulatus* Cookson 1947, *Margocolpites isukatai* Ramanujam 1966, *Lakiapollis ovatus* Venkatachala & Kar 1969, *Proxapertites operculatus* van der Hammen 1956, *Proxapertites cursus* van Hoekken-Klinkenberg 1966, *Calophyllumpollenites rotundus* Sah & Kar 1974, etc. On the basis of palynoflora an Early Eocene age is ascribed to the assemblage. Rao and Vimal (1950), Sah and Kar (1974) and others worked on the Early Tertiary palynofossils of Rajasthan. Besides, some new forms are also present in the assemblage. The hexacolpate form, described here, are first encountered at 134 m depth and very common at 80 m. The slides of the concerning palynomorphs have been deposited at the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

**GEOLOGY**

The 'West Rajasthan Shelf', according to Das Gupta (1973), is made up of a number of sedimentary basins separated from each other by basement ridges. The Bikaner-Nagaur Basin is one of these basins while the others are Jaisalmer Basin, Barmer Basin and Sanchoore Basin. The major part of these basins is, however, covered by sand and sand dunes making correlation and mapping an uphill task. Bhola (1940), Jacob and Sastri (1950), Singh (1951, 1952, 1953, 1971), Ghosh (1962), Khosla (1967, 1968), Shrivas tava (1971), Das Gupta (1977), Pareek (1981), Singh (1984) and others studied the geology of this shelf. Shrivastava (1971) proposed a rock stratigraphic classification of Bikaner-Nagaur area as under:

<table>
<thead>
<tr>
<th>System</th>
<th>Formation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quaternary</td>
<td>Mar Formation</td>
<td>Dirty white, brown ferruginous, medium to coarse grained, gritty and conglomeratic, current bedded sand with minor variegated slate and clay (560 ft thick).</td>
</tr>
<tr>
<td>Jogira Formation</td>
<td>Nummulitic yellow limestone, marl, test beds, foraminiferal limestone and grey to yellow Fuller's earth (520 ft thick).</td>
<td></td>
</tr>
<tr>
<td>Tertiary</td>
<td>Palana Formation</td>
<td>Variegated clays, interbedded nummulitic limestone and marls with dark to grey sticky clays and minor sandstones: lignite at places (700 ft thick).</td>
</tr>
<tr>
<td>Triassic</td>
<td>Mayakor Formation</td>
<td>Dark coloured ferruginous and interbedded sandstones and conglo-merates (100 ft thick).</td>
</tr>
<tr>
<td>Palaeozoic</td>
<td>Palaeoza Formation</td>
<td>Yellow to red coloured gritty sandstone, interbedded ferruginous and variegated clays. Bap boulders contain boulders of igneous and metamorphic rocks (100 ft thick).</td>
</tr>
</tbody>
</table>

**PLATE 1**

(All photomicrographs are enlarged ca. x 1000, unless otherwise mentioned)

1-6, *Ocimumpollenites indicus* gen. et sp. nov., Slide nos. 11285, E27/1; 11275, K29/1; 11286, E26/1; 11275, M18/2; 11286, D28/3; 11275, K29/1.
2-5. Parts of exine showing pluricolumellate reticulation.
7. Pollen of *O. basilicum* showing the disposition of colpi.
SYSTEMATIC DESCRIPTION

Genus—Ocimumpollenites gen. nov.

Type species—Ocimumpollenites indicus sp. nov.

Generic diagnosis—Pollen grains subcircular-circular in polar view, size range 56-72 µm, 6 colpate, brevicolpate, colpi slit-funnel shaped in polar view. Exine 2-4 µm thick, sexine thicker than nexine. Tectate, columellate, some columella fused at top but free at base, reticulation broad, muri pluricolpulate, columella also present in lumina.

Comparison—Retistephanocolporites van der Hammen & Wijmstra 1964 is distinguished from the present genus by its colporate nature. Similarly, Psialastephanocolporites Leidelmeyer 1966 is differentiated by its colporate condition and laevigate exine and Stephanocolporopollenites Thomson & Pflug 1953 is mostly porate. Ocimumpollenites proposed here is distinguished from all the polycolpate forms by its thick exine, pluricolpulate reticulation and presence of columella in lumina.

Ocimumpollenites indicus sp. nov.
Pl. 1, figs 1-6, 8

Holotype—Pl. 1, fig. 4, size 65x60 µm, Slide no. 11275, M 18/2.

Type locality—Bore hole core no. K 12, depth 80 m, Palana Formation, Early Eocene, Bikaner District, Rajasthan.

Description—Pollen grains mostly found in polar view, subcircular-circular, 56-68 x 54-65 µm, hexacolpate, brevicolpate, colpi generally slit like, distinct. Exine 2-4 µm thick, sexine thicker than nexine; tectate, columellate, columella closely placed, some columellae fused at top but free at base. Reticulate, reticulum broad, square-rhomboidal in shape, muri pluricolpulate, few columella also present in lumina.

Remarks—Muller (1981) thinks that there are only few fossil records of undoubtedly Lamiaceous pollen. Embolden (1964) described fossil Salvia pollen from the Late Miocene of Alaska. Van Campo (1976) reported some Lamiaceous pollen from the Late Miocene of Spain while Menke (1976) reported same type of pollen from the Pliocene of Germany.

