

# Early Danian lacustrine - brackish water Ostracoda from the Deccan Inter-trappean beds near Jhilmili, Chhindwara District, Madhya Pradesh, India

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**ABSTRACT:** Twenty lacustrine – brackish water ostracode species are described from the recently discovered early Danian Planktic Foraminiferal Zone P1a sediments in the Deccan Inter-trappean beds of Jhilmili, Chhindwara District, Madhya Pradesh, India. These include two brackish water species – *Neocyprideis raoi* (Jain 1978), *Buntonia* sp. - and 18 lacustrine species of which one species - *Strandesia jhilmiliensis* - is new, 15 species are assigned to previously known species, and 2 species are left in open nomenclature. The Inter-trappean beds in the central Deccan volcanic province of India were previously mostly considered as Maastrichtian in age but at Jhilmili, on the basis of associated planktic foraminifera, their deposition clearly persisted into early Danian time.

## INTRODUCTION

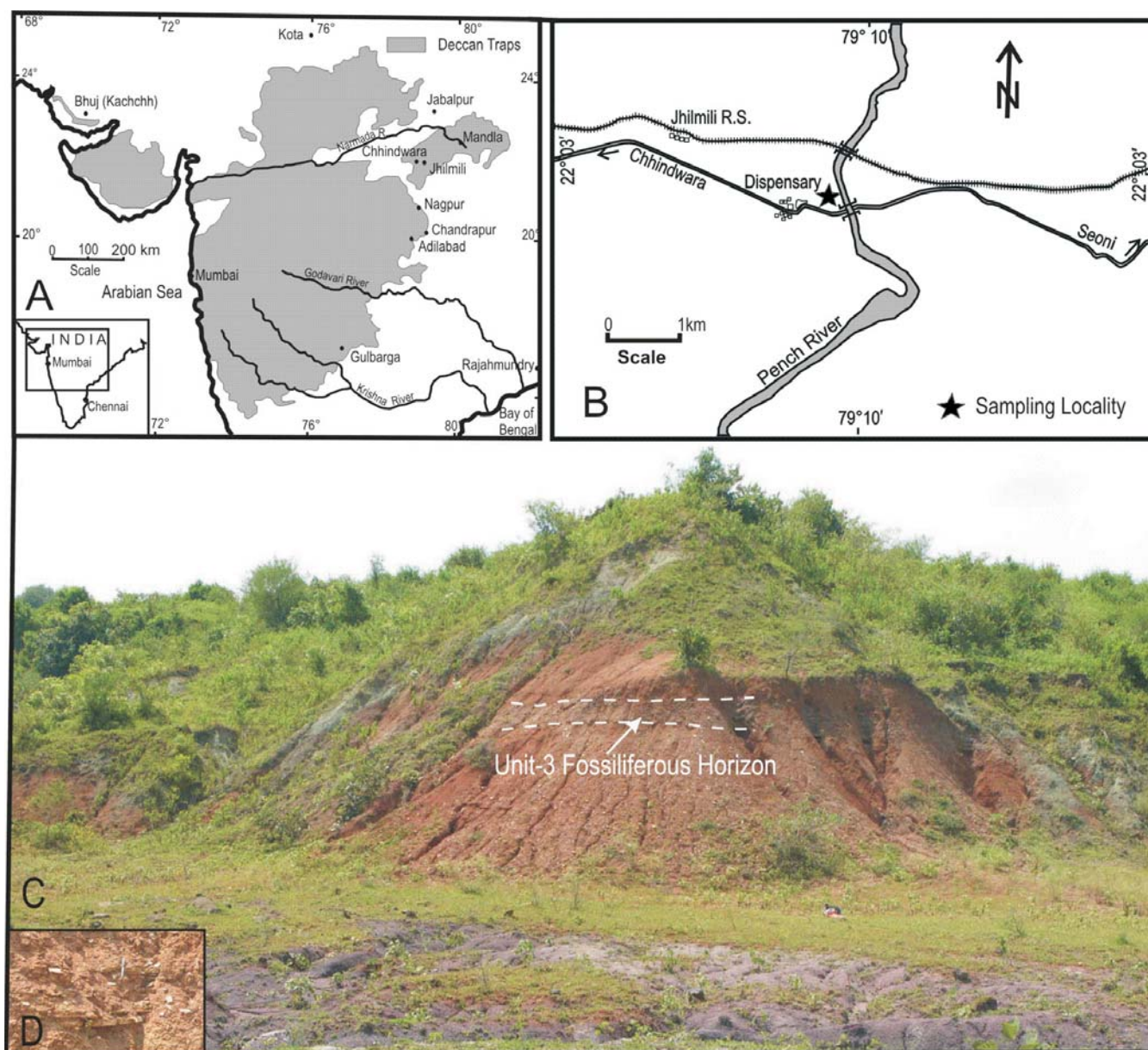
The paper is sequel to the recent papers by Keller et al. (2009a and b; in which the present first author, SCK, is one of the co-authors) and Khosla et al. (2009a). Keller et al. (2009b) reported the discovery of early Danian Zone P1a planktic foraminifera associated with lacustrine to brackish water ostracode assemblages from the Deccan Inter-trappean beds (hereafter designated as Inter-trappean beds) of Jhilmili, Chhindwara District, Madhya Pradesh, India. These foraminiferal assemblages identify the K-T boundary in Inter-trappean sediments bracketed by basalt traps that are regionally correlative with C29R (Ambenali Formation) and the C29R-C29N transition (Mahalabeshwar Formation). The Jhilmili sequence is thus correlative with the shallow-marine, Inter-trappean early Danian Zone P1a and underlying and overlying basalt traps of C29R and C29N magnetic polarity exposed in Rajahmundry quarries on the east coast of India. The purpose of this paper is to describe the ostracodes associated with the foraminifera and assess paleoenvironmental significance.

During the past two and a half decades the study of ostracodes from the Inter-trappean beds along the southern and eastern periphery of the Deccan basaltic province in central and western India has received great impetus. With the intention of enhancing our knowledge the authors took up their study from different sections. The present paper dealing with systematics, paleoecology and age and affinity of lacustrine - brackish water ostracode assemblages associated with planktic foraminifera of the supra cit. early Danian Zone P1a in the Inter-trappean beds of Jhilmili is part of this study. Earlier in this series two of us described lacustrine ostracodes from the Inter-trappean beds of Anjar in Kachhh District, Gujarat (Khosla and Nagori 2005), Mohgaon-Haveli in Chhindwara District, Madhya Pradesh (Khosla and Nagori 2007a), and Takli in Nagpur, Maharashtra (Khosla and Nagori 2007b).

## PREVIOUS WORK

Rode (in: Sahni and Rode 1937) discussed the geology of Chhindwara District, including the Inter-trappean beds of Jhilmili. The microfossils of these beds, however, have remained virtually unstudied until recently Keller et al. (2009a and b) recorded the discovery of typical early Danian Zone P1a planktic foraminifera, from these beds, which are: *Eoglobigerina edita*, *E. eobulloides*, *E. pentagona* [= *Globigerina* (*E.*) *pentagona*], *Globanomalina compressa*, *Globoconusa daubjergensis*, *Parasubbotina pseudobulloides*, *Parvularugoglobigerina eugubina*, *P. extensa*, *Praemurica taurica*, *Subbotina triloculinoides*, and *Woodringina hornerstownensis*. The other recorded foraminifera included: the Cretaceous survivors *Globigerinelloides aspera*, *Hedbergella* cf. *holmdelensis*, and the disaster opportunist *Guembelitra cretacea*. Associated ostracodes recorded are: *Buntonia* sp., *Candona amosi* Whatley et al. 2002, *Cypria cyrtionidion* Whatley and Bajpai 2000, *Cypridopsis hyperectyphos* Whatley and Bajpai 2000, *Darwinula torpedo* Whatley et al. 2002, *Eucypris verruculosa* Whatley et al. 2002, *Frambocythere tumiensis anjarensis* Bhandari and Colin 1999, *Gomphocythere strangulata* (Jones 1860), *Limnocythere deccanensis* Khosla et al. 2005, *Neocyprideis raoi* (Jain 1978), *Paracyprretta jonesi* Bhatia and Rana 1984, *Zonocypris spirula* Whatley and Bajpai 2000, and *Z. viriensis* Khosla and Nagori 2005.

