
Charophyta from the Deccan Intertrappean beds near Rangapur, Andhra Pradesh, India

S. B. Bhatia, Janine Riveline & R. S. Rana

Bhatia, S. B., Riveline, Janine & Rana, R. S. 1990. Charophyta from the Deccan Intertrappean beds near Rangapur, Andhra Pradesh, India. *Palaeobotanist* 37(3) : 316-323.

Two charophytes—*Platychara perlata* (Peck & Reker) Grambast and *Nemegtichara grambasti* sp. nov.—are described and illustrated from the Deccan Intertrappean beds near Rangapur, district Rangareddi, Andhra Pradesh. The genus *Nemegtichara* Karczewska & Ziembinska-Tworzydlo, first described from the Palaeogene "White Beds" of the Nemegt Basin in Mongolia and also known from the Cretaceous-Middle Eocene of China, is being recorded for the first time from India. The age and palaeobiogeographic implications of the assemblage are also discussed.

Key-words—Charophyta, *Platychara*, *Nemegtichara*, Deccan Intertrappean beds, Tertiary (India).

S. B. Bhatia, Department of Geology, Panjab University, Chandigarh 160 014, India.

Janine Riveline, Laboratoire de Géologie des Bassins Sédimentaires, Université Pierre et Marie Curie, Paris VI, France.

R. S. Rana, Department of Geology, Kumaun University, Nainital, India.

सारांश

आंध्र प्रदेश (भारत) में रंगापुर के समीपस्थ दक्खिन अन्तर्द्वीपी संस्तरो से केरोफाइड की प्राप्ति

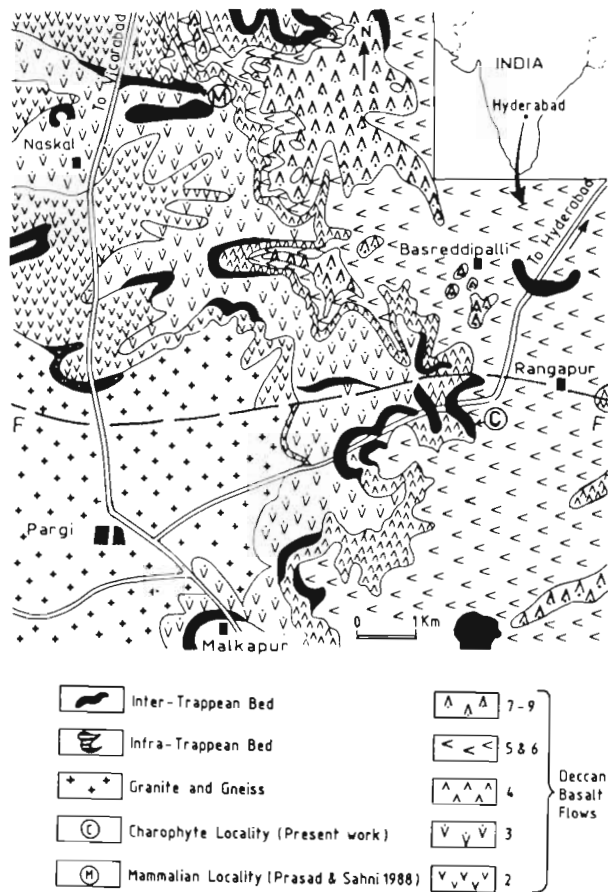
एस० बी० भाटिया, जेनी रिवेलीन एवं आर० एस० राना

आंध्र प्रदेश में रंगारेड्डी जनपद में रंगापुर के समीपस्थ दक्खिन अन्तर्द्वीपी संस्तरो से दो केरोफाइडों—प्लेटिचारा पर्लेटा (पेक व रेकर) ग्रामबास्ट एवं निमेग्टीचारा ग्रामबास्टाई नव जाति का चित्रण एवं वर्णन किया गया है। निमेग्टीचारा कार्सजेस्क व जिम्बिन्स्क-ट्वोर्जिडलो नामक प्रजाति, जो पहले मंगोलिया में निमेग्ट द्रोणी के पुरानतन कालीन "व्हाइट संस्तरो" से तथा चीन के क्रीटेशी-मध्य आदिनतन से ज्ञात थी, इस शोध-पत्र में पहली बार अभिलिखित की जा रही है। इस समुच्चय की आयु तथा पुराभौगोलिक महत्वों पर भी विवेचना की गई है।

IN recent years, the charophytes have played a significant role in the biostratigraphy of continental deposits (Feist & Ringeade, 1977; Feist-Castel, 1977; Bhatia & Mathur, 1978; Kyansap-Romashkina, 1980; Massieux *et al.*, 1981; Berger, 1983; Karczewska & Ziembinska-Tworzydlo, 1983; Riveline, 1986). Similarly they are proving useful in delimiting the Cretaceous-Tertiary boundary (Feist, 1979; Feist & Colombo, 1983; Lepicard *et al.*, 1985; Huang, 1979, 1985; Weitong, 1985), in working out global events (Feist, 1986; Martin-Closas & Serra-Kiel, 1986), and in palaeobiogeographic studies (Bhatia & Rana, 1984). It is in these contexts that a study of the charophyta of the well-known Deccan Intertrappean beds assumes great importance. Although charophytes have been known since 1837 when Sowerby first described and illustrated *Chara malcolmsoni* from Nagpur, and through subsequent

