Boraginaceae seeds from the Lameta Formation (Late Cretaceous) of Gujarat, India and possible evolutionary trends in fossil borages

Anil K. Mathur[1] and U. B. Mathur[2]

[1]Palaeontology Division, Northern Region, Geological Survey of India, Sector E, Aliganj, Lucknow-226024, India; Present address: H. No. 77, Sector 14, Indira Nagar, Lucknow-226016, India
[2]Western Region, Geological Survey of India, Jaipur; Present address: Flat No. 103, Apple Palm Apartment, B 198 University Marg, Jaipur-302015, India
E-mail: dr_anil_mathur@yahoo.co.in; ubmathur@gmail.com

ABSTRACT

Mathur A. K. & Mathur U. B. 2011. Boraginaceae seeds from the Lameta Formation (Late Cretaceous) of Gujarat, India and possible evolutionary trends in fossil borages. Geophytology 40(1-2): 75-82.

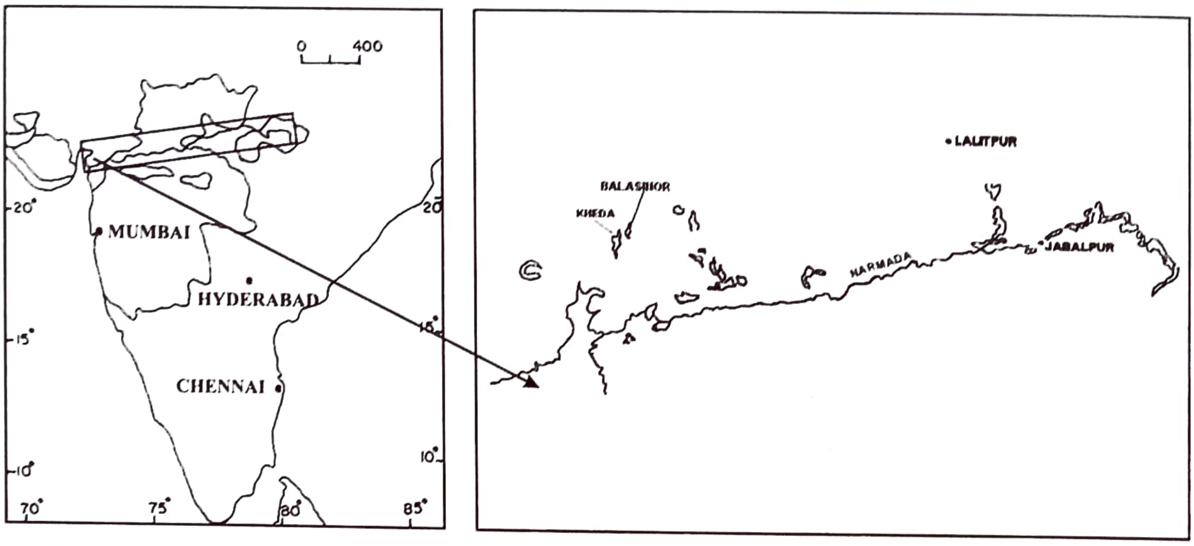
Seeds assignable to the dicotyledonous family Boraginaceae are described, for the first time, from the dinosaur rich Lameta Formation. The seeds recovered from dinosaur egg and bone bearing limestone and marl beds near Balasinor, Kheda District, Gujarat, western India have been assigned to a new genus and species *Proboraginocarpus balasinorensis*. Further, a review of fossil and modern Indian borage seeds reveals that the characters of basal attachment scar, i.e. its shape, tapering anterior end, surface ornamentation are characters which indicate close lineage links of Late Cretaceous *Proboraginocarpus balasinorensis* with *Boraginocarpus lakhanpalii* Mathur from Tatrot Formation (Pliocene) of the Siwalik Group and the modern *Anchusa officinalis*. An American Pliocene borage seed *Cryptantha coroniformis* from Ogallala Formation also has characters which are close to *Boraginocarpus lakhanpalii* and appears to belong to the basic Late Cretaceous stock. Many genera of the Tribe Boragineae, family Boraginaceae are native to the Old World and are distributed in Asia, Africa and Europe. Studies on the origin and evolution of Tertiary relict floras have shown that these are distributed throughout large part of the Tertiary in Northern Hemisphere and are now restricted to south-eastern and western North America, East Asia and South-west Eurasia.

Key-words: Boraginaceae seeds, Lameta Formation, Late Cretaceous, Balasinor, Gujarat, evolutionary trends.

INTRODUCTION

The Lameta Formation is well known in Indian stratigraphy for its dinosaurian remains and is widely distributed in central and western India as thin outcrops (Text-figure 1). Besides Jabalpur (Madhya Pradesh), where they show the best development, the Lameta sediments are present in Kheda, Panchmahal (Gujarat), Chhindwara, Seoni, Narsingpur, Sagar (Madhya Pradesh) and Chanda, Nagpur (Maharashtra) (Sahni 1983). The discovery of dinosaurian eggs in Kheda (Gujarat) revived attention of palaeontologists in Lameta sediments (Mohabey 1983, 1984, Srivastava et al. 1986, Mathur & Pant 1986, Mathur & Srivastava 1987).