The lacustrine ostracodes from the Inter-trappean beds elsewhere in central and western India have long been known. Sowerby (in: Malcolmson 1840) first studied them from the Sichel Hills, Andhra Pradesh and described two new species – *Cypris cylindrica* and *C. subglobosa*. Incidentally this was also the first systematic record of ostracodes from India. Subsequently, Carter (1852) reported 3 species - *Cypris cylindrica* Sowerby, *C. semimarginata* n. sp., and *Cypris* sp. - from the Inter-trappean beds of Bombay, while Jones (1860) reported 5



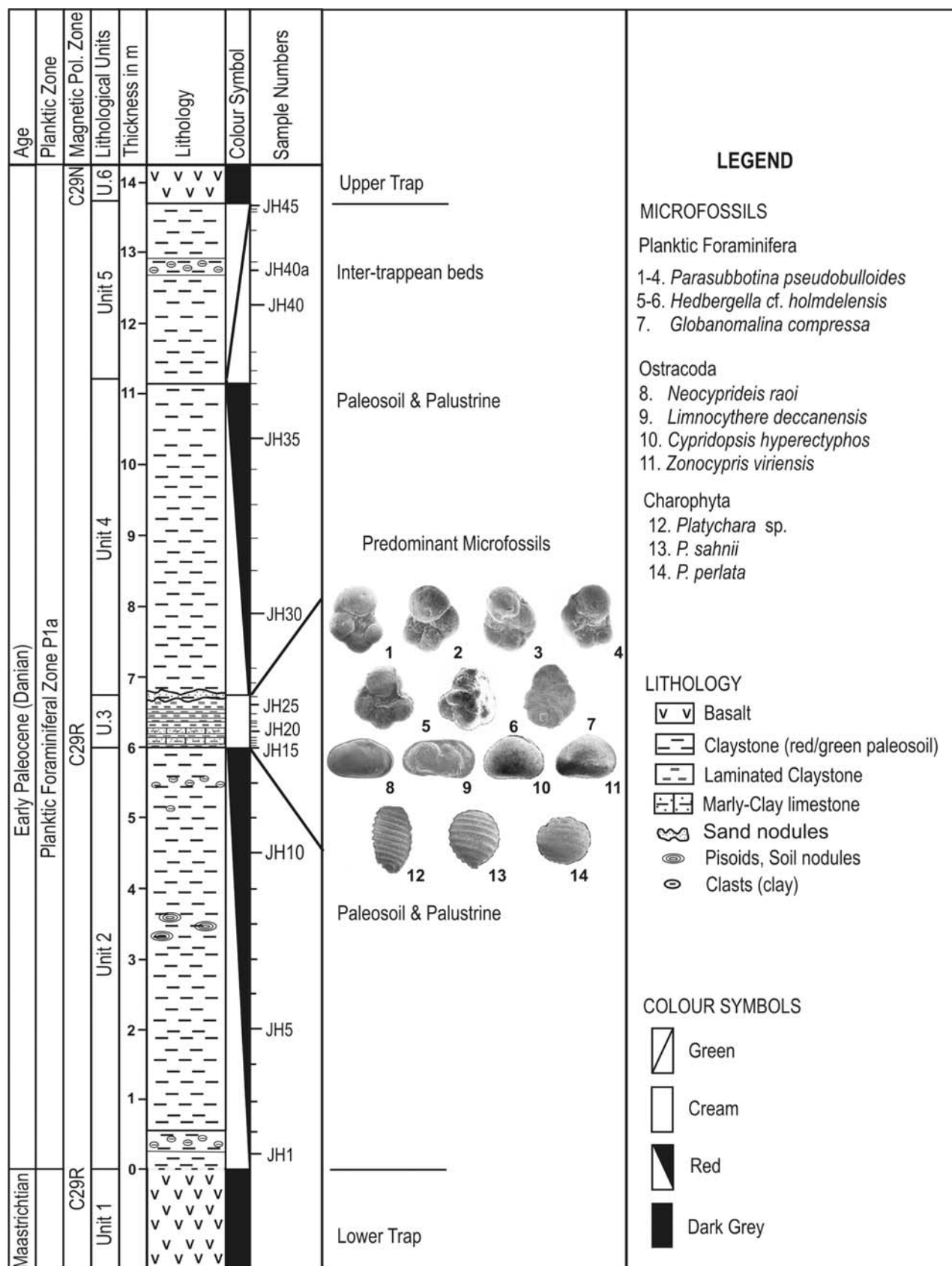
TEXT-FIGURE 1

A, Index map showing extent of Deccan Volcanic Province (DV). B, Location of Jhilmili, Chhindwara District, Madhya Pradesh. C, Field photograph of Inter-trappean sequence near Jhilmili. Inset D, Close-up view of the Unit 3 fossiliferous horizon.

species - *Cypris cylindrica* Sowerby, *C. hislopi* n. sp., *C. hunteri* n. sp., *C. strangulata* n. sp., and *C. subglobosa* Sowerby - from these beds of Nagpur, Maharashtra. However, despite these earlier finds, the lacustrine ostracodes of the Inter-trappean beds remained neglected for over a century till Bhatia and co-workers (Bhatia and Rana 1984; Bhatia et al. 1990a, b, 1996) described the Inter-trappean ostracodes from a number of localities and postulated that the fauna is not only conclusive evidence in support of a Late Cretaceous, Maastrichtian age of the Deccan Volcanism, but also for a Laurasian affinity of the ostracode assemblages. Prasad (1986) recorded five species of Ostracoda from Asifabad, Andhra Pradesh, while Mathur and Verma (1988) described 6 species, including one new, from the Inter-trappean beds near Narli, south of Jhalrapatan, Jhalawar

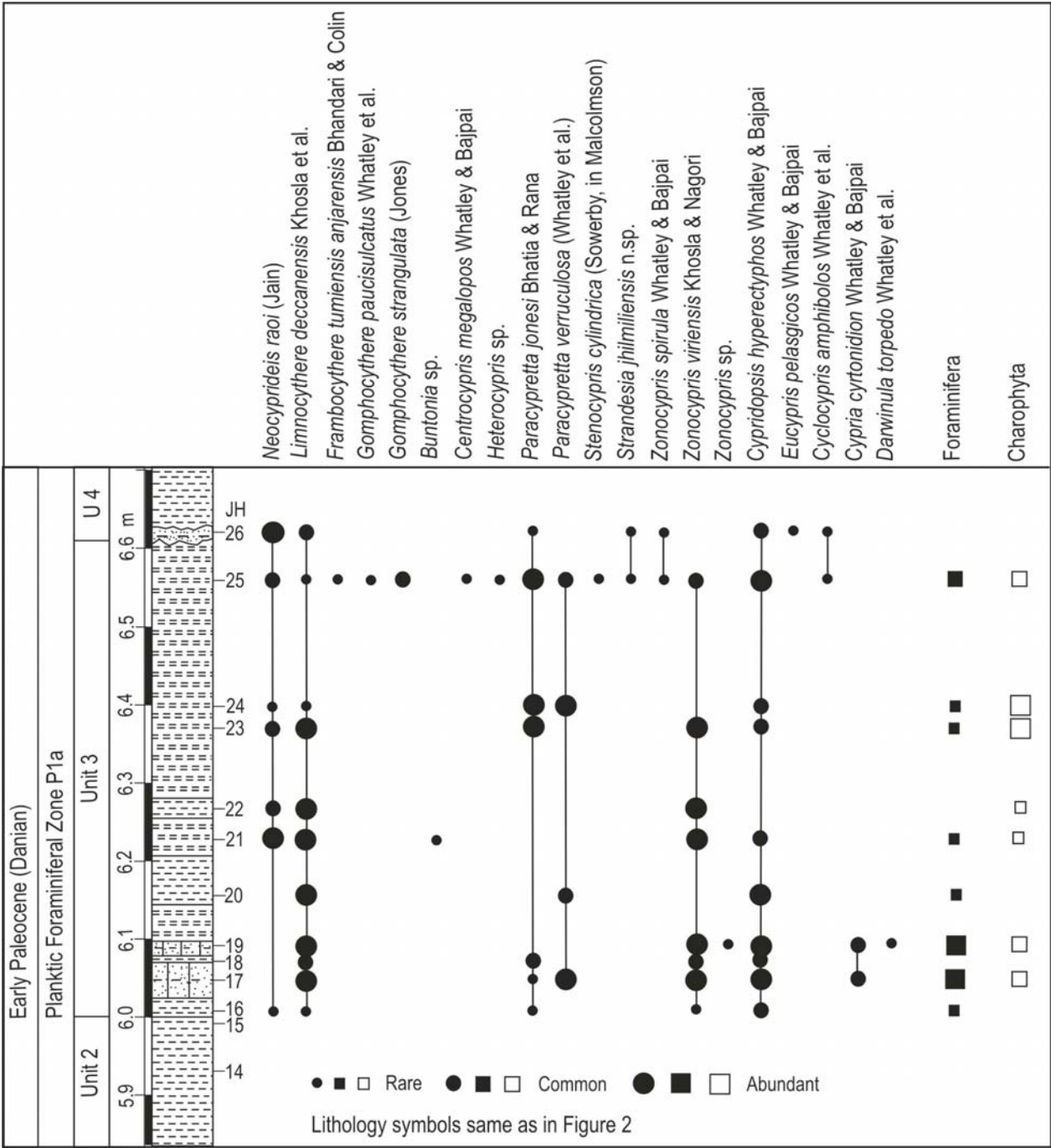
District and Mamoni, Kota District, both in Rajasthan. Singh and Sahni (1996) discussed the age and faunal affinities of the Bombay Inter-trappean beds, based on a variety of fossil groups with special attention being given to the Ostracoda. Bhandari and Colin (1999) described 11 species, including a new species and a subspecies, from the iridium-bearing Inter-trappean beds near Anjar, Kachchh District, Gujarat.