works of Sahni and Rao (1934), Rao and Rao (1939), Mahadevan and Sarma (1948), Rao (1955), Bhatia and Mannikeri (1976), Shivarudrappa (1972 *et seq.*), Singh and Mathur (1979) and Singh (1980), there is apparently a need for a thorough revision of the flora as emphasized by Bhatia (1982), who also discussed the entire gamut of the Post-Palaeozoic charophyta of India. In a recent communication, Bhatia and Rana (1984) recorded for the first time the occurrence of the cosmopolitan taxon *Platychara perlata* (Peck & Recker) Grambast from Nagpur and discussed the palaeobiogeographic implications of the charophytic flora and the fresh-water ostracode fauna.

In the present paper, the authors describe and illustrate two species—*Platychara perlata* (Peck & Reker) Grambast and *Nemegtichara grambasti* sp. nov., from the Intertrappean beds near Rangapur,



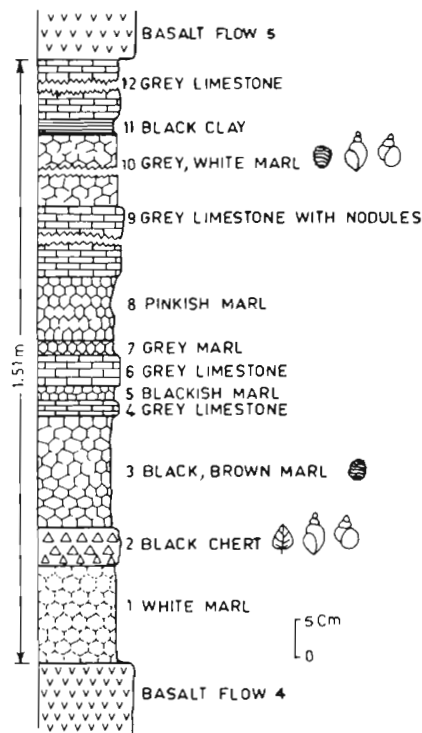
Text-figure 1—Geological map of the area, west of Rangapur, district Rangareddi, Andhra Pradesh (after Dutt, 1975).

district Rangareddi, Andhra Pradesh (Survey of India Toposheet no. 56G/16, 1 : 50,000; Text-fig. 1). The area has been geologically mapped by Dutt (1975) and a reference may be made to his work for details of geology. Dutt recognized nine flows in the region with four distinct Intertrappean beds (between flows 1 and 5), besides the so-called Infratrappaeans occupying a position between the lowermost flow and the Proterozoic sedimentaries (Bhima Group) or the Archaean granites and gneisses. Of the four Intertrappean beds recorded and mapped by Dutt, only the one between flows 4 and 5 is richly fossiliferous and contains abundant angiospermic leaf-impressions, fish remains and molluscs belonging to the genera *Physa* and *Viviparus*. In this connection it is interesting to recall that the first charophyte from the area under investigation was recorded by Mahadevan and Sarma (1948) who identified abundant gyrogonites belonging to *Chara malcolmsoni* Sowerby from near Vicarabad. The exact location and horizon of the sample, however, was not mentioned by these authors. More recently, the Inter-trappean beds of this region have yielded

abundant fossil vertebrate remains including osteoglossid fish (Prasad, 1987), first Cretaceous mammal (Prasad & Sahni, 1988) and fish otoliths (Rana, 1988), while the Infratrappaeans have yielded dyrosaurid crocodile remains (Rana, 1987). The age implications and stratigraphic significance of the fossil assemblages in general from the Inter-trappean beds of Andhra Pradesh have been discussed by Rao and Yadagiri (1981) and Prasad *et al.* (1986), while the entire gamut of Deccan Volcanism and Cretaceous-tertiary boundary events have been discussed by Sahni *et al.* (1986) and Sahni (1988)

LITHOSTRATIGRAPHY AND LOCATION OF SAMPLES

The Intertrappean bed near Rangapur (Text-fig. 1) from which the charophytes are being described, and from which Rana (1988) has found a rich suite of fish otoliths, is located between lava flows 4 and 5 (*sensu* Dutt, 1975). At this locality 1.75 km WSW of Rangapur, a 1.51 m thick section was measured (Text-fig. 2). The sequence comprises essentially of white, pink and brownish-black marls and grey limestones with a 5 cm thick black chert band towards the base. The charophytes occur in beds no.



Text-figure 2—Lithostratigraphic section of the Intertrappean Bed (between Basalt flow 4 and 5) exposed 1.75 km WSW of Rangapur.

3 and 10. The associated faunas in these two beds include fish otoliths molluscs and freshwater ostracodes. The black chert band also contains leaf-impressions and molluscs. The samples were collected by one of us (RSR) who is responsible for details of geology and lithostratigraphic section.

All the specimens illustrated in this paper are at present in the collection of Dr Janine Riveline of Paris VI University. These will eventually be deposited in the Geology Museum of that University. Representative samples are also in the personal collections of the other authors.