During the last two decades, a number of contributions on various aspects such as palaeobiogeography, palaeovegetation, terrestrial fauna, etc. of volcano-sedimentary sequences of the K-T boundary and especially on the Late Cretaceous events have been made (Sahni 1984, Sahni & Tripathi 1990 Bhatia et al. 1990, 1996, Ghosh et al. 1995, Mohabey 1996). Mathur and Mathur (1985) were the first to record angiospermous seeds assigned to the family Boraginaceae from the Lameta beds of Gujarat but



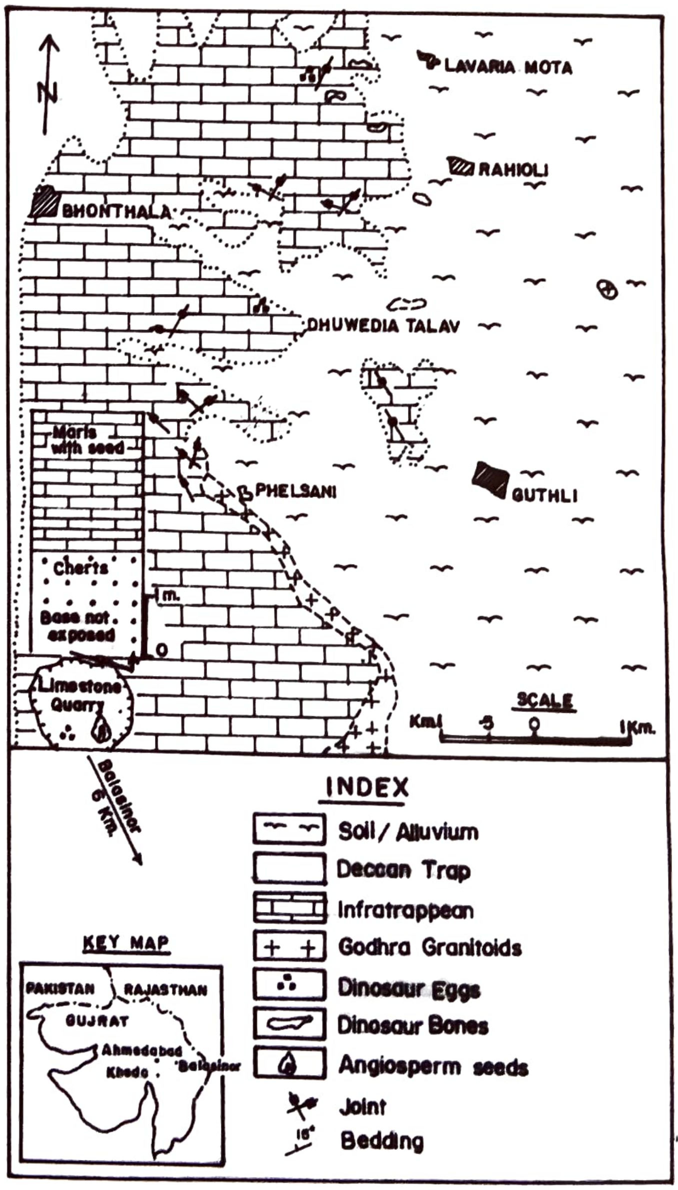
Text-Figure 1. Distribution of Lameta Formation (Late Cretaceous) in India

did not describe them in detail. Sahni et al. (1999) described three seed types, Seed Type Ia, Seed Type Ib and Seed Type II from Lameta Formation of Bara Simla Hill section near Jabalpur, Madhya Pradesh.

The Lameta Formation exposed in a quarry near Balasinor, Kheda District, Gujarat has yielded dinosaurian eggshells and seeds (Text-figure 2). The basal part of Lameta Formation here comprises gritty and pebbly calcareous/ ferruginous sandstone followed upwards by yellow calcareous claystone and brown marl lenses. The eggshells as well as seeds have been found in the marl in upper part.

MATERIAL AND METHOD

The marls from Lameta Formation are hard, compact and well indurated. To separate microfossils from these, small pieces, 2-3 cm in size, were boiled with sodium thiosulphate ($Na_2S_2O_7$ known as hypo in photographic material) for about 1½ hour and then transferred to a dish and placed in oven at 180° to 200°C. In this way, sodium thiosulphate was recrystalised which helped in breaking down the marls and release fossil seeds after repeated processing. The material was washed through 20, 60, 100 ASTM mesh sieves and dried in oven at 60°C. The dried material was examined under Leica stereozoom MZ 12 microscope. The fossil seeds were picked and studied. Selected seeds were placed over stub and further studied and photographed under Scanning Electron



Text-figure 2. Geological map of Balasinor – Rahioli area, Kheda district, Gujarat, India (after Mohabey 1984), showing fossil seed locality.

Microscope LEO 440. The specimens described in this work are deposited with Curator, Geological Survey of India, Kolkata under catalogue nos. 20360 to 20362.

SYSTEMATIC DESCRIPTION

Family: Boraginaceae

Genus: *Proboraginocarpus* A. K. Mathur & U. B. Mathur, gen. nov.

Type Species: *Proboraginocarpus balasinorensis* A. K. Mathur & U. B. Mathur, sp. nov.

Diagnosis: Seed small, bilaterally symmetrical, ovoid trigonal, scar of attachment basal (posterior), circular with raised collar. Ventral side with knotty keel running from collar of attachment scar to apical end. Apically narrowed, basally inflated. Surface with varying degree of irregular ridges and blunt spines.