Recently Whatley and associates brought out series of papers on ostracodes from lacustrine Inter-trappean beds (Maastrichtian) from different localities in western and central India. These authors described rich ostracode faunas from three localities - Lakshmipur, Anjar and Kora - of Kachchh District, Gujarat. From Lakshmipur Whatley and Bajpai (2000a) reported 17 spe-



TEXT-FIGURE 2

Stratigraphic succession of the Inter-trappean beds near Jhilmili, Chhindwara District, Madhya Pradesh.



TEXT-FIGURE 3  
Relative abundance of Ostracoda (rare = <10 specimens, common = 10-20 specimens, abundant = >20 specimens), Planktic foraminifera and Charophyta in Unit 3 of the Inter-trappean beds at Jhilmili, Chhindwara District.

cies and a subspecies, including 13 species and a subspecies new; from Anjar Whatley and Bajpai (2000b) added 2 species, to the fauna earlier described by Bhandari and Colin (1999); while from Kora Bajpai and Whatley (2001) reported 23 species, including 4 new species. These faunas have been shown to be endemic Indian faunas without links at specific level to contemporary lacustrine ostracode faunas from Mongolia and China. Whatley et al. (2002a, b) further described 19 species, including 9 new, from Chandarki and Yanagundi, both in

Gulbarga District, Karnataka, and 9 species, including 3 new, from the classic locality Mohagaonkala, Chhindwara District, Madhya Pradesh respectively. Whatley, Bajpai and Whittaker (2002) gave new records and new species of the Upper Cretaceous Ostracoda from Indian Inter-trappean deposits. The same authors further described 8 species, including 2 new, from Mamoni, Kota District, Rajasthan (Whatley et al. 2003a); 8 species, including one new, from the collections of Indian Inter-trappean ostracodes housed in Department of Palaeontol-

ogy, The Natural History Museum, London (Whatley et al. 2003b); and 3 species of *Paracyprretta* from Inter-trappean type collections in The Natural History Museum, London and from the material from a number of Inter-trappean localities in India (Whatley et al. 2003c). More recently Sharma et al. 2008 recorded 14 species from the Inter-trappean beds at Papro near Lalitpur, U. P.

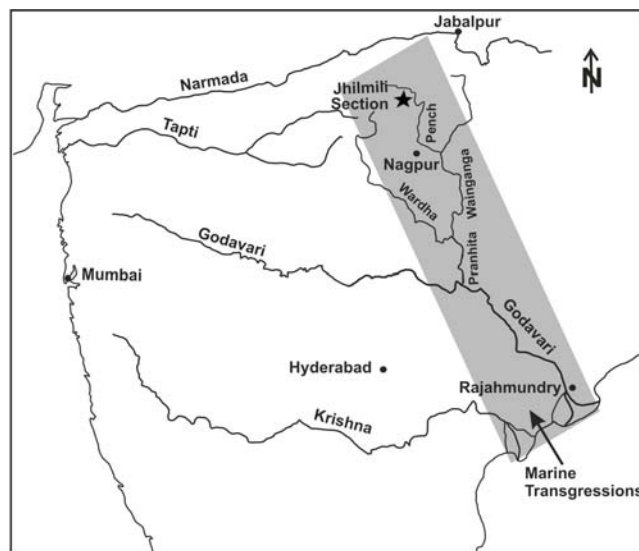
#### LOCATION OF SAMPLES STUDIED AND METHODS

The samples on which this study is based come from the Inter-trappean section exposed along a hillside at 22° 02' 44" N: 79° 09' 34" E near the west bank of Pench River near Jhilmili on Seoni-Chhindwara road (text-fig. 1). The Inter-trappean beds are about 13.6m thick and underlain as well as overlain by basalt traps. They were trenched to expose fresh rock, which was examined for lithological changes, described, measured, and systematically sampled. The stratigraphic succession as worked out at this locality is given in Figure 2. It can be subdivided into six lithological units. Units 1 and 6 represent the lower and upper basalt traps respectively. Unit 2 marks the lower 6m of these beds, which comprises red clayey siltstone with carbonate nodules and occasional quartz pebbles. Units 4 and 5 constituting top 7m Inter-trappean sediments, have similar lithologies, except for a colour change to grey-green in unit 5. Unit 3 is just 60cm thick from 6-6.6m above the lower basalt trap. This is the main fossiliferous horizon at Jhilmili, which has yielded typical early Danian Zone P1a planktic foraminifera within lacustrine to brackish water ostracode assemblages. In the lower part (6.0-6.38m; samples JH16-JH23) Unit 3 consists of alternating yellow to pink clays and marly limestones, while in the upper part (6.38-6.6m; samples JH24-JH26) it is composed of mainly pink clays and laminated claystones. The Units 2, 4-5 were sampled at 20-50cm intervals and Unit 3 was sampled at 2-5cm intervals across the laminated layers of the lower part and at 10-15cm intervals in the thicker layers of the upper part. Routine procedure was followed to disintegrate the samples. They were boiled in water to which one or two tablespoons of soda ash were added. The disintegrated samples were washed through set of sieves and left to dry. The dried residues were examined under stereozoom microscope for ostracodes and foraminifers. Most of the foraminifer specimens thus recovered are larger than 150µm. Subsequent sample processing for smaller foraminifer species (36-63µm, 63-100µm, 100-150µm) yielded only rare and poorly preserved specimens. Further investigation therefore concentrated on thin section studies to evaluate the presence of smaller planktic foraminifer species (<100µm) by Professor Gerta Keller at the Department of Geosciences, Princeton University, Princeton, NJ, U.S.A. and these were reported by Keller et al. (2009b).

Besides the above described section, the authors had earlier collected samples of the Unit 3 from a nearby parallel section and the ostracode fauna recovered from them has also been utilized in the present systematic study.

#### BIOSTRATIGRAPHY

In the Inter-trappean section of Jhilmili microfossils comprising ostracodes, planktic foraminifera and charophytes occur mainly in Unit 3, from 6 to 6.6m above the lower basalt trap, as shown in text-figure 3. The monotonous red shale of the Unit 2, lower 6m, and red and green shales of Units 4 and 5, upper 7m, are devoid of microfossils. These lithologies consist primarily of paleosols (Keller et al. 2009b).



TEXT-FIGURE 4

Sketch map of part of Peninsular India showing route of Early Danian marine transgressive waters to Jhilmili.

Insofar as ostracodes are concerned they first appear rarely at 6m (sample JH16) but soon become more diversified and abundant at 6.03m (sample JH17). Thereafter they occur intermittently up to 6.6m (sample No. JH26). The following species, in order of abundance, extend through out the Unit 3: *Neocyprideis raoi*, *Limnocythere deccanensis*, *Paracyprretta jonesi*, *Cypridopsis hyperectyphos*, *Zonocypris viriensis* and *Paracyprretta verruculosa*. The species *Cypria cyrtionidion*, *Darwinula torpedo*, *Buntonia* sp. and *Zonocypris* sp. occur only in lower part of the unit (samples JH17-21), whereas *Gomphocythere strangulata*, *Strandesia jhilmiliensis*, *Zonocypris spirula*, *Cyclocypris amphibolos*, *Frambocythere tumiensis anjarensis*, *Gomphocythere paucisulcatus*, *Centrocypris megalopos*, *Heterocypris* sp., *Stenocypris cylindrica* and *Eucypris pelagicos* occur only in the upper part of the unit (samples JH25-26).