SYSTEMATIC DESCRIPTIONS

Genus—*Platychara* Grambast 1962

Platychara perlata (Peck & Reker) Grambast
Pl. 1, figs 1-5

- 1924 *Chara elliptica* Fritzche, p. 28, pl. 2, fig. 3
1937 ?*Chara oebleri* (Dollfus) Rao & Rao, p. 8, pl. 1, fig. 9; pl. 3, fig. 2.
1947 *Chara perlata* Peck & Reker, p. 3, figs 19-21.
1951 *Chara perlata* Horn af Rantzien, p. 661.
1951 ?*Aclistochara cruciana*, new name, Horn af Rantzien, p. 672.
1967 *Platychara perlata* (Peck & Reker) Grambast *et al.*, p. 2.
1972 ?*Platychara cruciana* (Horn af Rantzien) Musacchio, p. 229, text-figs 1-4, pl. 1, figs 1-4-7; pl. 2, figs 15-17.
1979 *Platychara perlata* (Peck & Reker) Grambast, Peck & Forester, p. 230, pl. 2, figs 5-7-8.
1984 *Platychara perlata* (Peck & Reker) Grambast, Bhatia & Rana, p. 30, pl. 1, figs 2, 3.

Description—Gyrogonites subglobular in shape, flattened longitudinally, typically wider than long, rounded at the top and base. Lime spirals: smooth, generally convex, sometimes flat, thin intercellular ridges, 6 to 8 convolutions of (89) 102-153 μm width visible in lateral view. Apex: lime spirals narrow and constricted at about 250 μm from the margins, swollen and convex in the centre forming a distinct apical rosette: 435-692 μm in diameter. Base: rounded, very rarely tapering, basal pore opening narrow, 25-50 μm wide, basal plaque not observed.

Dimensions—Length 640-925 μm , width 760-1050 μm . L/W ratio 0.73-0.94, average 0.84.

Locality—Material comes from a locality 1.75 km WSW of Rangapur, Andhra Pradesh.

Generic affinities—The oblate shape of the gyrogonites and the extreme rareness of the basal tapering could possibly lead one to think of generic affinities with either some species of the genus *Dugbiella* (eg. *D. obtusa* Grambast & Gutierrez or *D.*

pomeroli Gutierrez & Lauerjat) having smooth lime spirals, or with some species of the genus *Gyrogona* (eg. *G. morelleti* Grambast), also with smooth lime spirals. The similarities, however, are superficial as it is possible to distinguish the Indian material from the above mentioned species of *Dugbiella* by its large overall dimensions, particularly the width of the gyrogonites and also by the presence of a large and distinct apical rosette. In the genus *Dugbiella*, the lime spirals are only slightly modified in the apical region. The distinction between the Indian material and genus *Gyrogona* is based also on the apical structure. In *Gyrogona*, almost the entire apical area is occupied by terminal nodules and the constriction of the lime spirals is located close to the margins or periphery. In our specimens, the constriction occurs at a distance more than 250 μm from the periphery. In view of the above attributes, we have no hesitation in assigning our material to the genus *Platychara* Grambast.

Specific affinities—The absence of a tapering base, the absence of ornamentation and the length/width ratio suggest the placement of our material in *Platychara* group *compressa-perlata*. According to Peck and Forester (1979), the average ratio for *P. compressa* is around 0.75, while for *P. perlata* is more than 0.81. Since in our material the average ratio is 0.84, we have assigned our species to *P. perlata*. Our specimens are identical to those described by Bhatia and Rana (1984) from Nagpur.

Genus—*Nemegtichara* Karczewska & Ziembinska-Tworzydło 1972

Nemegtichara grambasti sp. nov.
Pl. 1, figs 6-9

Diagnosis—Gyrogonites of *Nemegtichara* characterised by an ovoid shape with very slightly calcified lime spirals in the apical part.

Description—Gyrogonites with an ovoid shape, summit rounded, slightly protruding in the centre, base progressively tapering. Lime spirals: smooth, slightly concave, 8-11 convolutions visible in lateral view, 51-90 μm wide, thick intercellular ridges. Apex: very slight calcification of lime spirals in the apical part, lime spirals narrow near the apical periphery, wide at the centre, strongly concave with tapering intercellular ridges. Base: progressively tapering, basal pore situated in the centre of a "pseudochannel" constituted by the thickening of lime spirals, pentagonal basal pore 25-100 μm wide, basal plaque not observed.

Dimensions—Length 640-770 μm , width 487-564 μm , L/W ratio 1.23/1.62.

Type material—Holotype, figures 6 and 7;

