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CHAROPHYTES FROM DECCAN INTERTRAPPEAN BEDS OF PENINSULAR INDIA : IMPLICATIONS FOR AGE AND CORRELATION OF DECCAN VOLCANICS

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ABSTRACT

A taxonomically diverse charophyte assemblage from the Deccan intertrappean beds around Gurmatkal (District Gulbarga, Karnataka), and a corresponding assemblage from another intertrappean locality over 1500 Km to the north (Kora, District Kachchh, Gujarat), are described. The Gurmatkal assemblage comprises 8 genera and 10 species, whereas the Kachchh charophytes are assigned to 4 species. Several of the Gurmatkal taxa are common to other Deccan intertrappean localities of peninsular India. The assemblage includes cosmopolitan species such as *Platychara perlata* and *P. compressa* whose presence is consistent with a Late Cretaceous (Maastrichtian) age indicated unambiguously by associated ostracodes. Earlier age assignments (Upper Eocene-Oligocene) need to be discounted. Apparently there are no biostratigraphically resolvable temporal differences between the Gurmatkal intertrappean beds and those outcropping along the northwestern and eastern fringes of the Deccan volcanics.

KEY-WORDS : CHAROPHYTES, MAASTRICHTIAN, DECCAN VOLCANICS, PENINSULAR INDIA.

RÉSUMÉ

Un assemblage diversifié de charophytes des niveaux intertrapps du Deccan autour de Gutmatkal (District de Gulbarga, Karnataka) et un assemblage correspondant d'un autre niveau intertrapps situé à 1500 km au nord (Kora, District de Kachchh, Gujarat) sont décrits. L'assemblage de Gurmatkal comprend 8 genres et 10 espèces de charophytes tandis que celui de Kachchh ne renferme que 4 espèces. Plusieurs des taxons de Gurmatkal sont communs à d'autres localités intertrapps du Deccan de l'Inde péninsulaire. L'assemblage renferme des espèces cosmopolites telles *Platychara perlata* et *P. compressa* qui indiquent un âge crétacé tardif (Maastrichtien) concordant avec les ostracodes associés. Les datations antérieures (Eocène supérieur - Oligocène) doivent être rabaissées. Il ne semble pas qu'il y ait des différences biostratigraphiques significatives entre les niveaux intertrappes de Gurmatkal et ceux qui affleurent sur les bordures nord-occidentales et orientales des couches volcaniques du Deccan.

MOTS-CLÉS : CHAROPHYTES, MMASTRICHTIEN, VOLCANIQUES DU DECCAN, INDE PÉNINSULAIRE.

INTRODUCTION

Palaeontological constraints on the timing of initiation and cessation of Deccan volcanism in peninsular India are crucially important in the context of ongoing debate over the role of this extensive flood basaltic activity in the end Cretaceous mass extinctions (Courtillot, 1990). Over the past one decade or so, there has been a significant rise in documentation of fossil biotas from sediments associated with the Deccan volcanics, particularly from those that occur locally intercalated within the basaltic flows, namely "intertrappean beds". As a result of these investigations, aided greatly by collaboration with French scientists, data are presently available on several diverse groups including fish, dinosaurs, mammals (Sahni 1984 ; Sahni *et al.* 1982, 1986, 1987 ; Gayet *et al.* 1984 ; Prasad & Sahni 1988 ; Rana 1988 ; Prassad 1989 ; Bajpai *et al.* 1990 ; Prasad &