Comparison: Among the fossil borage seeds the new genus has resemblance in overall shape, size, surface ornamentation with the Siwalik (Indian Pliocene Tatrot Formation) *Boraginocarpus* Mathur represented by the species *Boraginocarpus lakhanpalii* Mathur (Text-figure 3.2a, b) and to the Ogallala Formation (American Pliocene) genus *Cryptantha* Elias represented by *Cryptantha coroniformis* (Elias) (Text-figure 3.1a, b), *C. auriculata* (Elias) and *C. chaneyi* (Elias). The new taxon differs from *Boraginocarpus* Mathur in having a circular basal scar of attachment, a prominent knotty ventral keel running from the apical end to the basal end and irregularly shaped and haphazardly arranged ridges on the surface. From *Cryptantha* Elias the new genus is distinguished by the shape of the scar of attachment, presence of irregular ridges on the surface, more tapering apical end and well defined ventral keel. The living European as well as Indian *Anchusa* Linnaeus has shape of the seed and scar of attachment and size close to the new fossil genus but differs in its pitted surface, some irregular ridges around the collar and two ridges from apical end to basal part of collar. The above characters distinguish the Late Cretaceous *Proboraginocarpus* from other closely resembling living and fossil borage taxa.

Affinity: The present genus is close to Indian Pliocene genus *Boraginocarpus* Mathur in its small size, ovoid trigonal shape, surface structure comprising irregular spines and a keel on the ventral side. *Proboraginocarpus* is treated as ancestor to *Boraginocarpus* during Late Cretaceous as the collar around the scar of attachment in the latter appears to have split along the ventral keel to give it an inverted 'v' shape instead of a circular one. The surface ornamentation also has modified into spines instead of ridges as in Late Cretaceous form yet retaining the overall shape.

Derivation of name: The genus is named to show it as a precursor to the Neogene genus *Boraginocarpus* Mathur known from Tatrot Formation (Pliocene), Siwalik Group, Indian Himalaya.

Proboraginocarpus balasinorensis
A. K. Mathur & U. B. Mathur, sp. nov.

Plate 1, figures 1a-c, 2a-e, 3a-b, 4;
Text-figure 3.3-4

Material: Eight specimens from Lameta Formation, Kheda District, Gujarat, India.

Holotype: Geological Survey of India, Kolkata Catalogue No. 20360.

Description: Seed small, bilaterally symmetrical, ovoid-trigonal in shape, 1-5-2.5 mm in length, 1.0-1.35 mm in maximum width, 0.9-1.4 mm in height. Apical end tapering to acutely rounded, basal end inflated, broad circular; lateral margins slightly convex and converging towards apical end from maximum width which lies in the basal 2/5 of the total length. Width is more than half the length. Scar of attachment is basal, circular with irregularly placed blunt spines on the collar. and a slight constriction behind (Plate 1, figure 1c); a well developed keel in ventral side running from collar of attachment scar at the basal end to the apical end (Plate 1, figures 1a, 2a; Text-figure 3.4) having short irregularly shaped ridges in the basal half giving it a knotty appearance (Plate 1, figures 1a, c, 2a, 3a); the basal end of the keel may have slight protrusion (Plate 1, figure 1b; Text-figure 3.3); irregularly shaped and haphazardly arranged ridges and blunt spines usually dense on dorsal surface.

Dimensions: Holotype: G.S.I. Catalogue No. 20360 (Length 1.85 mm, Height 1.04 mm, Max. Width 1.04 mm; Plate 1, figures 1 a-c; Text-figure 3.3);