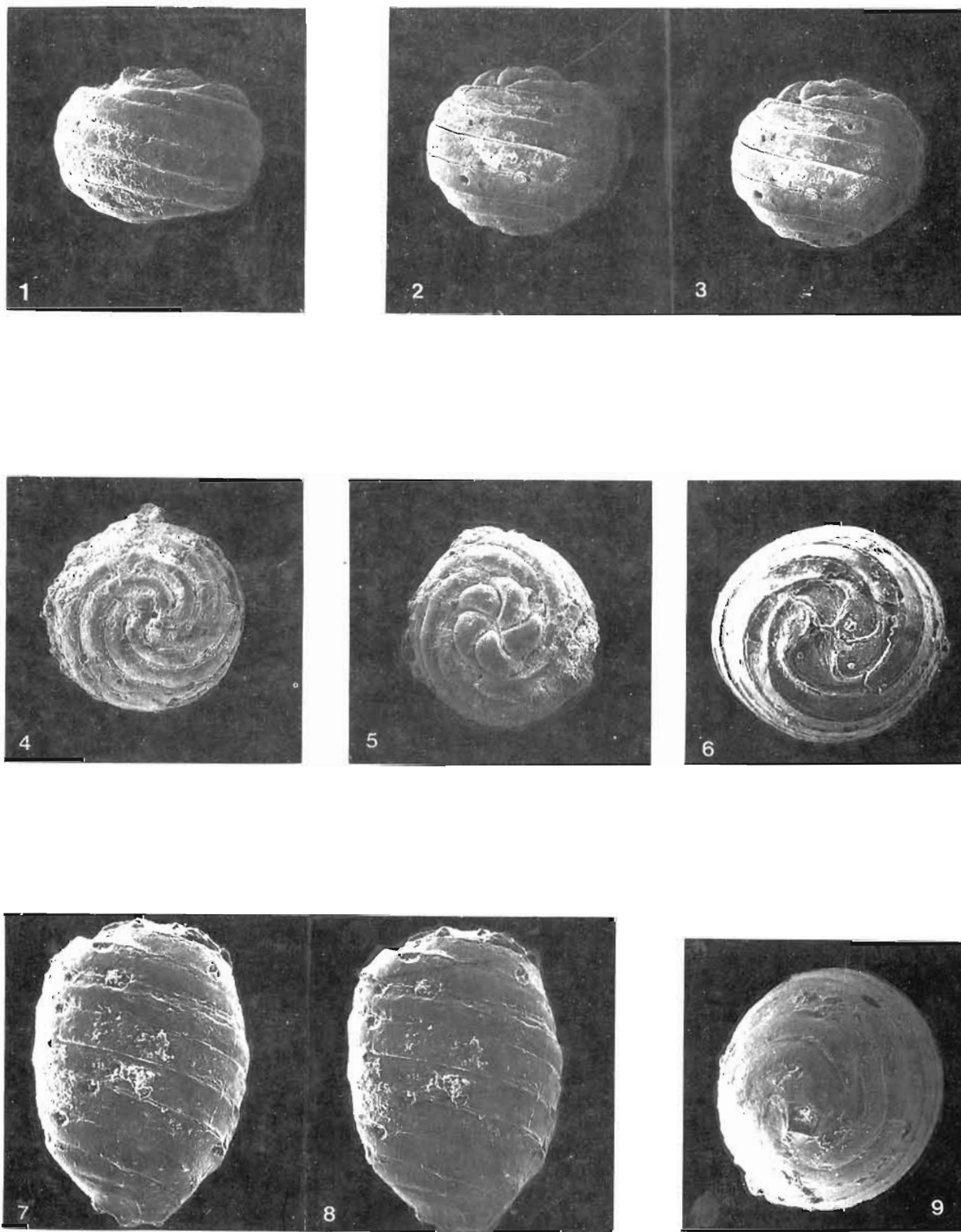


PLATE 1

- 1-5. *Platychara perlata* (Peck & Recker) Grambast, × 30
 1. Lateral view
 2,3. Stereoscopic view
 4. Apical view
 5. Basal view

- 6-9. *Nemeglichara grambasti* sp. nov., × 70.
 6,7. Stereoscopic view
 8. Basal view
 9. Apical view

Paratype I, figure 8; Paratype II, figure 9.

Type Locality—1.75 km WSW of Rangapur, district Rangareddi, Andhra Pradesh, India.

Type level—Intertrappean bed between Lava flows 4 and 5 (*sensu* Dutt, 1975).

Generic Affinities—The apical structure described above suggests ‘Lamprothamnoide’ type of gyrogonites (*sensu* Feist & Grambast-Fessard, 1982) with characteristic protruding summit and absence of apical nodules. The periapical depression, however, is not so well-marked in our material, suggesting affinities with either *Pseudolatochara* (Wang Zhen, 1978a) or *Mongolichara* (Kyansep-Romashkina, 1975) emend. Karczewska and Kyansep-Romashkina, 1979. The Indian material, however, can neither be ascribed to *Pseudolatochara* because of the less protruding summit, nor to *Mongolichara* because it lacks the slightly thickened lime spirals at the apex and also the surface ornamentation. In view of the above facts, we have assigned our material to the genus *Nemegtichara*.

Specific affinities—The new species of *Nemegtichara* described herein is bigger in overall dimensions than any other described in the literature, particularly insofar as the length is concerned. The length/width ratio, however, falls partially within the values for *N. prima* and completely within those for *N. quarta*, both described by Karczewska and Ziembinska-Tworzydlo (1972). From the former, our species differs in having a tapering base rather than a rounded one, while from the latter, it differs in details of basal part, and in having the maximum width in the upper third of the gyrogonite, rather than in the middle. The above characteristics may also be used for distinguishing our species from *Nemegtichara* sp. described by Wang Zhen *et al.* (1983) from China.