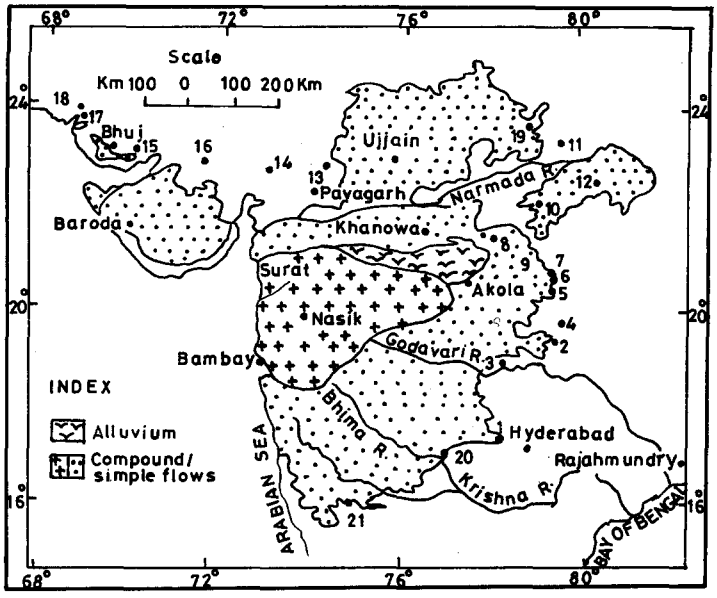


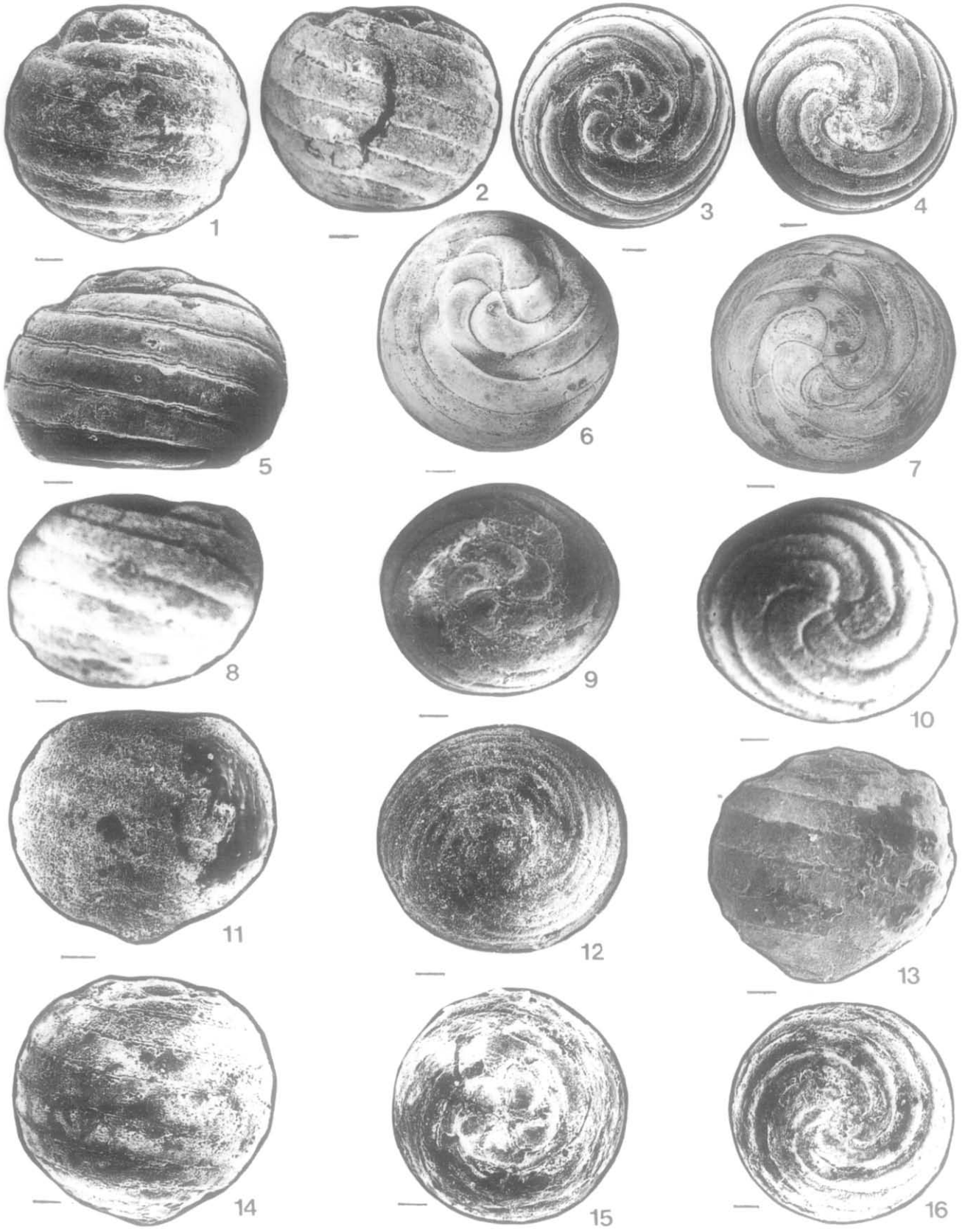
Figure 1 -Map showing major localities of Deccan Trap associated sediments (Lameta Formation and Intertrappean beds) of peninsular India (modified after Deshmukh 1990). *Carte indiquant les principales localités de sédiments associés aux Trapps du Deccan (Formation Lameta et couches intertrappes) de l'Inde péninsulaire (modifiée d'après Deshmukh 1990).*

Sahni 1988 ; Rana 1988 ; Prassad 1989 ; Bajpai et al. 1990 ; Prasad & Rage 1991), ostracodes, charophytes (Bhatia & Rana 1984 ; Bhatia *et al.* 1990a, b, c ; Srinivasan *et al.* 1992) and pollen grains (Prakash *et al.* 1990 ; Mathur & Sharma 1990). These studies have in general led to assignment of a Late Cretaceous (Maastrichtian) age for the Deccan intertrappean beds at several localities (Sahni & Bajpai 1988). On the other hand, the major contrary viewpoint favouring a Palaeocene age for the intertrappean on the basis of megafloral remains, is still advocated (see Bande *et al.* 1986 for a review of earlier works). In still other cases (e. g. Gurmatkal intertrappeans), ages as young as Oligocene have been proposed in the past (Shivarudrappa 1989) and are often cited as evidence of protracted Deccan volcanic activity (e. g. Sastri 1981 ; Mahomey 1988). Thus, because of inadequate biostratigraphic data base, temporal relationships are not yet established between several individual parts of the Deccan basaltic province. This situation is unlike the case of subcrop data from deep wells drilled by the Oil and Natural Gas Commission (ONGC) in the Krishna-Godavari and Cauvery Basins, which allow high resolution biostratigraphic control on the basis of planktonic foraminifera (Raju *et al.* 1991). The problem is further compounded by the question of source(s) of the Deccan eruptions and the possibility of progressive southward decrease in age of Deccan volcanics, as indicated by the geochemical mapping by lava sequences (Mitchell & Cox 1988 ; Mitchell & Widdowson 1991).

Viewed against this background, the intrappean localities of District Gulbarga in Karnataka and district Kachchh of Gujarat (Fig. 1) are of special interest as they demarcate the northwestern and southwestern limits of the Deccan volcanics. Fossil assemblages from these peripheral outcrops are very important because they help to ascertain if there is evidence of biostratigraphically resolvable age progression within the Deccan province. To this end, this paper describes charophyte assemblages recovered from two intertrappean localities, one in the vicinity of Dayapar (kachchh) and the other near Gurmatkal (Gulbarga). Their relationships with corresponding assemblages known from other intertrappean localities in the province are also discussed.