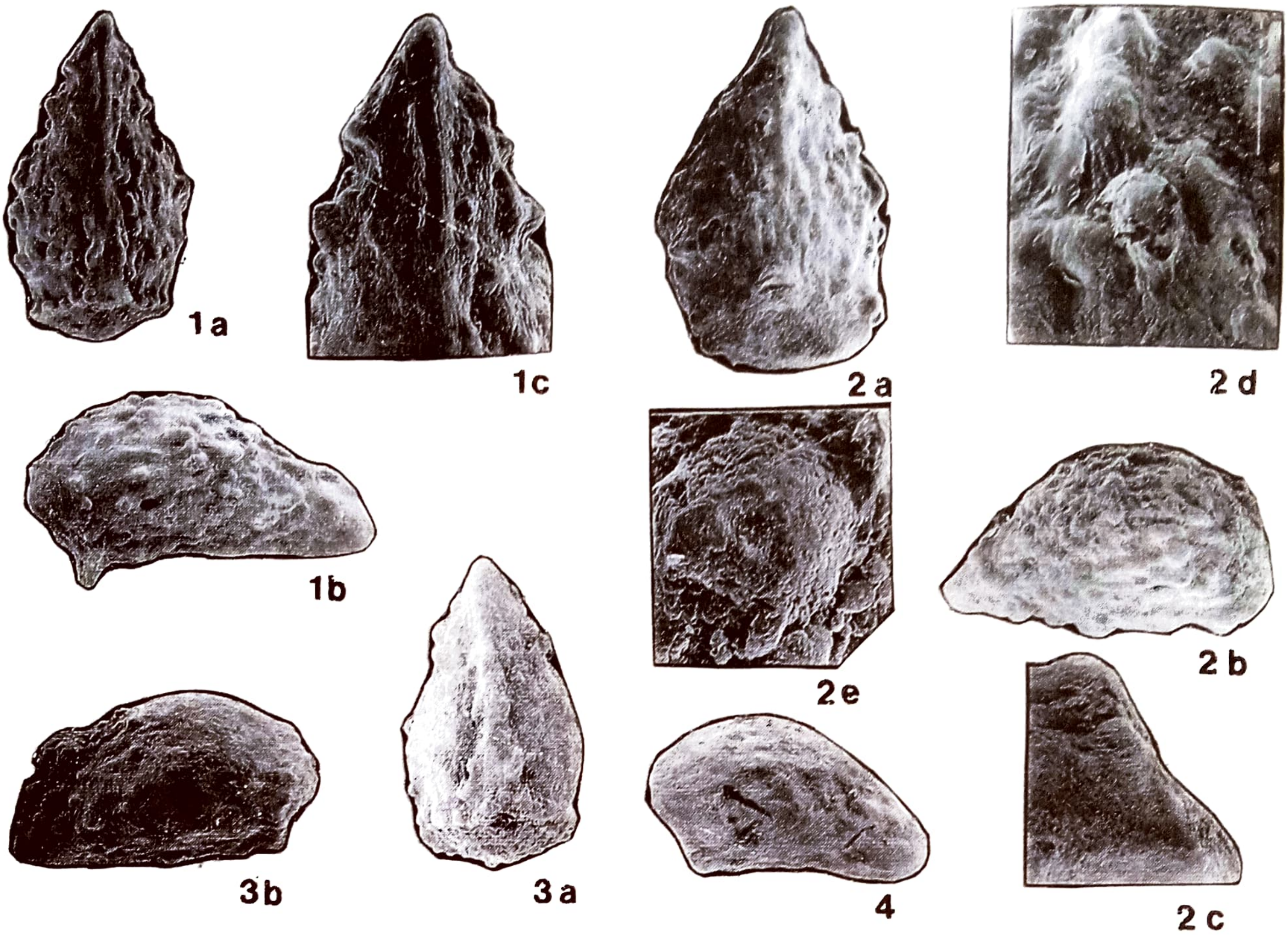
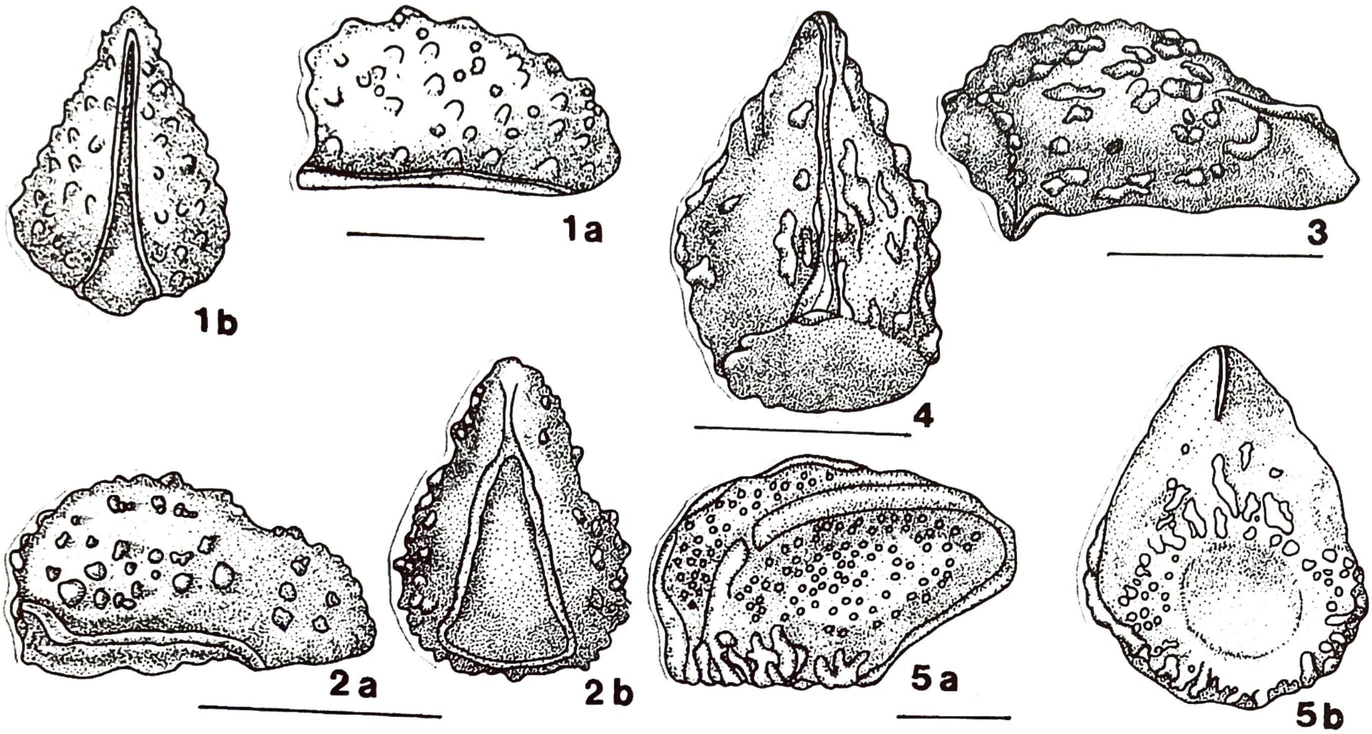


Plate 1

Proboraginocarpus balasinorensis gen. et sp. nov. 1a-c. Holotype. GSI Catalogue No. 20360. L: 1.85mm; a-ventral view, b-lateral view c-enlarged view of ventral apical half. 2a-e. Paratype A GSI Catalogue No. 20361. L: 1.95mm; a-ventral view, b-lateral view, c-enlarged view of basal part, d-enlarged view of rounded tubercles, e-enlarged view of one tubercle showing depression in middle. 3a, b Paratype B. GSI Catalogue No. 20362. L: 1.74mm; a-ventral view, b-lateral view. 4. L: 1.70mm. showing poor surface ornamentation.