Planktic foraminifera occur abundantly in samples JH17-19, commonly in sample JH25, rarely in samples JH16, 20, 21, 23 and 24, while being absent in samples JH22 and 26. From thin section assemblages, Keller et al. (2009b) reported 14, predominantly smaller (40-100µm), poorly preserved, earliest Danian Zone P1a planktic foraminiferal species, which have already been listed earlier in this work. In washed residues Keller et al. found only larger specimens (>150µm) of *Parasubbotina pseudobulloides*, *Subbotina triloculinoides*, *Eoglobigerina pentagona* (= *Globigerina pentagona*), *Globanomalina compressa*, *Hedbergella* cf. *holmdeleensis* and *Globigerinelloides aspera*.

Charophytes occur abundantly in samples JH23 and 24, commonly in samples JH17, 19 and 25, while rarely in samples JH21 and 22.

#### AGE AND AFFINITY

The Deccan Inter-trappean beds of Nagpur, Chhindwara and Mandla regions have been assigned to Paleocene-Eocene (Bande et al. 1981; Mehrotra 1989) or Maastrichtian ages

(Bhatia and Rana 1984; Bhatia et al. 1996; Sahni and Bajpai 1988; Srinivasan et al. 1994; Kar and Srinivasan 1998; Whatley et al. 2002b; Khosla et al. 2004; Bajpai et al. 2004; Samant and Mohabey 2005; Prasad et al. 2007; Khosla and Nagori 2007a and b) based on freshwater micro- and macrofauna and flora. The recent discovery of planktic foraminifera with lacustrine to brackish-marine ostracode assemblages in the Inter-trappean of Jhilmili by Keller et al. (2009b) provides the first definite age control and reveals this Inter-trappean sediment locality as early Danian Zone P1a in age. Further, according to Keller et al. (2009b) it permits correlation of this Inter-trappean sequence to the shallow-marine Inter-trappean sediments in the Rajahmundry quarries where similar early Danian Zone P1a assemblages have been identified between the lower trap of C29R and the upper trap of C29R-C29N transition age, correlative with the Ambenali and Mahalabeshwar formations, respectively (Keller et al. 2008). This identifies the Jhilmili and Rajahmundry lower trap basalt flows as marking the end of the main Deccan volcanic phase (Keller et al. 2009b) at or near the K-T boundary and the Inter-trappean sediments as early Danian immediately following the K-T mass extinction.

Other reported occurrence of early Danian Zone P1a planktic foraminifera from eastern India are from the Langpur Formation of the Um Sohryngkew River section, Meghalaya (Mukhopadhyay 2007); Baratang Formation of Andaman (Kumar and Soodan 1976) and Paleocene of Pondicherry (Venkatachalapathy 1972). In western India Paleocene P1c to 5 Zones have been reported from subsurface sections in Jaisalmer, Rajasthan (Singh 1976; Kalia and Kintso 2006). In Kachchh the Paleocene beds have been grouped as Poorly Fossiliferous Zone and here Late Paleocene (P-4) strata are overlapped by Eocene (P-6b) strata (Sastri 1988). In Cambay Basin *Turborotalia praecursoria* Zone with *Turborotalia pseudobulloides*, *T. praecursoria* and *T. inconstans* planktic foraminifers have been recognized in the subsurface Paleocene beds. Presently *T. pseudobulloides* corresponds to *Parasubbotina pseudobulloides* and *T. praecursoria* and *T. inconstans* correspond to *Praemurica inconstans* ranging from P1a to c Subzones.

The ostracode fauna from the Inter-trappean beds of Jhilmili shows affinity with the ostracode assemblages recorded from the Inter-trappean beds of Anjar (Bhandari and Colin 1999; Khosla and Nagori 2005), Lakshmipur (Whatley and Bajpai 2000a) and Kora (Bajpai and Whatley 2001), all in Kachchh District, Gujarat; Takli, Nagpur, Maharashtra (Bhatia and Rana 1984; Bhatia et al. 1996; Khosla and Nagori 2007b); Chandarki and Yanagundi, both in Gulbarga District, Karnataka (Whatley et al. 2002a); Mamoni, Kota District, Rajasthan (Whatley et al. 2003a); Phulsagar, Mandla District, Madhya Pradesh (Bajpai et al. 2004); Mohagaonkala (Whatley et al. 2002b) and Mohgaon-Haveli (Khosla and Nagori 2007a), both in Chhindwara District, Madhya Pradesh; Lalitpur, Uttar Pradesh (Sharma et al. 2008); Rajahmundry and Duddukuru, East and West Godavari Districts respectively, Andhra Pradesh (Jain 1978; Bhandari 1995; Khosla and Nagori 2002); subsurface Danian Ghatal Formation of West Bengal Basin (Bhandari 2000); and the Lameta Formation of Jabalpur Cantonment, Madhya Pradesh (Khosla and Sahni 2000); and Nand-Dongargaon Basin, Chandrapur District, Maharashtra (Udhoji and Mohabey 1996; Khosla et al. 2005). Of the 20 recorded in the present paper, 16 have been previously described from these localities (Table 1).