PLATE 1

Fig. 1-4 - ***Platychara perlata***. **1.** lateral view, VPL/S 1050 ; **2.** lateral view, VOL/IB 3978 ; **3.** apical view, VOP/S 1051 ; **4.** basal view, VPL/S 1052 ; 5-7. ***P. compressa***. **5.** lateral view, VPL/S 1048 ; **6.** apical view, VPL/S 1048; **7.** basal view, VPL/S1049 ; **8-10.** ***P. rajahmundrica***. **8.** lateral view, VPL/IM 4054 ; **9.** apical view, VPL/IB 4058 ; **10.** basal view, VPL/IB 4057. 11,12. ***P. raoi***. **11.** lateral view, VPL/IB 4106 ; **12.** basal view, VPL/IB 4107 ; **13-16.** ***P. sahnii***. **13.** lateral view, VPL/IB 4092 ; **14.** lateral view, VPL/S 1055 ; **15.** apical view, VPL/S 1056 ; **16.** basal view, VPL/S 1057.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PREVIOUS INVESTIGATIONS

The occurrence of fossiliferous intertrappean beds in northern karnataka was first recorded by Foote (1876) in his extensive geological investigations of the erstwhile "South Mahratta Country". Following him Kazim (1945) gave a brief account of the intertrappean beds at Gurmatkal and recorded a few gastropods and lamellibranchs including *Paludina*, *Lymnaea*, *Physa* and *Unio*. Subsequently, Shivarudrappa (1972a, b ; 1977, 1989), in a series of papers has reported a diverse assemblage of charophytes from various sections in the vicinity of Gurmatkal. Based on this assemblage, which has not been adequately described or illustrated until now, Shivarudrappa (1989) has long held an age as young as Oligocene for the Gurmatkal intertrappeans. Recently, the present authors (Srinivasan *et al.* 1992) in a brief report, have recorded as many as 10 charophute taxa in association with ostracodes from the same area.

The intertrappean beds of Kachchh, first recorded by Wynne (1972) and subsequently described briefly by Khanna & Mohan (1965), have recently been studied in detail (Sahni & Bajpai 1988 ; Bajapi *et al.* 1990 ; Bajpai *et al.* 1993 ; Ghevariya 1988 ; Ghevariya & Srikarni 1990). Bajpai *et al.* (1990) have recorded a diverse microfossil assemblage including dinosaur remains and charophytes from the intertrappean beds at the Kora, Dayapar, Lakhmipar and Anjar localities.

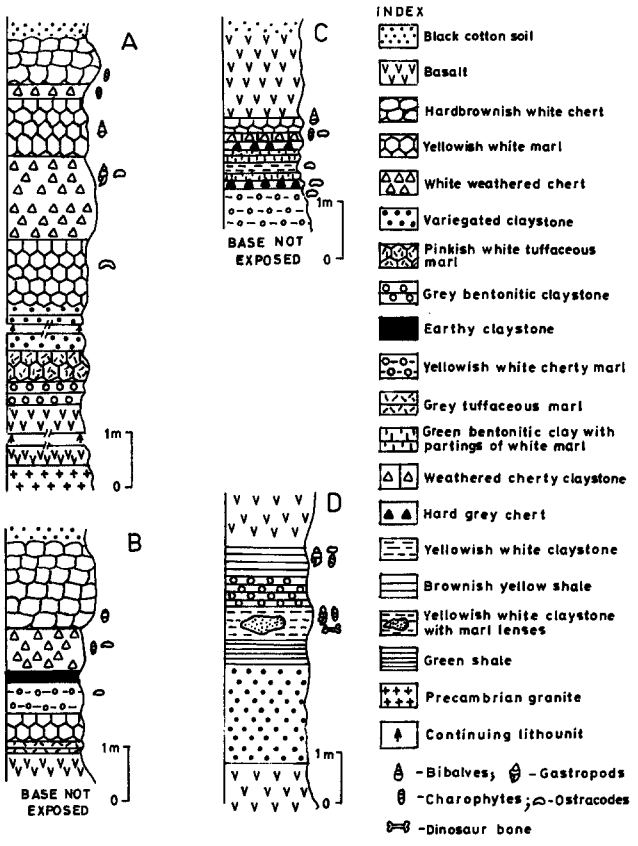


Figure 2 - Lithostratigraphic sections at Gurmatkal (A), Chandarki (B), Yanagundi (C) and Kora (D). *Coupes lithostratigraphiques à Gurmatkal (A), Chandarki (B), Yanagundi (C) et Kora (D).*

SECTIONS INVESTIGATED

GURMATKAL

The charophytes described here come from three localities around the well known Gurmatkal village (16 52' 12" N : 77 24' 28" E) ; which is about 40 km SW of the Talug headquarters at Yadgir, District Gulbarga. The section exposed about 1.5 km SW of Gurmatkal is the thickness (about 7m) and comprises a sequence of weathered chert and marl, towards the top of which charophytes occur (Fig. 2). The second section under investigation was measured at a locality about 2 km NNW of the village Chandarki (16 51' 42" N : 77 27' E), near the 3 km stone on Chandarki-Yanagundi road. Lithologically, this section is similar to the one near Gurmakal but is about one-half in thickness. The white weathered chert here yields aboundant as well as taxonomically diverse assemblage of charophytes and ostracodes. The third charophyte-yielding section is exposed along a small stream-cutting 1 km SW of the village Yanagundi (16 53' 45" N : 77 27' 5" E). The intertrappean beds here comprise an about 2m thick sequence of claystone and marl which are often cherty. Here, the charophytes lie in a yellowish white claystone only.