Paratype A: G.S.I. Catalogue No. 20361 (Length 1.95 mm, Height 0.90 mm, Max. Width 1.35 mm; Plate 1, figures 2a-e; Text-figure 3.4); Paratype B: G.S.I. Catalogue No 20362 (Length 1.74 mm, Height 0.96 mm, Max. Width 1.00; Plate 1, figures 3a, b)

Comparison: The new taxon has been compared with a number of present day seeds of Boraginaceae living in central and western India which include *Cordiya myxa* Linnaeus, *C. rothii* Roemer and Schimper, *Ehretia aspera* Roxburgh, *E. laevis* Roxburgh, *Aenebia hispidissima* de Candolle, *Trichodesma indicaum* Brown, *Bothiospermum tenellum* Fischer and Meyer, *Heliotropium zeylanicum* Lamarck, *Cynoglossum lanceolatum* Forskal and *C. wallichi* Don. The new taxon is distinct from the above mentioned present-day borage seeds in having an ovoid-trigonal shape, the narrow circular basal scar of attachment and the ventral keel. *Anchusa officinalis* Linnaeus (Text-figure 3.5a, b) resembles the new fossil taxon in ovoid triangular shape, tapering anterior and rugose surface ornamentation but is distinguished by the wide open invaginate scar of attachment, two lateral ridges running from basal to apical end, mostly smooth to pitted surface and short ventral keel restricted to apical half instead of knotty keel extending from apical end to basal end. Among the fossil borage seeds the new taxon compares well in shape, size and surface ornamentation with *Boraginocarpus lakhanpalii*



Text-figure 3. Line sketches of selected borage seeds from different horizons and locations of India, America and Europe. 1a, 2a, 3, 5a: lateral view; 1b, 2b, 4, 5b: ventral view; Bar = 1 mm. 1a, b. *Cryptantha coroniformis* (Elias) from Ogollala Formation (Pliocene), America. 2a, b. *Boraginocarpus lakhanpalii* Mathur from Tatrot Formation (Pliocene), India. 3-4. *Proboraginocarpus balasinorensis* gen. et sp. nov. from Lameta Formation (Late Cretaceous), India. 5a, b. *Anchusa officinalis* Linnaeus, native of Europe, also occurs in India.

Mathur known from the Tatrot Formation (Pliocene), Siwalik Group (Indian Himalaya) and *Cryptantha coroniformis* (Elias) known from the Ogallala Formation (America). The new taxon differs from *B. lakhanpalii* Mathur in having a circular basal attachment scar with collar, a prominent knotty ventral keel running from the apical end to the basal attachment scar and irregularly shaped and haphazardly arranged ridges on the surface. From *C. coroniformis* (Elias), *C. auriculata* (Elias) and *C. chaneyi* (Elias) the new form is distinguished by the shape of the attachment scar, presence of irregular ridges on the surface, more tapering apical end and well defined ventral keel.

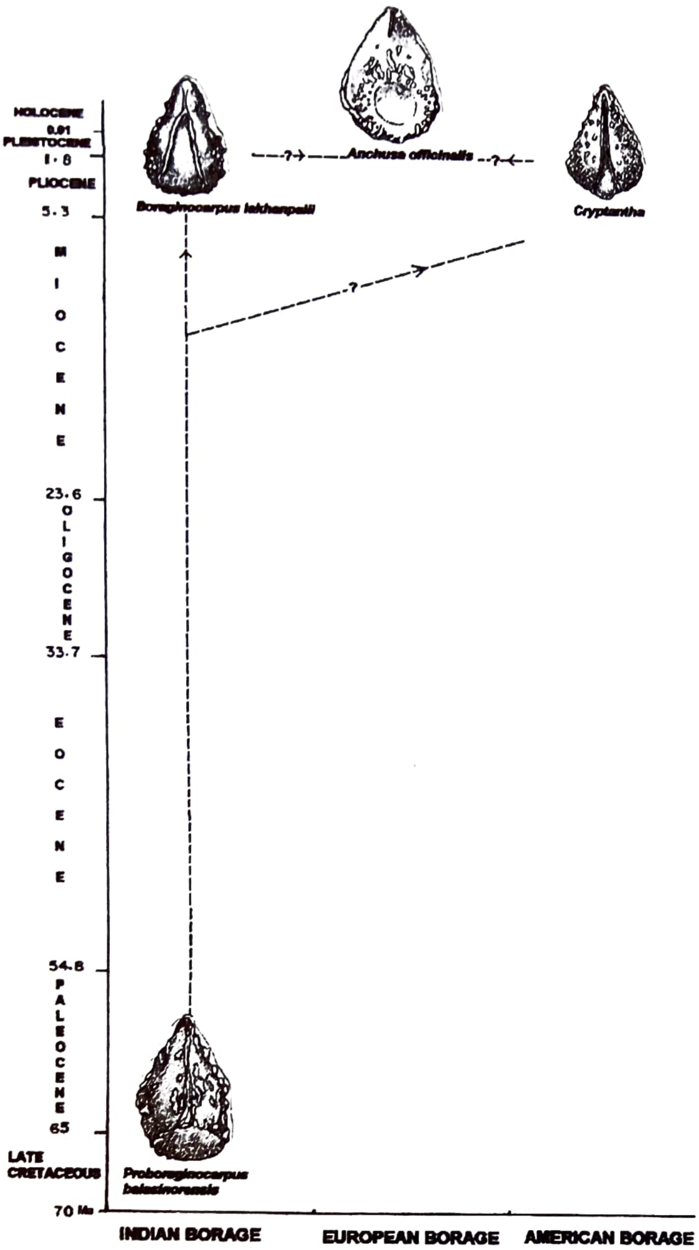
Type Locality: 6 km NNW of Balasinor, Kheda District, Gujarat, India.