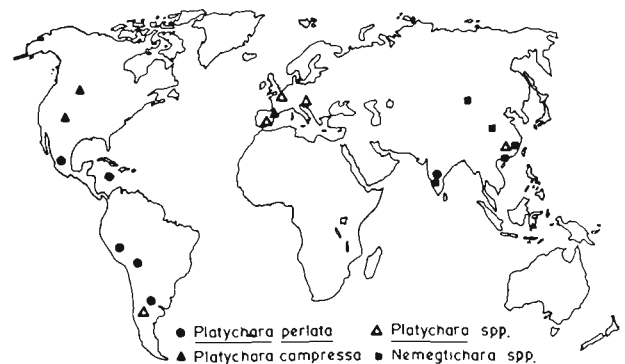
Etymology—The species is named in honour of the Late Prof. L. Grambast, Montpellier, France.

PALAEOBIOGEOGRAPHIC AND AGE IMPLICATIONS

The morphologically distinctive genus *Platychara* occurs abundantly in the Late Cretaceous lacustrine sediments in North and South America (Musacchio, 1973; Peck & Forester, 1979), in Europe (Bignot & Grambast, 1969; Grambast & Gutierrez, 1973; Massieux *et al.*, 1985) and possibly also in China, where some species belonging to the genus *Gyrogonia* (particularly *G. hubeiensis* Wang Zhen, 1978a) may belong to *Platychara* (*fide* Grambast-Fessard, 1980; Weitong, 1985). According to Karczewska and Ziembinska-Tworzydlo (1983), the apparent absence of *Platychara* in China is due to

the different taxonomical approach of the Chinese authors and, that, on the other hand, *Platychara* is definitely absent from the Upper Cretaceous assemblages of Charophyta from Mongolia. It is, therefore, obvious that a taxonomic revision of the Chinese material is necessary to help arrive at a clearer palaeobiogeographic picture. However, be that as it may, the genus *Platychara* does persist up to the Lower Palaeocene with certainty in Europe (Stratotype of Montian in Belgium, Grambast-Fessard, 1980; Massieux *et al.*, 1985), and in North America (Willow Creek Formation, Member E in Canada, Peck & Forester, 1979), but with uncertainty in Argentina in South America (Musacchio, 1973). In India, the genus has been recorded from the Deccan Intertrappean beds of Nagpur (Bhatia & Mannikeri, 1976; Bhatia & Rana, 1984). The precise age of these beds remains controversial and probably straddles the Cretaceous-Tertiary Boundary. The present record from Andhra Pradesh extends the geographic range of the genus within the Peninsular India. The taxon has a cosmopolitan distribution, as is apparent from the above discussion (Text-fig. 3). However, its absence from Africa is significant and may be attributed either to incomplete charophyte inventories, which is true, or to lack of favourable lacustrine systems with charophyte vegetation. At the specific level, *Platychara perlata* has been recorded from Upper Cretaceous localities in Mexico and South America (Musacchio, 1973; Peck & Forester, 1979). Bhatia and Rana (1984) have recorded this species from the Intertrappean beds of Nagpur.

The genus *Nemegtichara* was first described by Karczewska and Ziembinska-Tworzydlo (1972) from the “White Beds” of the Nemegt Basin in Mongolia. These beds have been variously assigned, either to Palaeocene (Gradzinski *et al.*, 1977; Szalay & Mckenna, 1971) or to Eocene (Karczewska & Ziembinska-Tworzydlo, 1972). In China, however,



Text-figure 3—Map showing geographic distribution of the charophyte genera *Platychara* and *Nemegtichara*.

the genus first appears in the Turonian-Maestrichtian (Wang Zheng, 1978; Huang, 1979; Wang Zhen *et al.*, 1983; Wang Zhen & Wang Ke-Yong, 1985) and continues into Palaeocene and Eocene (Wang Zhen, 1978b, 1981; Huang, 1985). The present record of the genus from India extends its geographic distribution. As at present, the genus has been recorded only from Mongolia, China and India.

In so far as the age of the Intertrappean beds is concerned, it is not possible to give a precise age based entirely on the hitherto known charophyte assemblages. As already stated, at the generic level, both *Platychara* and *Nemegtichara* occur abundantly in the Upper Cretaceous and persist into the Lower part of Palaeocene, and in the case of latter, even up to Eocene, as in China. Since we have a new species of *Nemegtichara* in our material, its stratigraphical value at present is uncertain. *P. perlata*, which occurs abundantly in our material is known to range from Upper Cretaceous to Palaeocene from Mexico through South America, while its close ally *P. compressa* also has a similar stratigraphic range in North America (Peck & Forester, 1979) and in localities north of Pyrenees in Europe (Massieux *et al.*, 1985). Notwithstanding the lack of clear relationship between these two species as stated by Peck and Forester (1979), it is certain that they both occur abundantly in the Upper Cretaceous and persist into the Lower Palaeocene. On the basis of negative evidence, it is worth noting that the genus *Septorella*, indicative of Maestrichtian in western Europe, is absent in the Upper Cretaceous deposits of not only Mongolia and China (*fide* Karczewska & Ziembinska-Tworzydło, 1981) but of India also. Similarly, characteristic Paleocene species of Europe, like *Sphaerochara edda/elongata* group and *Dughiella bacillaris* (*fide* Feist, 1979), as also the characteristic components of the Mongolian Palaeocene assemblages comprising *Gobichara* and *Grovesichara* (*fide* Karczewska & Ziembinska-Tworzydło, 1981), are absent in the Intertrappean beds. According to Feist and Grambast-Fessard (1982) the genus *Gobichara* is a junior synonym of the genus *Microchara*. If this contention is correct, then the genus *Gobichara* is no more a characteristic component of the Mongolian Palaeocene assemblages. We thus see that from our present state of knowledge concerning the charophytan assemblages, it is not possible to fix precisely the age of the Deccan Intertrappean beds.