KACHCHH

The kachchh charophytes were recovered from an intertrappean locality at the northwestern corner of the presently ruined village of Kora (23 35' 55" N : 68 53' 40"E) which is situated about 2 km NNW of Dayapar. Lithologically, this section exposes about 4m thick succession of shales and claystones with intercalations of marl (Fig. 2). The brownish yellow shales which constitute the topmost unit of this section, contain abundant ostracodes and fish remains, besides charophytes.

Systematic description. Tab. 1, Pl. 1, 2.

Platychara perlata PECK & REKER, 1947 (Pl. 1, 1-4) - *P. perlata* is the most abundant species in both the Gurmatkal and Kachchh intertrappeans. In India it was first reported from the Nagpur

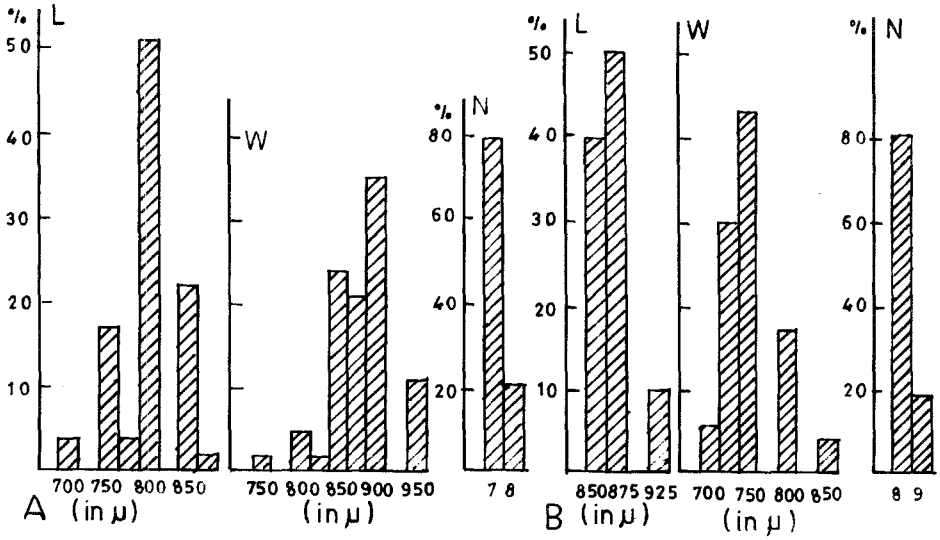


Figure 3 - Variation in length (L), width (W) and number of convolutions in lateral view (N) as observed in 100 gyrogonites of (A) ***Platychara perlata*** and (B) ***Peckichara varians***. *Variation de la longueur (L), de la largeur (W) et du nombre de convolutions en vue latérale (N) observée chez 100 gyrogonites.*

Taxa	Number of gyrogonites	Horizon yielding charophytes	Dimensions (in μm)
Platychara perlata	> 100	white weathered chert of sections A&B; yellowish white cherty marl of section C and brownish yellow shale of section D	L:700-886;W:750-966;L/W ratio: 0.85-0.97(Fig.3A)
P. compressa	8	white weathered chert of section B	L:870;W:1110; L/W ratio: 0.78
P. rajahmundrica	7	brownish yellow shale of section D	L:497-672;W:737-957; L/W ratio: 0.65-0.67
P. raoi	10	yellowish white claystone with marl lenses of section D	L:425-500;W:600-625;L/W ratio: 0.68-0.89
P. sahnii	18	white weathered chert of section B and yellowish white claystone with marl lenses of section D	L:900;W:940; L/W ratio:0.95
Peckichara varians cf. P. varians meridionalis	>100	white weathered chert of section B	L:715-925;W:615-630;L/W ratio: 1.11-1.21(Fig.3B)
Harrisichara muricata	7	white weathered chert of section B	L:790;W:670; L/W ratio: 1.17
Nemeqtichara grambasti	16	weathered cherty claystone of section C	L:730-785;W:470-530;L/W ratio: 1.48-1.57
Stephanochara cf. S.levis	14	weathered cherty claystone of section C	L:740;W:615; L/W ratio: 1.21
Grambastichara sp.	6	white weathered chert of section B	L:675;W:350; L/W ratio:1.91
Microchara sp.	8	white weathered chert of section B	L:645;W:390; L/W ratio: 1.68
Chara sp. indet.	10	white weathered chert of sections A & B	L:660-675;W:410-435;L/W ratio: 1.55-1.60

Abbreviations : L - Length;W - Width

Table 1 - Check list of recovered charophyta taxa. *Liste des taxons de charophytes rencontrés.*

intertrappeans by Bhatia & Rana (1984). This species is characteristically subglobular or spherical in shape and is wider than long (average ISI = L/W ratio x 100 = 88) with a rounded base. Its apex is swollen and forms a distinct apical rosette.

P. compressa PECK & REKER, 1948 (Pl-1, 5-7) - These gyrogonites are essily referable to *Platychara compressa* on the basis of their lower Isopolarity Index (ISI) value (av. ISI = 78) than that of *P. perlata* and typically larger size. They are also closely comparable with *P. rajahmundrica* but the latter has a lower ISI value (65-67). Also the apical rosette is less convex in *P. rajahmundrica*.

P. rajahmundrica (RAO & RAO) BHATIA *et al.* 1989 (Pl-1, 8-10) - This species is next in abundance to *P. perlata* in Kachchh. Its width is characteristically much greater than length (ISI = 65-67). The apex is flattened with a well developed rosette whereas the pore opening is narrowly rounded. Rao & Rao (1939) originally described this species as *Chara rajahmundrica* from the intertrappean beds at Kateru near Rajahmundry in Andhra pradesh. Recently, Bhatia *et al.* (1989) have referred similar gyrogonites from the Kachchh intertrappeans to a new combination *Platychara rajahmundrica*.