Horizon: Lameta Formation (Late Cretaceous).

Derivation of name: The species is named after the village Balasinor which is close to the locality from where material was collected by one of the authors (UBM).

EVOLUTIONARY TRENDS

In the Indian subcontinent, no significant work on fossil borage seeds has been published except by Mathur (1974) who described and illustrated *Boraginocarpus lakhanpalii* from the Tatrot Formation (Upper Siwalik) near Chandigarh. In contrast, the Boraginaceae seeds are well documented from the American Neogene (Berry 1926, 1928, Elias 1932, 1935, 1942, 1946, Brown 1935, Elias & Chaney 1941). Chandler (1961), while cataloguing Early Tertiary floras of southern England, described Boraginaceae (*Ehretia* spp.) seeds from Lower Bagshot Beds (London Clay) of Palaeocene age that is apparently the oldest horizon known for Boraginaceae seeds. The fossil seeds of herbaceous borages are identified by their shape, sculpture, and the characteristics of the scar of attachment (Elias 1946). The shape of seeds is influenced by their position in the fruit as four seeds are attached symmetrically around a common style and these are adpressed to each other on sides. According to Elias (1946), the fossil nutlets are either symmetrical



Text-figure 4. Evolutionarty trends in some Boraginaceae taxa

near the central plane (in fossil and living *Cryptantha* or *Krynitzkia*), or depart from this symmetry, perhaps because of differential pressure in the course of early growth, which results in the development of an equal number (two and two) of dextral and sinistral nutlets (in fossil *Biorbia* and living *Anchusa*, and others).

It has been shown that the living *Lithospermum* (with smooth nutlets) and *Anchusa* (with very corrugated nutlets) have developed from *Biorbia*, apparently ancestral to both of them, whose nutlets are slightly to moderately corrugated and species with intermediate surface texture are reported from Late Pliocene of High Plains (Elias 1946). The closeness in shape and surface structure of Pliocene *Boraginocarpus* of Indian Tatrot Formation (Siwalik Group) and *Cryptantha* of American Pliocene Ogallala Formation is very significant in understanding the evolutionary trends of Boraginaceae. According to Elias (1946), there is great similarity in most Tertiary and even Cretaceous angiospermous arboreal leaves with living species, and the ensuing difficulty in differentiating fossil from living species, also indicate a slow differentiation of angiospermous trees. The American *Biorbia* is closer to the European *Anchusa* and its allies and according to Elias (1946) is apparently ancestral to European Anchuseae.

Thomasson (1979), who carried out comprehensive palaeobotanical survey of the northern extent of the Ogallala Group, recorded *Cryptantha*, *Biorbia*, *Lithospermum.* According to Hilger et al. (2005) *Borago* L. and all the 16 genera of Tribe Boragineae, family Boraginaceae are native to the Old World and distributed in Asia, Africa and Europe. Milne and Abbot (2002), who worked on the origin and evolution of Tertiary relict floras, have shown that these are distributed throughout large part of the Tertiary in Northern Hemisphere and are now restricted to south-eastern and western North America, East Asia and south-west Eurasia. On the basis of their molecular phylogenetic studies they suggested two refugial (warm humid) groups having geographical distribution centred on Japan/ Korea/ northeast China and southeast China/ Himalaya regions respectively. North Atlantic Land Bridge (NALB) which connected floras of Europe and North America was severed around 50 Ma, but from relict floras it appears that partial NALB allowed migration of floras between Europe and North America throughout the Tertiary (Milne & Abbot 2002). During Neogene it is indicated by the presence of closely related borage taxa *Cryptantha* in America, *Biorbia* in Europe and *Boraginocarpus* in India.

The distribution and proliferation of angiosperms during Late Cretaceous and their slow morphological modification (stasis) during Cenozoic could be due to allopatric speciation together with stabilizing selection (Milne & Abbot 2002). The slow change in morphological characters of leaves of fossil angiosperm plants of Late Oligocene-Early Miocene Dagshai and Kasauli formations of north-western Himalaya is obvious from the fact that these can easily be compared with living plant taxa (Mathur et al. 1996). It can be surmised that the change in morphological characters like the replacement of well developed ventral knotty keel in Late Cretaceous Indian *Proboraginocarpus* to its splitting into an inverted narrow V-shape in Pliocene American *Cryptantha*, wide V-shape in Late Pliocene Indian *Boraginocarpus* and rudimentary and restricted to apical half in living European as well as Indian *Anchusa* are the slow evolutionary changes. Similarly there is change in the surface ornamentation from irregular ridges and blunt spines in Late Cretaceous Indian *Proboraginocarpus* to pointed closely spaced spines in Pliocene American *Cryptantha* and widely spaced relatively blunt spines and ridges in Late Pliocene Indian *Boraginocarpus* and pitted surface, some irregular ridges around the collar and two ridges from apical end to basal part of collar in living European as well as Indian *Anchusa*.