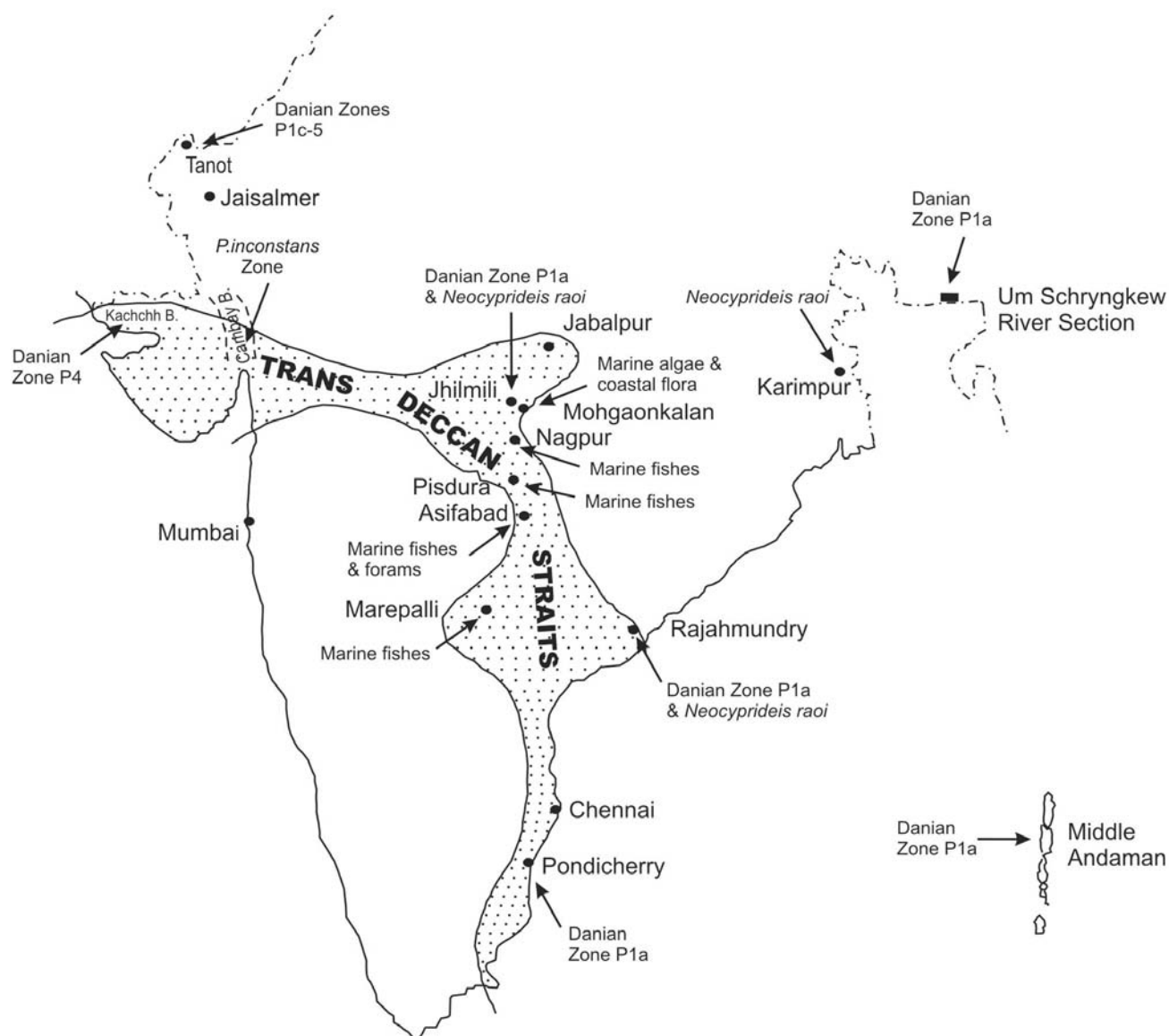
## PALEOECOLOGY

The dominant ostracode genera in Unit 3 of the Inter-trappean section, Jhilmili are: *Neocyprideis*, *Limnocythere*, *Zonocypris*, *Cypridopsis*, *Paracyprretta*, *Eucypris*, *Frambocythere*, *Cypria*, *Cyclocypris*, *Gomphocythere*, *Strandesia*, *Heterocypris* and *Stenocypris*. The remaining ostracodes are represented by 1 specimen each and are not of paleoecological significance. Therefore they have not been taken into consideration. Whatley and Bajpai (2005) have discussed at length aspects of paleoecology of non-marine ostracodes from the Inter-trappean deposits and the Lameta Formation of Peninsular India and these have been utilized here in our interpretations. Accordingly, except for the brackish water genus *Neocyprideis*, the above stated lacustrine genera can be grouped in two ecologies: i. non-swimming, endobenthonic or epibenthonic walkers / crawlers, which include *Limnocythere*, *Frambocythere* and *Gomphocythere*; ii. swimming, varying from moderate to very active swimmers, they are *Zonocypris*, *Cypridopsis*, *Paracyprretta*, *Eucypris*, *Cypria*, *Cyclocypris*, *Strandesia*, *Heterocypris* and *Stenocypris*.

The ostracode genera *Limnocythere*, *Frambocythere* and *Gomphocythere* of the first group belong to the family Limnocytheridae. McKenzie (1971, p. 273) suggests that some species of *Limnocythere* may be endobenthonic, spending part of the day within the sediment and part on it, while *Frambocythere* and *Gomphocythere* are clearly epibenthonic walkers / crawlers. Although some species of *Limnocythere* have been recorded from temporary pools, most members of the family require permanent waters.

Among the second group the genus *Paracyprretta* is well known as a good swimmer at the present day. The genus *Cypridopsis* is mainly found in permanent lakes and ponds, much more rarely in rivers and stream. Modern species *Cypridopsis vidua* (Müller) although usually occurring in weed-rich ponds, swim actively in the open water. The genus *Zonocypris*, with its heavy ornament, is probably rather more sluggish. Modern *Cyclocypris* species are very active swimmers, and although some species occur in temporary ponds, and others in only shallow permanent waters, many range from small ponds to large lakes. Recent species of *Cypria* are probably even better swimmers, and *C. ophthalmica* (Jurine), an almost universally distributed in Northern Hemisphere freshwater and oligohaline species in permanent and temporary water bodies. The genus *Stenocypris* is characteristic of shallow, warm freshwater environments. The first author (SCK) has picked up numerous adult and molt specimens of this genus from freshwater lakes of Udaipur City and Srikolayatji in Bikaner District. The present day living representatives of *Strandesia* have been recovered from ponds, swamp pools, salt lagoons, rice field, streams, waterfalls, springs and ditches in peninsular India. Most *Eucypris* and *Heterocypris* species live in temporary water bodies that dry out in the summer months, the species being represented then by desiccation resistant eggs that hatch with rains.

From the ecological data given above it is evident that the genera *Eucypris*, *Heterocypris* and also probably *Strandesia* are indicative of temporary pool environments, while other genera are suggestive of the existence of permanent water bodies (a pool or lake) during accumulation of the beds of Unit 3 at Jhilmili. Whatley and Bajpai (2005) have explained that it is probable that *Eucypris* and other taxa that prefer temporary waters, lived around the margins of ponds and lakes in area that



TEXT-FIGURE 5

Sketch map of part of India showing paleogeography during Late Cretaceous - Early Paleocene times (modified after Prasad and Singh 1991).

dried out in the dry season, while *Cypridopsis* and other taxa requiring permanent waters would retreat to the deeper parts of the water body.

Insofar as the genus *Neocyprideis* is concerned it is closely related to the living genus *Cyprideis*, which probably evolved from the former (Morkhoven 1963). The latter genus inhabits freshwater to hypersaline conditions, but is most abundant in mesohaline salinities and hence regarded as a typical brackish water ostracode. According to Keij (1957), Morkhoven (1963), Oertli (1967), Keen (1977) and Neale (1988) *Neocyprideis* also occurs predominantly in brackish water environments. Keen (1977) recorded the genus from three brackish water assemblages, maximum predominance being in assemblage IV of the Upper Eocene beds of the Hampshire Basin, U.K. Assemblage IV of the Upper Eocene is taken to represent salinities of 9.0

‰ to 16.5 ‰. Neale (1988) has observed that minimum diversity of species and abundance of individuals are reached in low brackish environments. The genus *Neocyprideis* occurs in great abundance in Unit 3 at Jhilmili and is represented by its molt stages indicating that it thrived along with lacustrine ostracodes in permanent waters, which had low mesohaline salinities.

The planktic foraminifers recorded from Unit 3 might have been carried to Jhilmili by repeated incursions by marine transgressive waters either from the west coast through the Narmada-Tapti rift zones or from the east coast through the Godavari rift zone resulting in the formation of an estuarine or shallow coastal marine environment.

Marine incursions in Peninsular India during Cenomanian - Turonian times along the Narmada- rift zone are well docu-

mented by the Bagh Formation, but highly controversial during the Maastrichtian where different workers have differently interpreted the environment of deposition of the Lameta Formation succeeding Bagh Formation. Mostly on sedimentological data some workers (e.g. Singh 1981) interpreted the Lameta beds deposited in estuarine to tidally influenced marine environments, while others (e.g. Tandon et al. 1995) interpreted them deposited in semi-arid fluvial environments. Recently, Shukla and Srivastava (2008) interpreted the Lameta beds at Jabalpur as lagoonal deposits. On paleontological data Brookfield and Sahni (1987) considered the Lameta Formation semi-arid and pedogenic deposits.

The Cambay Basin situated at the mouths of Narmada and Tapi Rivers on the northwest coast is a NNW-SSE trending graben with a width of 40 to 80 km and a depth of 5 to 7 km. It came into existence during Late Cretaceous Deccan Trap volcanism with outpouring huge volumes of basaltic lava flows over 2000 m thick in the basin (Chowdhary 2004). The succeeding Paleocene beds are poorly fossiliferous and only one planktic foraminifer *Praemurica inconstans* Zone with two species, *P. inconstans* and *Parasubbotina pseudobulloides* has been recognized from them (Sastri 1988).

In view of the facts that the Paleocene beds of Cambay Basin are poorly fossiliferous and no other definite marine Maastrichtian and early Danian sediments have been recorded from the Narmada-Tapi rift zones it is doubtful that they might have served as seaway for marine incursions to Jhilmili particularly when foraminiferal assemblages recorded from Jhilmili are much more diversified comprising 14 species. Jaisalmer shelf in Rajasthan from where Kalia and Kintso (2006) have recorded Danian P1c to 5 planktic foraminiferal zones was distally located from Narmada-Tapi rift zones and could not have contributed to Jhilmili marine transgressions. Keller et al. (2009a, b) however favoured Narmada-Tapi rifts as route for marine transgressions to Jhilmili.