As dated above *P. rajahmundrica* is distinct from both *P. perlata* and *P. compressa* on the basis of greater degree of flattening i. e. lower ISI values. Nevertheless, Chanda *et al.* (1989) have recently synonymised *P. rajahmundrica* (= *Chara rajahmundrica* RAO & RAO, 1939) with *Platychara compressa*. Absence of illustrations or descriptions by Chanda *et al.* (1989) makes it difficult to resolve taxonomic uncertainity. Therefore, these gyrogonites from Kachchh are presently retained under the name *P. rajahmundrica*.

P. raoi BHATIA & MANNIKERI, 1976 (Pl-1, 11, 12) - The specimens can be distinguished from *P. sahnii* by their less developped apical rosette. These gyrogonites are nearly spherical with 5-7 slightly convex lime spirals visible in side view. Their bases steeply taper into a distinct projection with pentagonal opening.

P. sahnii (RAO & RAO) Bhatia & Mannikeri, 1976 (Pl- 1, 13-16) - Rao & Rao (1939) originally described this species as *Chara sahnii* from Rajahmundry intertrappean beds. Later, Bhatia & Mannikeri (1976) changed the generic assignment to the genus *Platychara*. The specimens described herein have higher average ISI values (95) than *Platychara perlata*. They have 7-8 concave to flat lime spirals visible in lateral view, an apical rosette about 400 µm in diameter and a characteristically tapering base unlike that in *P. perlata* and *P. compressa* which is relatively flat or rounded.

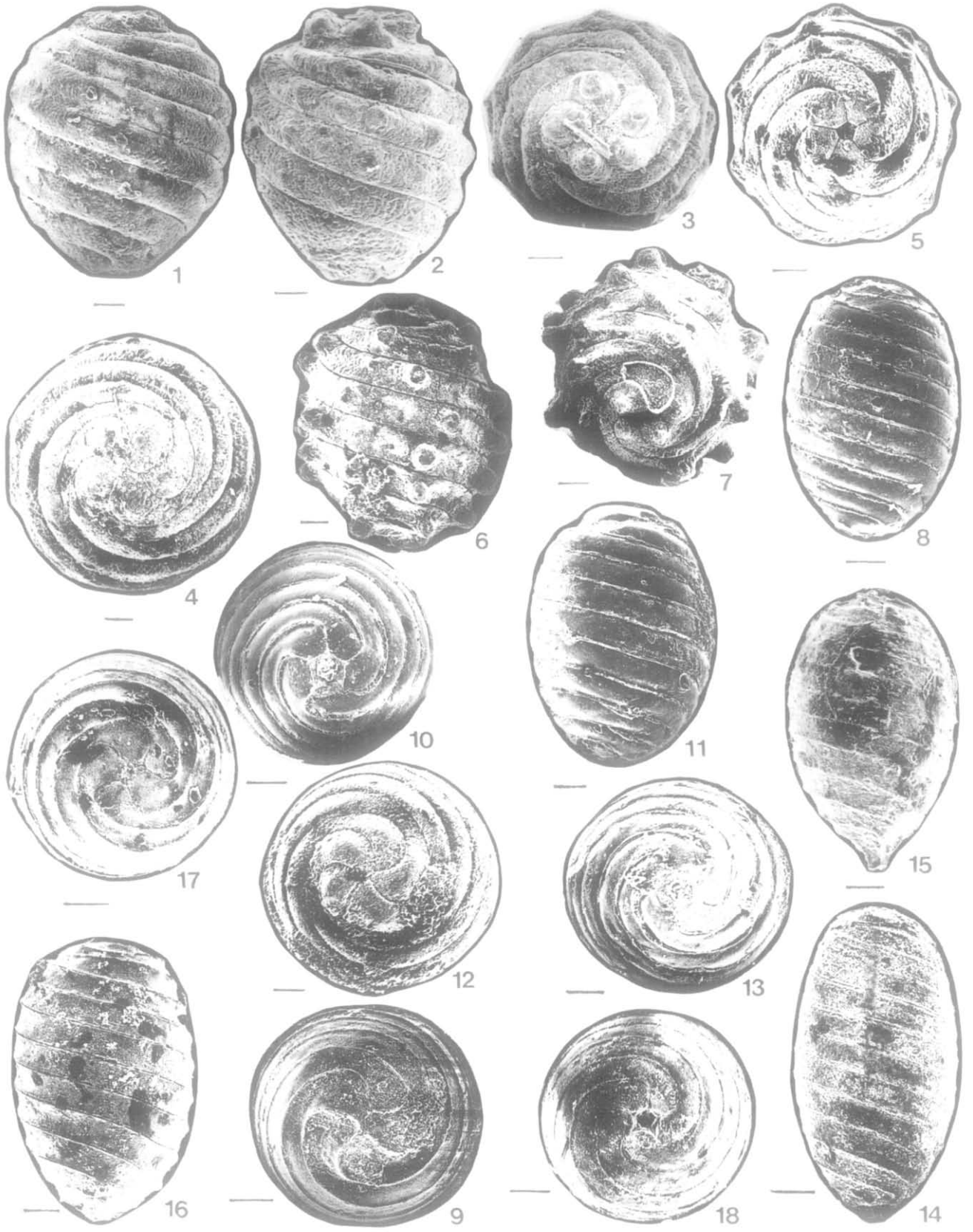
Peckichara varians cf. *P. varians meridionalis* MASSIEUX *et al.* 1981 (Pl- 2, 1-5) - Morphologically, these gyrogonites are characterized by ellipsoidal shape, rounded summit, 8-9 convolutions in lateral view and a progressively tapering funnel-shaped base. However, considerable intraspecific variation is seen in surface ornamentation. The specimens show a gradual change from smooth forms (Pl- 2, 1, 4) to those ornamented with nodes (Pl- 2, 2, 3, 5). Their sub-specific affinities lie with *Peckichara varians meridionalis* described from continental sediments of Massif de Mouthoumet in Pyrénées (Thanetian), France (Massieux *et al.* 1981).