Boltenhagen (1976a, 1976b) reported some pollen resembling Salvia as Hexacolpites michelbichvili from the Coniacian of Gabon. Muller (1981), in view of the similar pollen occurring in other genera of Lamiaceae and considerable stratigraphic hiatus between his and other records kept this finding as pending.


A comparative study of pollen morphology and cytology investigated by Leitner (Erdtman, 1952) in-
indicates that tricolpate pollen are shed in 2 nucleate stage and hexacolpate pollen in 3 nucleate stage. This led Erdtman to divide Lamiales into two broad groups. In the group with 2 nucleate stage having 3-4 colpi he included Ajugoideae (except Rosmarineae), Prostantheroideae, Prasinoideae, Scutellarioideae and Stachyoidae (in parts). In the other group, he placed Rosarineae of Ajugoideae, Lavanduioideae, Stachyoidae (Salvia and others), Ocimoideae and Catopherioideae.

Varghese and Verma (1968) worked on the pollen grains of some Indian Lamiaceae (Labiatae). They observed hexacolpate pollen grains in different species of Salvia, Elsholtzia, Micromeria, Origanum, Calamintha, Thymus, Ocimum, Plectranthus and Coleus. Of all these genera, Ocimum pollen described and illustrated by them resemble the fossil pollen described here by thick exine, pluricolumellate, broad reticulation and presence of columella in the lumina. The pollen grains of Salvia coccinea (Varghese & Verma, 1968, fig. 5) and Plectranthus gerardinus (Varghese & Verma, 1968, figs 11-12) have also pluricolumellate reticulation but the columella are absent in lumina. Erdtman (1952, fig. 130C, p. 218) illustrated the pollen of Catopheria chiapensis. Here the reticulation is simplibaculate and the colpi margin is provided with granulate membrane.

Ocimum basilicum pollen illustrated by Reille (1992, p. 171) closely resemble Ocimumpollenites by its hexacolpate condition and ornamental pat tern. Reille (1992) described several species of Polygonum. Most of them are either tricolporate (e.g., P. bistorta, P. aviculare) or periporate (viz., P. hydropiper, P. minus) and only P. amplexicaule is pentacolpate.

Pollen of Ocimum—From the above discussion it is clear that the fossil pollen described here closely resemble the pollen of extant Ocimum. To ascertain the nearest resembling species, the pollen of Ocimum basilicum, O. sanctum, O. americanum and O. kilimandscharicum were examined at the French Institute, Pondicherry (courtesy of Dr C. Caratini). The pollen grains of these 4 species are very similar to each other in size range, hexacolpate nature, pluricolumellate reticulation and presence of columella in lumina. Thus it was very difficult to tag the fossil pollen with the pollen of any particular living species of Ocimum.

Present distribution—Ocimum is a genus of aromatic herbs, undershrubs or shrubs distributed generally in the tropics. Zaheer et al. (1966) remarked that the nomenclature of Ocimum species is complicated and confused. Mukerjee (1940) revised the Lamiales of the Indian subcontinent and remarked that the tribe Ocimoideae with the exception of Lavandula is confined to the East and tropical Africa and is almost entirely absent in other parts of the world. According to him, Ocimum basilicum is confined to India, Malay Peninsula, China, Formosa and Polynesia. Ocimum sanctum is found in India, Malay Peninsula, China, Pacific Islands, Australia, western Asia, Arabia and Japan. O. americanum flourishes in India, China, Japan, Western Asia, tropical Africa, Madagascar and America (cultivated). O. kilimandscharicum is originally a plant of tropical Africa but grows luxuriantly in the plains of India (Text-figure 3).
Homeland of Ocimum—The distributional pattern of different species of Ocimum enumerated above points out that India occupies a central region from where the different species might have migrated towards east and west except O. kilimandscharicum which seems to be migrated to India from the tropical Africa. The occurrence of fossil Ocimum pollen in the Early Eocene of Rajasthan also substantiates this assumption. Hexacolpites mitchelli chwili described by Boltenhagen (1976a, 1976b) from the Coniacian of Gabon is presumably Salviaceous pollen. The records of Embolden (1964), van Campo (1976) and Menke (1976) are from Late Miocene to Pliocene and supposed to be of Salvia and Mentha types of pollen. Since the present record happens to be the oldest record of Ocimum known so far it may be assumed that Ocimum originated in India and then migrated towards east and west.

Croizat (1952) observed that to investigate the genorheiron of Lamiaceae (Labiatae) is a difficult task as practically uninterrupted chain of intermediates could be aligned to associate Lamiaceae with Scrophulariaceae, Verbenaceae, Avicenniaceae, Acanthaceae, etc. He commented that the southern waters of the modern world are firmly held in the grip of Lamiaceous plants. So whether some plants are American or Asiatic in origin is nothing but mincing of words. However, since we are dealing only with
Ocimum which has rather a restricted distribution and undoubted fossil pollen record in the Early Eocene sediments of India we are rather forced to advocate its origin in India.

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REFERENCES