Alternately as the Inter-trappean section at Jhilmili is situated on the west bank of the Pench River which is a tributary of the Wainganga River, that in turn of the Pranhita River and the latter further of the Godavari River there was a direct link for marine transgressive waters from the east coast open sea to Jhilmili through these rivers (text-figure 4). Pranhita-Godavari Rivers flow in faulted valley roughly trending in NW-SE direction. Occurrence of correlative shallow marine, Inter-trappean sequence with early Danian Zone P1a planktic foraminifera and C29R and C29N magnetic polarity of the lower and upper basalt traps exposed in Rajahmundry quarries (Keller et al. 2008) and brackish water ostracode, *Neocyprideis raoi*, in great profusion in the Inter-trappean beds of east and west Godavari districts (Khosla and Nagori 2002) strongly support this hypothesis. This is further corroborated by the occurrence of marine-brackish water fish assemblages with freshwater fauna in the Infra- and Inter-trappean beds at Marepalli and Timsanpalli in Rangareddi (Prasad and Singh 1991) and at Asifabad (Prasad et al. 1986); in the Lameta Formation at Pisdura (Jain and Sahni 1983); in the Inter-trappean beds at Nagpur (Sahni et al. 1982); and marine algae and coastal plants in association with freshwater faunal and floral assemblages in the Inter-trappean beds at Mohgaonkalan (Bande et al. 1981; Bande and Prakash 1982; Mehrotra 1989). Besides there are records of occurrence of marine foraminifers in the Inter-trappean beds of Asifabad (Prasad 1986). The occurrence of early

Danian Zone P1a planktic foraminifera in Meghalaya, Andaman and Pondicherry and brackish water ostracode, *Neocyprideis raoi*, in West Bengal Basin also supports the hypothesis that marine transgressions to Jhilmili might have been from eastern India rather than from western India.

Earlier based on prevailing fossil evidence Sahni (1983), and subsequently Sahni (1984), Prasad et al. (1986), and Prasad and Singh (1991) suggested the existence of a narrow seaway (Trans Deccan Straits) connecting the Godavari and Sind-Gujarat basins along the major structural rift zones of the present day Godavari and Narmada Rivers (text-figure 5). Sahni (1983) surmised that the Trans Deccan Straits were of temporary nature and subject to marine transgressions, which did not allow the establishment of stable marine benthic communities, but permitted the dispersal for marine fishes and algae. The record of early Danian planktic foraminifera in the Inter-trappean beds at Jhilmili has revived this idea of a marine seaway. Similar evidence must be present in Inter-trappean beds along Narmada and Godavari rift zones and it will be a challenge for future workers to explore and document them.

## REPOSITORY

The ostracode specimens illustrated in the paper have been deposited in the Micropaleontology Laboratory, Department of Geology, Mohanlal Sukhadia University, Udaipur, India and references to them are designated by SUGDMF catalogue numbers in the text and plate explanations.

## SYSTEMATIC PALEONTOLOGY

Subclass OSTRACODA Latreille 1806  
Order PODOCOPIDA Müller 1894  
Suborder PODOCOPINA Müller 1894  
Superfamily CYTHEROIDEA Baird 1850  
Family CYTHERIDEIDAE Sars 1925  
Subfamily CYTHERIDEINAE Sars 1925  
Genus *Neocyprideis* Apostolescu 1956  
Type species: *Cyprideis (Neocyprideis) durocortoriensis* Apostolescu 1956

*Neocyprideis raoi* (Jain 1978)

Plate 1, figures 1-6

*Ovocytheridea raoi* JAIN 1978, p. 53, pl. 1, figs. 7-10. – BHANDARI 1995, p. 95-96, pl. 2, figs. 1-2.

*Neocyprideis raoi* (Jain). – KHOSLA and NAGORI 2002, p. 201-203, figs. 2.12-2.13.

*Material*: 1002 carapaces and open valves.

*Remarks*: The species was initially described as *Ovocytheridea raoi* from the Inter-trappean beds of Kateru, Rajahmundry, on the east coast of India by Jain (1978) and subsequently recorded from Duddukuru, West Godavari District by Bhandari (1995). Khosla and Nagori (2002), who restudied the ostracode fauna of Duddukuru, transferred the species to the genus *Neocyprideis* Apostolescu 1956. It is characterized by an elongate-subovate lateral outline, with greatest height about 3/5 of length slightly anterior to middle; left valve larger than right valve overlapping all along periphery; dorsal margin arched, somewhat subangulate; ventral margin nearly straight; anterior margin broad and evenly rounded; posterior margin less so; valve surface densely covered by normal pore pits and marked by a shallow depression in anterodorsal region; inner lamella moderately

TABLE 1

Distribution of Ostracode Species in Lameta Formation and Inter-trappean beds, Peninsular India (sources given in text).

Ostracode Species	Lameta Formation (Infra-trappean) and Inter-trappean beds											
	Madhya Pradesh			Maharashtra		Karnataka	Gujarat	Rajasthan	Andhra Pradesh		U.P.	
	Chhindwara	Mandla	Jabalpur	Nagpur	Chandrapur	Gulbarga	Kachchh	Kota	Adilabad	W. Godavari	Lalitpur	
	Jhilmili Mohgaon-Haveli Mohagaonkala Phulsagar Jabalpur Cantonment Takali Dongargaon Chandarki Yanagundi Anjar Lakshmipur Kora Mamoni Asifabad Duddukuru Papra											
<i>Centrocypris megalopos</i> Whatley and Bajpai	+							+				
<i>Cyclocypris amphibolos</i> Whatley, Bajpai and Srinivasan	+	+		+	+				+			
<i>Cypria cyrtonidion</i> Whatley and Bajpai	+	+	+	+	+	+	+	+	+		+	
<i>Cypridopsis hyperectyphos</i> Whatley and Bajpai	+			+	+	+	+	+	+		+	
<i>Darwinula torpedo</i> Whatley, Bajpai and Srinivasan	+	+		+	+	+						
<i>Eucypris pelasgicus</i> Whatley and Bajpai	+	+	+	+	+		+	+	+			
<i>Frambocythere tumiensis anjarensis</i> Bhandari and Colin	+	+		+	+	+	+		+	+	+	
<i>Gomphocythere paucisulcatus</i> Whatley, Bajpai and Srinivasan	+	+		+	+		+				+	
<i>G. stragulata</i> (Jones)	+			+	+	+			+	+		
<i>Limnocythere deccanensis</i> Khosla, Nagori and Mohabey	+	+	+	+	+	+						
<i>Neocyprideis raoi</i> (Jain)	+									+		
<i>Paracyprretta jonesi</i> Bhatia and Rana	+	+		+	+	+	+	+		+		
<i>P. verruculosa</i> (Whatley, Bajpai and Srinivasan)	+			+	+	+						
<i>Stenocypris cylindrica</i> (Sowerby)	+		+	+	+	+	+	+	+	+	+	
<i>Zonocypris spirula</i> Whatley and Bajpai	+	+		+	+	+	+	+	+		+	
<i>Z. viriensis</i> Khosla and Nagori	+						+					

+ Ostracode Present

wide, avestibulate; marginal pore canals by and large straight, about 18-20 anteriorly; hinge antimerodont, median element long; central muscle scars comprise a vertical row of four scars and a v-shaped frontal scar.

*Dimensions (mm):*

	Length	Height	Width
Female carapace (SUGDMF No.1117)	0.66	0.40	0.30
Female carapace (SUGDMF No. 1118)	0.66	0.40	0.30
Female right valve (SUGDMF No. 1119)	0.59	0.34	---
Female left valve (SUGDMF No. 1144)	0.61	0.37	---
Male carapace (SUGDMF No. 1145)	0.66	0.42	0.29

*Occurrence:* Samples JH16, JH21-26

Family LIMNOCYOTHERIDAE Klie 1938

Subfamily LIMNOCYOTHERINAE Klie 1938

Genus *Limnocythere* Brady 1868Type species: *Cythere inopinata* Baird 1843*Limnocythere deccanensis* Khosla, Nagori and Mohabey 2005

Plate 1, figures 7-11

*Limnocythere bhatiai* BAJPAI, MOHABEY, KAPOOR and SHARMA 2004, p. 150, pl. 1, figs. 1-r; pl. 2, figs. a-b (non *Limnocythere bhatiai* MATHUR 1972, p. 394-395, figs. 2 a-c).

*Limnocythere deccanensis* KHOSLA, NAGORI and MOHABEY 2005, pl. 1, figs. 1-2. - KHOSLA and NAGORI 2007a, p. 215, pl. 1, figs. 6-9. - KHOSLA and NAGORI 2007b, p. 6.

*Material:* 881 carapaces and valves.