Harrisichara muricata GRAMBAST-FESSARD, 1980 (Pl-2, 6, 7) - This species, reported herein for the first time from India, is characterized by ovoid or ellipsoidal shape, summit more rounded than base, 8 convex lime spirals in lateral view, ornamented with irregularly arranged tubercles, rounded apex with tubercles and a tapering base.

Nemegtichara grambasti BHATIA *et al.* 1990 a (Pl-2, 8-10) - These gyrogonites are ovoid in shape with 10-11 convex lime spirals in lateral view, rounded summit and a slightly tapering base. Their basal pore opening is pentagonal in shape.

PLATE 2

Fig. 1-5 - ***Peckichara varians***. 1. lateral view, VPL/S 1059 ; 2. lateral view, VPL/S 1069 ; 3. apical view, VPL/s 1069 ; 4. apical view, VPL/S 1064 ; 5. basal view, VPL/S 1070 ; 6,7. ***Harrisichara muricata.*** 6. lateral view, VPL/S 1076 ; 7. apical view, VPL/S 1076 ; 8-10. ***Nemegtichara grambasti***. 8. lateral view, VPL/S 1078 ; 9. apical view, VPL/S 1080 ; 10. basal view, VPL/S 1078 ; 11-13. ***Stephanochara levis***. 11. lateral view, VPL/S 1081 ; 12. apical view, VPL/S 1082 ; 13. basal view, VPL/S 1083 ; 14. ***Grambastichara*** sp. lateral view, VPL/S 1084 ; 15. ***Microchara*** sp. lateral view, VPL/S 1085 ; 16-18 ***Chara.*** 16. lateral view, VPL/S 1087 ; 17. apical view, VPL/S 1090 ; 18. basal view, VPL/S 1089. Bar represents 100 µm in all cases.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The specimens are closely comparable with *Nemegtichara grambasti* described recently from the intertrappean beds of Rangapur, Andhra Pradesh (Bhatia *et al.* 1990a).

Stephanochara cf. *S. levis* MASSIEUX, 1977 (Pl-2, 11-13) - These ovoid gyrogonites have a convex, protruding apical region which forms a characteristic rosette, about 325 μm in diameter. The lime spirals are 10-11 in side view. They are narrower in the peripheral region than at the centre and are typically shallow.

The genus *Stephanochara* is herein reported for the first time from Deccan intertrappean beds of peninsular India. The specimens are comparable with *S. levis* described by Massieux (1977) from the Palaeocene (Thanetian) of Petites Pyrénées, France, but differ in being slightly larger in size.

Grambastichara sp. (Pl. 2, 14) - These gyrogonites are elongated ovoid in shape with 12-13 slightly convex to flat lime spirals in side view, rounded summit and a progressively tapering base. The apical rosette is about 190 μm in diameter. They are comparable to *Grambastichara bailanteensis* LIU, reported from Cretaceous-Tertiary transitional sequences of the Shalamulum area of inner Mongolia. However, definite specific assignment await recovery of additional material.

Microchara sp. (Pl-2, 15) - These gyrogonites are ovoid in shape with a rounded summit and a progressively tapering base. In lateral view, 10-11 convolutions are seen. Bhatia & Rana (1984) reported the species *Microchara vestita* from intertrappean beds of Nagpur for the first time in peninsular India. The present specimens are slightly larger than the Nagpur ones. Specific assignment of these gyrogonites is not possible because of their poor preservation.

Chara sp. (Pl-2, 16-18) - Characteristic features of these gyrogonites include ovoid shape with a rounded summit forming an apical rosette, slightly tapering base, starshaped pore opening and 10-11 concave lime spirals visible in side view. They are referable to the long ranging genus *Chara* but their specific affinities cannot be decided at present.

DISCUSSION

The presently described charophyte assemblage from Gurmatkal is taxonomically one of the most diverse known from the Deccan intertrappeans. It comprises 8 genera and 10 species, most of which being reported for the first time from Gurmatkal. Among the most abundant taxa are *Platychara perlata* and *Peckichara varians* recorded from Chandarki and Gurmatkal Sections. Of the remaining 8 species, *Harrisichara muricata* and *Stephanochara* cf. *S. levis* are recorded for the first time from the Deccan intertrappeans. The Kachchh assemblage, in contrast, is taxonomically much less diverse and comprises four species of the genus *Platychara*. These are, in increasing order of abundance, *P. perlata*, *P. rajahmundrica*, *P. raoi* and *P. sahnii*.

P. perlata is apparently one of the most widely distributed species in the Deccan intertrappeans, having been recorded from Nagpur (Bhatia & Rana 1984), Asifabad (Prassad 1986), Rangapur (Bhatia *et al.* 1990a), and now also from Gurmatkal and Kachchh. On the other hand, the species *Platychara compressa*, which is closely related to *P. perlata* (PECK & FORESTER, 1979), has only recently been recognised in the Kateru (Rajahmundry) intertrappean assemblage (Chanda *et al.* 1989). Elsewhere in the world (Fig. 4), these species are widely distributed in the Late Cretaceous rocks : *P. perlata* in South America and Mexico and *P. compressa* in North America and Europe (Peck & Forester 1979 ; Feist 1986). The genus *Platychara* is likely also represented in the Late Cretaceous chinese assemblages (see Bhatia *et al.* 1990a and contained references). However, both *P. perlata* and *P. compressa* are known to persist into the Early Palaeocene at least in Europe and North America (Bhatia *et al.* 1990a).