However, be that as it may, in the Intertrappean beds of Nagpur (= Takli Formation in which *P. perlata* occurs abundantly, *fide* Bhatia & Rana, 1984), Asifabad and Anjar (in Gujarat), dinosaur dental and egg-shell fragments and limb bones

occur abundantly (*fide* Sahni *et al.*, 1986; Rao & Yadagiri, 1981; Ghevaria, 1988). More recently, Prasad and Sahni (1988) have described the first Cretaceous mammal, a new taxon, from the Intertrappean beds between lava flows 2 and 3 from a locality north-east of Naskal, close to our charophyte locality near Rangapur (*see* Text-fig. 1). These finds suggest a Late Maestrichtian rather than a Tertiary age for the Intertrappean beds (Prasad & Sahni, 1988). Similarly, the recent ^{40}Ar - ^{39}Ar isochron ages (mean 67.4 ± 0.7 Myr) for Deccan basalts by Duncan and Pyle (1988) show that the Deccan volcanism occurred within a very short span of time (perhaps one million years) very close to the Cretaceous-Tertiary Boundary. Similar results were obtained earlier by Courtillot *et al.* (1986) and confirmed subsequently by Courtillot *et al.* (1988). The charophytan evidence is not inconsistent with the radiometric and palaeomagnetic data and the evidence of vertebrate fossils.

ACKNOWLEDGEMENTS

One of us (SBB) is grateful to the Indian National Science Academy and the French Academy of Sciences for financial assistance under Exchange of Scientists Programme which enabled him to work at Paris and Montpellier Universities and finalize the paper. To Drs N. Grambast-Fessard, Monique Feist, I. Soulié-Mâsche and M. Massieux, he is indebted for fruitful discussion and help in many ways. RSR is grateful to the Ministry of Education, Government of France for providing Post-Doctoral Fellowship, and to the U.G.C. and C.S.I.R., New Delhi for financial assistance for field work. The authors also thank Prof. A. Sahni, for loan of literature and many stimulating discussions.

REFERENCES

- Berger, J. P. 1983. Charophytes de l' "Aquitaniens" de Suisse occidentale. Essai de taxonomie et biostratigraphie *Geobios* **16** (1): 5-37.
- Bhatia, S. B. 1982. Post-Paleozoic fossil Charophyta of India. *Recent advances in Cryptogamic Botany*, pp 268-286. The Palaeobotanical Society, Lucknow.
- Bhatia, S. B. & Mannikeri, M. S. 1976. Some Charophyta from the Deccan Intertrappean beds near Nagpur, central India. *Geophytology* **6** (1): 75-81.
- Bhatia, S. B. & Mathur, A. K. 1978. The Neogene charophyte flora of the Siwalik Group, India and its biostratigraphical significance. *Geophytology* **8** (1): 79-97.
- Bhatia, S. B. & Rana, R. S. 1984. Palaeogeographic implications of the Charophyta and Ostracoda of the Intertrappean beds of Peninsular India. *Mem. Soc. Geol. France*, N. S. **147**: 29-35.
- Bignot, G. & Grambast, L. 1969. Sur la position stratigraphique et les charophytes de la formation de Kozina (Slovénie,