*Remarks:* The species was originally described as *Limnocythere bhatiai* by Bajpai et al. (2004) from the Inter-trappean of Phulsagar, Mandla District. The specific name is invalid as it is preoccupied by *Limnocythere bhatiai* Mathur

1972 (p. 394-395, figs. 2a-c) described from the Tatrot Formation, Upper Siwalik, near Pinjaur, Haryana, India. The specific name *Limnocythere deccanensis* Khosla, Nagori and Mohabey 2005, described from the Late Cretaceous (Maastriichtian) Lameta Formation of Dongargaon, Chandrapur District though junior synonym of *Limnocythere bhatiai* Bajpai et al. 2004 was regarded as valid for the species under discussion by Khosla and Nagori (2007a). This view has been accepted herein. The species has been also recorded from the Inter-trappean beds of Mohgaon-Haveli, Sausar Taluka, Chhindwara District (Khosla and Nagori 2007a) and Takli, Nagpur (Khosla and Nagori 2007b).

The species has the following characteristics: carapace subquadrate in lateral outline and fusiform, somewhat flat sided in dorsal outline, ends compressed, anterior being more than posterior; greatest height in adults posteriorly but in juveniles anteriorly; valve surface marked by a median vertical sulcus, an arcuate anterior depression, a transverse rib extending from anteroventral to posteroventral region along ventral margin and reticulation over rest of the area; inner lamella quite wide along anterior margin and narrow along ventral and posterior margins; hinge appears to be lophodont, short terminal sockets in left valve connected by a bar; marginal pore canals and central muscle scars not visible.

*Dimensions (mm):*

	Length	Height	Width
Carapace (? juvenile) (SUGDMF No. 1131)	0.46	0.24	0.19
Carapace (SUGDMF No. 1146)	0.56	0.25	0.18
Carapace (? juvenile) (SUGDMF No. 1147)	0.48	0.27	0.18
Carapace (SUGDMF No. 1148)	0.57	0.26	0.19
Left valve (? juvenile) (SUGDMF No. 1149)	0.46	0.24	

*Occurrence:* Samples JH16-26.

Subfamily TIMIRIASEVIINAE Mandelstam 1960

Genus *Frambocythere* Colin 1980

Type species: *Bisulcocypis tumiensis* Helmdach 1978

***Frambocythere tumiensis anjarensis*** Bhandari and Colin 1999

Plate 1, figures 12-14

*Frambocythere tumiensis anjarensis* BHANDARI and COLIN 1999, p. 12-13, pl. 1, figs. 1-10. – WHATLEY, BAJPAI and SRINIVASAN 2002a, p.166-168, pl. 1, figs. 8-9. – KHOSLA, NAGORI and MOHABEY 2005, p. 137, pl. 1, figs. 3-4. – KHOSLA and NAGORI 2005, p. 574, pl. 1, fig. 4. – KHOSLA and NAGORI 2007a, p. 215, pl. 1, figs. 10-12. – KHOSLA and NAGORI 2007b, p. 6, pl. 1, figs. 4-7.

*Frambocythere* sp. cf. *F. tumiensis anjarensis* Bhandari and Colin. – WHATLEY, BAJPAI and WHITTAKER 2003a, pl. 1, figs. 10-11.

**Material:** 122 carapaces and valves.

**Remarks:** The subspecies was initially described from the Inter-trappean beds of Anjar, Kachchh District by Bhandari and Colin (1999). It has subsequently been recorded from the Inter-trappean beds of Chandarki and Yanagundi, Gulbarga District (Whatley et al. 2002a), Mamoni, Kota District (Whatley et al. 2003a), Mohgaon-Haveli, Chhindwara District (Khosla and Nagori 2007a), Takli, Nagpur (Khosla and Nagori 2007b) and the Lameta Formation, Dongargaon, Chandrapur District (Khosla et al. 2005). It is a strongly dimorphic subspecies of *Frambocythere tumiensis* with normal overlap, i.e. left valve larger than right valve, distinctly overlapping along anterodorsal and posterodorsal margins; females strongly inflated posteriorly whereas males much narrower, with maximum width near middle; surface ornamented by concentrically disposed dense papillate tubercles; tubercles somewhat coarser in anterodorsal region.

**Dimensions (mm):**

	Length	Height	Width
Female carapace (SUGDMF No. 1127)	0.39	0.23	0.30
Female carapace (SUGDMF No. 1150)	0.37	0.24	0.30
Male carapace (SUGDMF No. 1151)	0.32	0.20	0.21

**Occurrence:** Sample JH25.

Genus *Gomphocythere* Sars 1924

Type species: *Limnocythere obtusa* Sars 1910

***Gomphocythere paucisulcatus*** Whatley, Bajpai and Srinivasan 2002

Plate 1, figure 15

*Gomphocythere?* sp. 1 BHANDARI and COLIN 1999, p. 13, pl. 1, figs. 11-13.

*Gomphocythere paucisulcatus* WHATLEY, BAJPAI and SRINIVASAN 2002b, p. 107-109, pl. 1, figs. 1-6. – KHOSLA, NAGORI and MOHABEY 2005, p. 137, pl. 1, figs. 7-8. – KHOSLA and NAGORI 2005, p. 574, pl. 1, fig. 3. – KHOSLA and NAGORI 2007b, p. 8, pl. 1, figs. 10-11. – SHARMA, BAJPAI and SINGH 2008, p. 178, pl. 1, figs. E-G.

**Material:** 1 carapace.

**Remarks:** *Gomphocythere paucisulcatus* has been described from the Inter-trappean beds of Mohagaonkala (Mohagaon-Kalan), Chhindwara District (Whatley et al. 2002b), Anjar, Kachchh District (Bhandari and Colin 1999; Khosla and Nagori 2005), Takli, Nagpur (Khosla and Nagori 2007b), Papro, Lalitpur (Sharma et al. 2008) and the Lameta Formation Dongargaon, Chandrapur District (Khosla et al. 2005). It is a medium sized species having subfusiform outline in dorsal

view, almost equally acuminate at both ends and with a very slight median sulcus. Ornamentation comprises large reticulae having 1 to 4 secondary puncta within fossae.

**Dimensions (mm):**

	Length	Height	Width
Carapace (SUGDMF No. 1128)	0.66	0.37	0.33

**Occurrence:** Sample JH25.

***Gomphocythere strangulata*** (Jones 1860)

Plate 1, figures 16-19

*Cypis strangulata* JONES 1860, p. 187, pl. 10, figs. 73, a-d.

*Metacypris strangulata* (Jones). – BHATIA and RANA 1984, p. 33, pl. 2, figs. 8-9.

*Cytheridella strangulata* (Jones). – BHATIA, PRASAD and RANA 1990a, p. 47, pl. 3, figs. 1-2. – BHATIA, SRINIVASAN, BAJPAI and JOLLY 1990b, p. 118, pl. 1, figs. 4-5. – BHATIA, PRASAD and RANA 1996, p. 299, pl. 3, figs. 1-2. – UDHOJI and MOHABEY 1996, p. 413, pl. 2, figs. 1-3.

*Gomphocythere strangulata* (Jones). – WHATLEY, BAJPAI and SRINIVASAN 2002a, p. 169, pl. 1, figs. 10-11. – KHOSLA, NAGORI and MOHABEY 2005, p. 137-139, pl. 1, figs. 9-10.

*Limnocythere falsocarinata* WHATLEY and BAJPAI 2000a, p. 390, pl. 1, figs. 1-5. – KHOSLA, NAGORI and MOHABEY 2005, p. 137, pl. 1, figs. 5-6. – KHOSLA and NAGORI 2005, p. 575, pl. 1, fig. 1.

**Material:** 41 carapaces.

**Remarks:** *Gomphocythere strangulata* (Jones 1860) has been widely described from the Inter-trappean beds of Nagpur and Asifabad (Bhatia and Rana 1984; Bhatia et al. 1990a, 1996), Mamoni, Kota District (Bhatia et al. 1990b) and Yanagundi, Gulbarga District (Whatley et al. 2002a), Lakshmipur and Anjar, Kachchh District (Whatley and Bajpai 2000a; Khosla and Nagori 2005), Takli, Nagpur (Khosla and Nagori 2007b) and the Lameta Formation of Dongargaon, Chandrapur District (Udhoji and Mohabey 1996; Khosla et al. 2005). The form recorded as *Limnocythere falsocarinata* by Whatley and Bajpai (2000a) and Khosla and Nagori (2005) from the Inter-trappean beds of Lakshmipur and Anjar, both in Kachchh District respectively, is a junior synonym of *Gomphocythere strangulata* (Jones 1860).