Other biostratigraphically significant taxa in the Gurmatkal charophyte asemblage are *Harrisichara muricata*, *Stephanochara* cf. *S. levis* and *Peckichara varians*, the last being most common. Prior to this record, *P. varians* was reproted from the intertrappean beds at Kateru, Nagpur (Bhatia 1982 ; Bathia & Rana 1984) and Asifabad (Prasad 1986). Significantly, *P. varians* occurs in association with dinosaur teeth and eggshells at both Nagpur and Asifabad (Vianey-Liaud *et al.* 1987 ; Prasad 1989). Elsewhere in the world, although the genus *Peckichara* does occur in the Maastrichtian of southern France and northern Spain (Grambast 1971, 1974 ; Feist 1979), the species in question (*P. varians*) is restricted to the Palaeocene - Early Eocene of Europe (Feist 1979 ; Massieux *et al.* 1981) and China (Huang 1979). Similarly *H. muricata* and *Stephanochara levis* are restricted to the Palaeocene (Grambast-Fessard 1980 ; Massieux 1977), though at the generic level *Harrisichara* has been recorded from the Late Cretaceous of Nemegt Basin (Gradzinski *et al.* 1977).

In India, besides Gurmatkal, the genus *Harrisichara* (*H. leptocera*) has also been reported (but

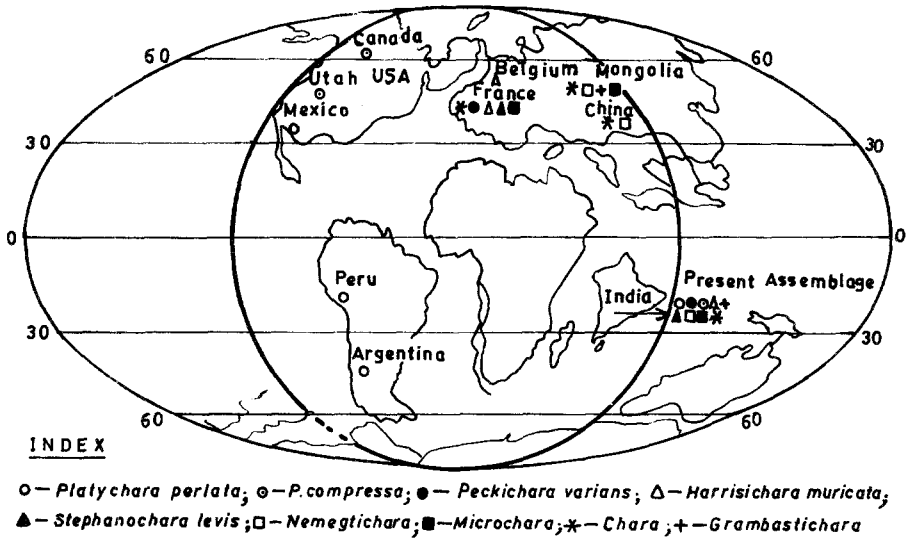

Figure 4 - Palaeogeographic distribution of the presently described charophyte taxa during Late Cretaceous Early Palaeocene. *Distribution paléogéographique des taxons du charophytes décrits au Crétacé tardif - Paléocène précoce.*

not described) from the Kateru intertrappeans (Chanda et al. 1989).

The record of *Nemegtichara grambasti* from Gurmatkal further reinforces Asiatic character of the intertrappean biotas of peninsular India (Sahni & Bajpai 1991). This long ranging (Cretaceous-Eocene) genus, common in Mongolia and China, has only recently been reported from the intertrappean beds at Rangapur in Andhra Pradesh, and Mamoni in Rajasthan (Bhatia *et al.* 1990a, b).

The specific affinities of the remaining three genera from Gurmatkal - *Microchara*, *Grambastichara* and *Chara* - can on only be evaluated when additional material is available. The stratigraphic value of these genera, in particular that of *Microchara*, is therefore uncertain. It is noteworthy that this genus has already been recorded from Rajahmundry (*M. tunicata* CHANDA *et al.* 1989), Nagpur (*M. vestita* BHATIA, 1982) and Sausar (*M. sausari* BHATIA, 1982).

In sum, the charophyte assemblage from Gurmatkal include taxa (*Platychara perlata*, *P. compressa*) which range in age from Late Cretaceous to Early Palaeocene as well as those that are largely restricted to the European Palaeocene (*Peckichara varians*, *H. muricata* and *Stephanochara* cf. *S. levis*). The endemic element is represented by the species *P. sahnii*. Chronologically, it is necessary to considerer the Gurmatkal charophytes in conjunction with the evidence of associated ostracode assemblages. This assemblage, which will be described in a separate publication, is taxonomically diverse and comprises 15 genera and 23 species. On the whole, the Gurmatkal ostracodes have distinct Chinese and Mongolian affinities (even up to species level) and include several taxa (*Talicypridea* - *Altanicypris* - *Mongolianella* - *Cypridea* - *Candona*) which are characteristic of non-marine uppermost Cretaceous sequences of Mongolia and China. Also included in the assemblage are forms such as *Timiriasevia* and *Bisulcocypris* which are long ranging (Jurassic-Late Cretaceous), but whose known record does not extend into the Tertiary.