The origin of land mammals during Palaeogene in Old World and their spread to New World, diversification and extinction during Neogene is well established. It is therefore expected that the herbs that form their food also followed the same route of spread, diversification and extinction. Just as *Cryptantha* is an index fossil and restricted to middle early Pliocene of Ogallala Formation of America, *Boraginocarpus* is restricted to Late Pliocene Tatrot Formation of India. In order to understand evolutionary trends in this group of borage seeds the most important feature is the ovoid-trigonal shape of seeds that places them in common stock. The character that is most significant in identifying the taxa of same group is the development of a attachment scar. It is medium sized subcircular in Late Cretaceous *Proboraginocarpus*, trilobate in the Indian *Boraginocarpus* and the American *Cryptantha* and again wide circular in modern *Anchusa*. The other important character is the surface ornamentation. In Late Cretaceous *Proboraginocarpus* the ridges are more prominent than spines whereas in Pliocene genera *Boraginocarpus* and *Cryptantha* the spines dominate and in modern the ridges dominate over a more or less smooth surface of *Anchusa*. The evolutionary links between the Late Cretaceous *Proboraginocarpus,* the Pliocene *Boraginocarpus* and *Cryptantha* and the modern *Anchusa* can be traced as shown in Text-figure 4.

DISCUSSION

The systematic study of the new borage taxon, first reported by authors (Mathur & Mathur 1985), is significant, as these seeds have been recovered from dinosaur egg bearing strata that are Maastrichtian in age (Srivastava et al. 1986). Sahni et al. (1996) described Seed Type I a, b and Type II from Lameta Formation of Jabalpur, India and compared Seed Type I a, b with *Costatheca diskoensis* and Type II with *Spermatites elongates* reported from Late Cretaceous of West Greenland. However, they (Sahni et al. op. cit.) were not definite about inter-relationship between the two. The morphological characters of Seed Type I a, b, i.e., prominent costae with deep furrows in between, small size (length 1.42 mm) is closer to *Ehretia ehretioides* (Reid & Chandler) described by Chandler (1961) from Palaeocene London Clay which is slightly larger in size being 1.5 to 1.75 mm in length, has longitudinal rows of costae and furrows and convex dorsal face. The genus *Ehretia*, belonging to family Boraginaceae, according to Chandler (op. cit.) is essentially tropical in the Old Wold. While dealing with paleogeographic and age implications on the basis of non-marine ostracodes of Lameta Formation, Bhatia et al. (1996) opined that Late Cretaceous assemblages from Asifabad and Takli have strong affinities with those of Central Asia which provided continuous terrestrial passage for the migration of Laurasian biotas to Peninsular India. The distribution and proliferation of angiosperms during Late Cretaceous and their slow morphological modification during Cenozoic has led earlier palaeobotanists to assign these fossil taxa to modern genera. But detailed SEM studies of such taxa may require their placement in genera having distinctive features from modern genera and an evolutionary lineage can then be developed in these genera as we find in Late Cretaceous *Proboraginocarpus* to modern *Anchusa*. The evolution and migration of mammals such as horses is important in understanding the corresponding dispersion of vegetation in space and time around the globe.

ACKNOWLEDGEMENT

The authors are grateful to the Director General, Geological Survey of India, Kolkata for permission to publish this work and to Professor David L. Dilcher for examining the material during his visit to Birbal Sahni Institute of Palaeobotany, Lucknow and also for going through the manuscript and making valuable suggestions. One of us (A.K.M.) is thankful to Saskia Kars for help in SEM photography at Free University, Amsterdem, The Netherlands. Thanks are also due to the colleagues and artists at Palaeontology Division, Geological Survey of India, Jaipur and Lucknow and at Operation Punjab, Haryana and Himachal Pradesh, Geological Survey of India, Chandigarh for their help in various ways.

REFERENCES

Bhatia S. B., Prasad G. V. R. & Rana, R. S. 1990. Deccan volcanism, A Late Cretaceous event: Conclusive evidence of ostracodes. In: Sahni A. & Jolly A. (Editors) - Cretaceous event stratigraphy and the correlation of Indian non-marine strata A Seminar-cum-Workshop IGCP 216 and 245, Chandigarh: 47-49.

Bhatia S. B., Prasad G. V. R. & Rana R. S. 1996. Maastrichtian non-marine ostracodes from Peninsular India: palaeobiogeographic and age implications. Mem. Geol. Soc. India 37: 297-311.

Berry E. W. 1926. The fossil seeds from the *Titanotherium* beds of Nebraska, their identity and significance. Amer. Mus. Nov. 221: 1-8.

Berry E. W. 1928. Fossil nutlets of the genus *Lithospermum*. Proc. U.D.S. Nat. Mus. 73(13): 1-3.

Brown R. W. 1935. Miocene leaves, fruits and seeds from Idaho, Oregon and Washington. J. Palaeontology 9(7): 573-587.