- Yugoslavie). *C. R. Acad. Sci. Paris*, **269** : 689-692.
- Courtillot, V., Besse, J., Vandamme, D., Montigny, R., Jaeger, J. J. & Capetta, H. 1986. Deccan flood basalts at the Cretaceous-Tertiary Boundary? *Earth Planet. Sci. Letter* **80** : 361-374.
- Courtillot, V., Ferand, G., Maluski, H., Vandamme, D., Moreau, M. G. & Besse, J. 1988. Deccan flood basalts and the Cretaceous-Tertiary boundary. *Nature* **333** (6176) : 843-846.
- Duncan, R. A. & Pyle, D. G. 1988. Rapid eruption of the Deccan flood basalts at the Cretaceous-Tertiary boundary. *Nature* **333** (6176) : 841-843.
- Dutt, N. V. B. S. 1975. Deccan Traps of the western part of Hyderabad District, Andhra Pradesh. *Rec. geol. Surv. India* **106** (2) : 126-141.
- Feist, M. 1979. Charophytes at the Cretaceous/Tertiary boundary. New data and present state of knowledge. *Cretaceous-Tertiary boundary events symposium. II Proc. Copenhagen* : 88-94.
- Feist, M. 1986. Bio-events in the continental realm during the Cretaceous-Tertiary transition; a multidisciplinary approach. *Lecture notes in Science*, (in Press), Springer Verlag Berlin.
- Feist, M. & Colombo, F. 1983. La limite Crétacé-Tertiaire dans le nord-est de l'Espagne, du point de vue des charophytes. *Geol. medit.* **10** (3-4) : 303-326.
- Feist, M. & Grambast-Fessard, N. 1982. Clé de détermination pour les genres de charophytes. *Paleobiologie Continentale*, **13** (2) : 1-28.
- Feist, M. & Ringeade, M. 1977. Etude biostratigraphique et paléobotanique (charophytes) des formations continentales d'Aquitaine, de l'Eocène supérieur au Miocène inférieur. *Bull. Soc. Geol. France, 7e ser.* **14** (2) : 341-354.
- Feist-Castel, M. 1977. Etude floristique et biostratigraphique des charophytes dans les séries du Paléogène de Provence. *Geol. medit.* **4** (2) : 109-138.
- Ghevaria, Z. G. 1988. Inter-trappean dinosaurian fossils from Anjar area, Kachchh District, Gujarat. *Curr. Sci.* **57** (5) : 248-251.
- Grambast, L. & Gutierrez, G. 1977. Espèces nouvelles de charophytes du Crétacé supérieur terminal de la province de Cuenca. *Paleobiol. Continental* **8** (2) : 1-34.
- Grambast-Fessard, N. 1980. Les Charophytes du Montien de Mons (Belgique). *Rev. Paleobot. Palynol.* **30** : 67-88.
- Huang, R. J. 1979. Late Cretaceous to Early Tertiary charophytes from Nanxiong basin of Guangdong Province. In: *Mesozoic and Cenozoic Red Beds of South China. Science Press* : 190-205 (in Chinese).
- Huang, R. J. 1985. Cretaceous and Early Tertiary charophytes from Sichuan. *Acta Micropaleont. sin.* **2** (1) : 77-89 (in Chinese).
- Karczewska, J. & Kyansep-Romashkina, N. P. 1979. Revision of the Late Cretaceous genus *Mongolichara* Kyansep-Romashkina. *Acta Paleont. polon.* **24** (4) : 423-427.
- Karczewska, J. & Ziembinska-Tworzydlo, M. 1972. Lower Tertiary Charophyta from the Nemegt Basin, Gobi Desert. *Acta Paleont. polon.* **27** : 51-81.
- Karczewska, J. & Ziembinska-Tworzydlo, M. 1983. Age of the Upper Cretaceous Nemegt Formation (Mongolia) on charophytan evidence. *Acta Paleont. polon.* **28** (1-2) : 137-146.
- Kyansep-Romashkina, N. P. 1975. Quelques charophytes du Jurassique supérieur et du Crétacé de Mongolie. *Iskop. fauna flora Mongoumest naya. sov. mong. paleont. sbksped* **2** : 181-204 (in Russian).
- Kyansep-Romashkina, N. P. 1980. The importance of the charophytes to the stratigraphy of the Paleogene. *Ezbeq. Vses. Paleont. O-va* **23** : 286-298.
- Lepicard, B., Bilotte, M., Massieux, M., Tambareau, Y., & Villatte, J. 1985. Faunes et flores au passage Crétacé-Tertiaire en faciès continental dans les petites Pyrénées (Zone sous-pyréenne). *Geobios* **18** (6) : 787-800.
- Mahadevan, C. & Sarma, S. R. 1948. Deccan Intertrappean Series (Vicarabad, Hyderabad State)—Charophyta from the Deccan-VI. *J. Indian bot. Soc.* **26** (4) : 260.
- Martin-Closas, C. & Serra-Kiel, J. 1986. Two examples of evolution controlled by large scale abiotic processes: Eocene nummulitids of the south-Pyrenean basin and Cretaceous Charophyta of western Europe. In: O. Walliser (Ed.)—*Global Bioevents*, 375-380, Springer Verlag, Berlin.
- Massieux, M., Bilotte, M., Tambareau, Y. & Villatte, J. 1985. Données préliminaires sur les charophytes du Campanien et du Maastrichtien du versant nord-Pyrénéen. *Act. du 110 Congrès Nat. des Soc. Savantes. Montpellier* **5** : 79-86.
- Massieux, M., Tambareau, Y. & Villatte, J. 1981. Characées paléocènes et éocènes du versant nord des Pyrénées. *Rev. micropaleont.* **24** (2) : 69-82.
- Musacchio, E. 1973. Charophytas y Ostracodos no marinos del frupo Neuquen (Cretacio superior) en algunos afloramientos de las provincias de Rio Negro y Neuquen Republica argentina. *Revta Mus. La Plata n.s.* **8** (Pal. 48) : 1-32.
- Peck, R. E. & Forester, R. M. 1979. The genus *Platychara* from the Western Hemisphere. *Rev. Paleobot. Palynol.* **28** : 223-236.
- Prasad, G. V. R. 1987. Squamules of osteoglossid fish from the Intertrappean beds of Pargi, Andhra Pradesh. *Curr. Sci.* **56** (24) : 1270-1272.
- Prasad, G. V. R. & Sahni, A. 1988. First Cretaceous mammal from India. *Nature* **332** : 638-640.
- Prasad, G. V. R., Sahni, A. & Gupta, V. J. 1986. Fossil assemblages from Infra- and Intertrappean beds of Asifabad, Andhra Pradesh and their geological implications. *Geosci. J.* **7**(2) : 163-180.
- Rana, R. S. 1987. Dyrosaurid crocodile (Mesosuchia) from the Infratrappan beds of Vikarabad, Hyderabad District, Andhra Pradesh. *Curr. Sci.* **56** (11) : 532-534.
- Rana, R. S. 1988. Freshwater fish otoliths from the Deccan Trap associated sedimentary (Cretaceous-Tertiary transition) beds of Rangapur, Hyderabad District, Andhra Pradesh. *Geobios* **21** (4) (in Press).
- Rao, B. R. J. & Yadagiri, P. 1981. Cretaceous Intertrappean beds from Andhra Pradesh and their stratigraphical significance. *Mem. geol. Soc. India Mem.* **3** : 287-291.
- Rao, K. S. & Rao, S. R. N. 1939. Fossil charophyta of the Deccan Intertrappeans near Rajahmundry, India. *Mem. geol. Surv. India Paleont. Indica* **29** (2) : 1-14.
- Rao, L. R. 1955. On charas from the Yellur Intertrappean bed. *J. Poona Univ., Sci. Sect.* **6** : 108-109.
- Riveline, J. 1986. Les charophytes du Paléogène et du Miocène Inférieur d'Europe occidentale, Biostratigraphie des formations continentales. *Ed. Cent. Nat. Rech. Scient., Paris* : 1-227.
- Sahni, A. 1988. Cretaceous-Tertiary boundary events: mass extinctions, iridium enrichment and Deccan volcanism. *Curr. Sci.* **57** (10) : 513-519.
- Sahni, A., Prasad, G. V. R. & Rana, R. S. 1986. New paleontological evidences for the age and initiation of the Deccan Volcanics, central Peninsular India. *Gondwana Geol. Mag.* **1** : 13-24.
- Sahni, B. & Rao, S. R. N. 1943. *Chara sausari* sp. nov., a *Chara* (sensu stricto) from the Intertrappean cherts at Sausar in the Deccan. *Proc. natn. Acad. Sci. India* **13** (3) : 215-223.
- Shivarudrappa, T. V. 1972a. On the occurrence of charophytic remains from the Intertrappeans of Gurmatkal, Gulbarga District, Mysore State. *Curr. Sci.* **41** (2) : 21-23.
- Shivarudrappa, T. V. 1972b. On *Gyrogonites medicaginula* and *Chara wrightii* from the Inter-Trappeans of Gurmatkal, Gulbarga District, Mysore State. *Proc. II Indian Colloq Micro-pal. Stratigr., Lucknow* : 115-119.