Thus the majority of ostracode taxa from Curmatkal suggests a Late Cretaceous (Maastrichtian) age which is also consistent with their association with *Platychara perlata* and *P. compressa*. However, the presence of some Palaeocene charophyte taxa is in apparent conflict with the overwhelming ostracode evidence and introduces the possibility that the uppermost parts of investigated intertrappean sections around gurmatkal may be Early palaeocene in age. Alternatively, the three species in question may have had an extended stratigraphic range down into Maastrichtian. In any case, The Gurmatkal intertrappean beds were deposited very close to the K-T transition and the long held Oligocene age needs to be discounted.

Similitaries of the Gurmatkal Charophyta and associated fauna with assemblages known from other intertrappean localities of peninsular India help to investigate the question of age progression in a north to south or an east to west sense within the Deccan province. Starting from the northwesternmost region, the intertrappean beds of Kachchh have recently been assigned to a Maastrichtian age (Bajpai *et al.* 1990) which is also consistent with the available ^{40}Ar - ^{39}Ar age of 60 0.3 My for tholeilithic basalts from Kachchh (Pande *et al.* 1988). Significantly, the presently described four species of *Platychara*

from Kachchh (*P. perlata*, *P. sahnii*, *P. raoi* and *P. rajahmundrica*), occur in association with definite remains of dinosaurs. Besides sharing the most abundant charophyte species *P. perlata*, the Kachchh assemblage also has come teleost fishes in common with the gurmatkal fauna, such as *Apateodus* (cf. *A. striatus* and *Stephanodus lybicus* (Bajpai *et al.* 1990 ; Srinivasan 1991). Ostracodes from Kachchh are still under study, but initial examination has significantly revealed several common Late Cretaceous taxa such as *Timiriasevia*, *Frambocythere tumiensis*, *Mongolianella palmosa*.

Data from northern and eastern fringes of the Deccan volcanics also suggest a Maastrichtian age for both the infratrappean (Lameta Formation and correlatives) and the intertrappean beds. From an intertrappean locality near Mamoni in District Kota, Rajasthan, Bhatia *et al.* (1990b) have recently recorded a small but important assemblage of charophytes and ostracodes. The taxa include several characteristic Late Cretaceous forms such as the charophyte *Pseudoharrisichara* cf. *P. baytishanensis* which is so far restricted to Mamoni, and the ostracodes *Altanicypris szcechurae*, *Mongolianella palmosa* and *Candoniella* all of which are now also known from Gurmatkal (Srinivasan 1991).

The Lameta ostracodes and charophytes have never been studied in detail. However, the initial examination of an assemblage recorded from Bara Simla Hill, Jabalpur (Sahni & Tripathi 1990), suggests the common presence of *Platychara*, *Peckichara* and *Microchara*. Significantly, the intertrappeans around Jabalpur (Padwar and Ranipur), have for the first time yielded a characteristic Maastrichtian palynoassemblage including *Aquilapollenites* (Prakash *et al.* 1990 ; At Ranipur, *Aquilapollenites* occurs in association with definite dinosaur remains (Sahni & Tripathi 1990).

The dinosaur-bearing intertrappean beds at Nagpur, in Central India, are known to be bounded by basalts of reversed polarity. The position of this central reversed interval in the Magnetic Polarity Time Scale (MPTS), is in dispute and is variously interpreted as corresponding to the polarity chron 29R which contains the K-T boundary or to the slightly older 31R (69-70 My) (courtillot *et al.* 1986 ; Sahni & Bajpai 1988 ; Vandamme *et al.* 1991 ; Wensink 1987 ; Klootwizk *et al.* 1992). There are striking similarities between the ostracode faunas of Nagpur (Bhatia *et al.* 1990c) and Gurmatkal as it is clear from the common presence of *Talicypridea*, *Altanicypris szczechurae*, *Mongolianella palmosa*, *Candona bagmodica* and *Condoniella*.

Similarly correlatable are the dinosaur-bearing intertrappean beds of Asifabad (Andhra Pradesh, about 225 km NE of Gurmatkal) which have yielded an almost identical ostracode assemblage (Bhatia *et al.* 1990c).

The intertrappean beds near Rajahmundry in the south-east have long been known for their rich charophyte flora (Rao & Rao 1939). Recently this assemblage was revised by Chanda *et al.* (1989). Although descriptions and illustrations are still awaited, it is important to note the common presence of *Platychara compressa*, *P. sahnii*, *Peckichara varians* and *Harrizsichara*. Significantly, absolute ages (^{40}Ar-^{39}Ar) of basalt samples from Rajahmundry are close to 65 My (Baksi *et al.* 1989).

However, The Rajahmundry intertrappean beds are of marine aspect and contain abundant foraminifera. Their affinities with the Gurmatkal intertrappeans can not be conclusively demonstrated at present as the latter lack this foraminiferal component. The same applies in respect of correlation between the Rajahmundry and Kachchh localities, despite the common presence of *P. rajahmundrica* and *P. sahnii* (BAJPAI *et al.* 1990).

In conclusion, the fossil biotas from Gurmatkal intertrappeans (mainly charophytes and ostracodes) include several taxa which help in establishing their biostratigraphic correlation with similar, Maastrichtian-aged deposits along the northern and eastern fringes of the Deccan volcanics. However, palaeomagnetic measurements and ^{40}Ar-^{39}Ar ages are needed from stratigraphically controlled sections for a more precise correlation between widely separated Maastrichtian intertrappeans of peninsular India. As of now, the investigation suggests that the previous estimates of an Early Oligocene age for the Gurmatkal intertrappeans were not well founded and that there is no appreciable southward younging in the Deccan province. Temporal differences, if any, are not within the limits of current biostratigraphic resolution.

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