Chandler M. E. J. 1961. The Lower Tertairy floras of southern England. I. Palaeocene floras: London Clay flora (Supplement). Brit. Mus. (Nat. Hist.) London: 1-354.

Elias M. K. 1932. Grasses and other plants from the Tertiary rocks of Kansas and Colorado. Univ. Kansas Sci. Bull. 20(20): 333-367.

Elias M. K. 1935. Tertiary grasses and other prairie vegetation from High Plains of North America. Amer. Jour. Sci. 29: 24-33.

Elias M. K. 1942. Tertiary prairie grasses and other herbs from the High Plains. Spec. Pap. Geol. Soc. America 41: 1-76.

Elias M. K. 1946. Taxonomy of Tertiary flowers and herbaceous seeds. Amer. Midland Natur. 36(2): 373-380.

Elias, M. K. & Chaney R. W. 1941. Late Tertiary prairie vegetation in Nebraska. In: Guide for a field conference on the Tertiary and Pleistocene of Nebraska. : 19-20.

Ghosh P., Bhattacharya S. K. & Jani R. A. 1995. Palaeoclimate and palaeovegetation in Central India during Upper Cretaceous based on stable isotope composition of the palaeosol carbonates. Palaeogeog. Palaeoclimatol. Palaeoecol. 114: 285-296.

Hilger H. H., Gottschling M., Selvi F., Bigazzi M., Langström E., Zippel E., et al. 2005. The Euro+Med treatment of Boraginaceae in Willdenowia 34—a response. Willdenowia 35: 43–48.

Mathur A. K. 1974. A new fossil seed (Boraginaceae) from Siwalik Group. Bull. Ind. Geol. Assoc. 7(1): 43-49.

Mathur A. K. & Mathur U. B. 1985. Boraginaceae (Angiosperm) seeds and their bearing on the age of Lameta beds of Gujarat. Curr. Sci. 54(20): 1070-1071.

Mathur A. K., Mishra V. P. & Mehra S. 1996. Systematic study of plant fossils from Dagshai, Kasauli and Dharmsala formations of Himachal Pradesh. Palaeontologia Indica N. S. L: 1-121.

Mathur U. B. & Pant S. C. 1986. Sauropod dinosaur humeri from Lameta Group (Upper Cretaceous- ?Palaeocene) of Kheda District, Gujarat. J. Palaeont. Soc. India 31: 22-25.

Mathur U. B. & Srivastava S. 1987. Dinosaur teeth from Lameta Group (Upper Cretaceous), Kheda District, Gujarat. J. Geol. Soc. India 29(6): 554-566.

Milne R. I. & Abbot R. J. 2002. Origin and evolution of Tertiary relict floras. Advances in Botanical Research 38: 281-336.

Mohabey D. M. 1983. Note on the occurrence of Dinosaur fossil eggs from Infratrappean limestone of Kheda District, Gujarat. Curr. Sci. 52(24): 1194-1195.

Mohabey D. M. 1984. The study of dinosaurian eggs from Infratrappean limestone in Kheda District, Gujarat. J. Geol. Soc. India 23(6): 329-337.

Mohabey D. M. 1996. Depositional environments of Lameta Formation (Late Cretaceous) of Nand-Dongargaon Inland Basin, Maharashtra: the fossil and lithological evidence. In: Cretaceous Stratigraphy and Palaeoenvironments – Rama Rao Volume (Ed. Sahni A.), Mem. Geol. Soc. India 37: 363-386.

Sahni A. 1983. Upper Cretaceous palaeobiogeography of peninsular India and the Cretaceous-Palaeocene transition: The vertebrate evidence. Conference Proceedings Indian Association of Palynostratigraphers, Lucknow: 128-140.

Sahni A. 1984. Cretaceous-Palaeocene terrestrial faunas of India. Lack of endemism and drifting of the Indian plate. Science 226: 441-443.

Sahni A. & Bajpai S. 1988. Cretaceous – Tertiary Boundary Events: the fossil vertebrate, palaeomagnetic and radiometric evidence from Peninsular India. J. Geol. Soc. India 32(5): 382-386.

Sahni A., Khosla A. & Sahni N. 1999. Fossil seeds from the Lameta Formation (Late Cretaceous), Jabalpur, India. J. Palaeont. Soc. India 44: 15-23.

Sahni A., Kumar K., Hartenberger J. L., Jaeger J. J., Rage J. C., Sudre J. & Vianey-Liaud M. 1982. Microvertebrates nouveaux des Trapps du Deccan (Inde); Mise en evidence d'une voie de communication terrestre probable entre la Laurasie et l'Inde a la limite Cretace-Tertiaire. Bull. Soc. Geol. France 24: 1093-1099.

Sahni A. & Tripathi A. 1990. Age implications of the Jabalpur Lameta Formation and intertrappean biotas. In: Sahni A. & Jolly A. (Editors) - Cretaceous event stratigraphy and the correlation of the Indian non-marine strata. Seminar-cum-Workshop IGCP 216 and 245, Chandigarh: 35-37.

Srivastava S., Mohabey D. M., Sahni A. & Pant S. C. 1986. Upper Cretaceous dinosaur egg clutches from Kheda District (Gujarat), India. Palaeontographica Abt. A 93: 219-233.

Thomasson J. R. 1979. Angiosperms from the Late Tertiary Keller local fauna of Ellis County, Kansas Rocky Mountain Geology 17: 59-63