- Shivarudrappa, T. V. 1976-77. Discovery of fossil reproductive organs of *Chara* from the Inter-trappeans of Gurmatkal, Gulbarga District, Karnataka State. *J. Mysore Univ.* **B27** : 104-110.
- Shivarudrappa, T. V. 1977. First report of charophytes from the Intertrappean sediments of Bilgi, Bijapur District, Karnataka State. *Proc. IV Indian Colloq. Micropal. Stratigr., Dehradun* : 196-200.
- Shivarudrappa, T. V. 1978. First record of *Nitellites* from the Lower Tertiary Intertrappean sediments of Gurmatkal, Gulbarga District, Karnataka State. *Abstract VII Indian Colloq. Micropal. Stratigr., Madras* : 33-34.
- Singh, M. P. 1980. Charophytes from the Infratrappean beds of Papro, Lalitpur District, Uttar Pradesh. *J. Paleont. Soc. India* **23-24** : 144-153.
- Singh, M. P. & Mathur, D. K. 1979. Discovery of some Charophyta from the fossiliferous Infratrappean beds of Lalitpur, Uttar Pradesh. *Curr. Sci.* **48** (5) : 208-209.
- Szalay, F. S. & McKenna, M. C. 1971. Beginning of the age of mammals in Asia. The Late Paleocene Gashato Fauna, Mongolia. *Bull. Am. Mus. Nat. Hist.* **144** : 273-317.
- Wang, Zhen 1978a. Cretaceous charophytes from the Yangtze-Han River basin with a note on the classification of Porocharaceae and Characeae. *Mem. Nanjing Inst. Geol. Paleont., Acad. sin.* **9** : 61-88 (in Chinese).
- Wang, Zhen 1978b. Paleogene charophytes from the Yangtze-Han River basin. *Mem. Nanjing Inst. Geol. Paleont., Acad. sin.* **9** : 101-120 (in Chinese).
- Wang, Zhen 1981. Paleocene and Eocene charophytes from Eastern Anhui and the coastal region of the Hangzhou Wan. *Bull. Nanjing Inst. Geol. Paleont., Acad. sin.* **3** : 263-286 (in Chinese).
- Wang, Zhen & Wang Ke-Yong 1985. On the age of some Red Beds and the relevant tectonic movements in Central Guizhon based on charopyte flora. *Acta Paleont. sin.* **24** (5) : 492-502 (in Chinese).
- Wang, Zhen, Yuan Pei-Xin & Zhao Zheng-Zhong 1983. Chihshan Formation and fossil charophytes. *Acta Paleont. sin.* **22** (5) : 493-503 (in Chinese).
- Weitung, L. 1985. On the age of the Paomagang Formation in the Jiangnan Basin, Hubei, China. *Keuxue Tongbao* **30** (11) : 1503-1506.