It is a strongly dimorphic form; females being much inflated posteriorly, males lensoid in dorsal outline with maximum width near middle; valve surface marked by a deep median, sinuous sulcus, a smaller anterior sulcus, ornament of polygonal and hexagonal reticulae which contain 4-5 puncta and a narrow ventrolateral rib.

**Dimensions (mm):**

	Length	Height	Width
Female carapace (SUGDMF No. 1129)	0.82	0.43	0.53
Female carapace (SUGDMF No. 1152)	0.82	0.46	0.46
Female carapace (SUGDMF No. 1153)	0.89	0.47	0.58
Male carapace (SUGDMF No. 1154)	0.86	0.45	0.38

**Occurrence:** Sample JH25.

Family TRACHYLEBERIDIDAE Sylvester-Bradley 1948

Genus *Buntonia* Howe 1935

Type species: *Buntonia shubutaensis* Howe 1935

?*Buntonia* sp.

Plate 1, figure 20

**Material:** 1 carapace.

**Remarks:** The species has the following characteristics: carapace elongate-subtriangular in lateral outline, with greatest height at anterior cardinal angle; left valve slightly larger than right valve, overlapping it along anterodorsal margin; surface marked by a depression in dorsomedian region. It resembles *Costabuntonia hartmanni* (Jain 1978) from the Inter-trappean beds of east coast of India in overall outline but lacks the ribs characteristic of that species. It is herein assigned questionably to *Buntonia* Howe.

**Dimensions (mm):**

	Length	Height	Width
Carapace (SUGDMF No. 1155)	0.66	0.37	0.26

**Occurrence:** Sample JH21.

Superfamily CYPRIDOIDEA Baird 1845

Family CYPRIDIDAE Baird 1845

Subfamily CYPRIDINAE Baird 1845

Genus *Centrocypris* Vávra 1895

Type species: *Cypris* (*Centrocypris*) *horrida* Vávra 1895

***Centrocypris megalopos*** Whatley and Bajpai 2000

Plate 2, figure 1

*Centrocypris megalopos* WHATLEY and BAJPAI 2000a, p. 394-396, pl. 2, figs. 14-18.

**Material:** 1 valve.

**Remarks:** The species has so far been described from the Inter-trappean beds of Lakshmipur, Kachchh District (Whatley and Bajpai 2000a). It is a large subovate species with ornament of very numerous, densely distributed, very small spinose papillae without preferential orientation that extend beyond the periphery in both lateral and dorsal view; eye tubercle large and prominent; inner lamella moderately wide along anterior margin, with narrow vestibulum; selvage distinct, near middle; central muscle scars comprise three prominent anterior scars and two small posterior to them; hinge adont.

**Dimensions (mm):**

	Length	Height	Width
Right valve (SUGDMF No. 1120)	0.69	0.42	---

**Occurrence:** Sample JH25.

Genus *Heterocypris* Claus 1893

Type species: *Cypris incongruens* Ramdohr 1808

***Heterocypris* sp.**

Plate 2, figure 2

**Material:** 4 carapaces.

**Remarks:** The species has the following characteristics: Carapace large, subrectangular in lateral outline and fusiform in the dorsal, anterior end compressed; greatest height 2/3 of length anterior to middle; left valve larger than right valve overlapping prominently along anterior and ventral margins; dorsal margin convex, gently sloping down posteriorly, more so anteriorly; ventral margin straight; anterior margin narrowly rounded; posterior margin broad, somewhat truncated; valve surface indistinctly pitted. The species resembles *Heterocypris similis* Klie 1933 and *Heterocypris incongruens* (Ramdohr 1808), Recent species, in overall outline but differs in being much larger in size. *Heterocypris levis* Hartmann 1964, another Recent species

from Iran is as large as the present species but differs in lateral outline. The species is left in open nomenclature until internal characters are known.

**Dimensions (mm):**

	Length	Height	Width
Carapace (SUGDMF No. 1130)	1.97	1.25	0.96

**Occurrence:** Sample JH25.

Genus: *Paracypretta* Sars 1924

Type species: *Paracypretta ampullacea* Sars 1924

***Paracypretta jonesi*** Bhatia and Rana 1984

Plate 2, figures 3-4

*Paracypretta jonesi* BHATIA and RANA 1984, p. 30-33, pl. 2, figs. 1-3. – UDHOJI and MOHABEY 1996, p. 413, pl. 2, figs. 4-6. – BAJPAI and WHATLEY 2001, p. 95-96, pl. 1, figs. 2, 4. – WHATLEY, BAJPAI and WHITTAKER 2002, p. 166-168, pl. 1, figs. 8-9. – WHATLEY, BAJPAI and WHITTAKER 2003c, p. 1293-1294, pl. 2, figs. 14, 17. – KHOSLA and NAGORI 2007a, p. 215-217, pl. 1, figs. 13-16; pl. 2, figs. 1-3. – KHOSLA and NAGORI 2007b, p. 8, pl. 1, figs. 15-16.

*Leiria jonesi* (Bhatia and Rana). – BHATIA, PRASAD and RANA 1996, p. 304, pl. 3, fig. 7.

*Altanicypris* sp. SAHNI and KHOSLA 1994, p. 458, figs. 2 n-p.

*Altanicypris bhatiai* KHOSLA and SAHNI 2000, p. 58-59, pl. I, figs. a-g.

*Paracypretta bhatiai* (Khosla and Sahni). – WHATLEY and BAJPAI 2000b, p. 174-176, pl. 1, figs. 1-3. (Non *Paracypretta bhatiai* WHATLEY, BAJPAI and SRINIVASAN 2002a, p. 173, pl. 3, figs. 1-5. – WHATLEY BAJPAI and SRINIVASAN 2002b, p. 109, pl. 2, fig. 10.)

*Paracypretta anjarensis* KHOSLA and NAGORI 2005, p. 576-578, pl. 1, figs. 13-16.

**Material:** 317 carapaces and valves.

**Remarks:** The species was originally described from the Inter-trappean beds of Gitti Khadan (stone quarry), Nagpur (Bhatia and Rana 1984). It was subsequently recorded from the Inter-trappean beds of Kora, Kachchh District (Bajpai and Whatley 2001), Chandarki, Gulbarga District, (Whatley et al. 2002a) and Mohgaon-Haveli, Chhindwara District (Khosla and Nagori 2007a), Takli, Nagpur (Khosla and Nagori 2007b) and the Lameta Formation of Dongargaon, Chandrapur District (Khosla et al. 2005).

The species is characterized by large carapace, subtriangular in lateral outline and strongly inflated in the dorsal, with anterior 1/6 of length conspicuously compressed, lip-like; greatest height and maximum width nearly equal and about 2/3 of length; left valve larger than right valve, overlapping all along margin; dorsal margin symmetrically convex, subangulate in the middle; ventral margin straight; anterior and posterior margins broadly rounded; surface of each valve ornamented by very minute, dense pits, arranged in longitudinal striations parallel to ventral margin in lower half.

According to Whatley et al. (2003c) who reviewed the systematics of three species of *Paracypretta*, namely *P. subglobosa* (Sowerby in Malcolmson 1840), *P. elizabethae* Whatley, Bajpai and Whittaker 2003c and *P. jonesi* Bhatia and Rana 1984 from the Inter-trappean beds of India, *P. jonesi* differs from *P. elizabethae* in its greater tumidity as seen in dorsal view and in its more laterally compressed and projecting anterior margin in the same view. As against these, *P. elizabethae* is notably less inflated and is more gracile and regularly fusiform in dorsal and

ventral views, with the anterior margin much less strongly laterally compressed. However, in its punctuate ornament and the orientation of the puncta parallel to the ventral margin ventrally *P. jonesi* resembles *P. elizabethae*. *P. jonesi* is also very similar in dorsal and ventral views to *P. subglobosa* but in that species the ornament is papillate and is not oriented parallel to the ventral margin.

Whatley et al. (2003c) placed *Paracyprretta bhatiai* (Khosla and Sahni 2000) within the synonymy of *P. jonesi*. In our opinion the forms described as *Paracyprretta bhatiai* by Whatley et al. (2002a, pl. 3, figs. 1-5; 2002b, pl. 2, fig. 10) are not *P. jonesi* but should be included in *P. elizabethae*.

Further *Paracyprretta anjarensis* Khosla and Nagori 2005 described from the Inter-trappean beds of Anjar in Kachchh District is also considered herein junior synonym of *P. jonesi*.

#### Dimensions (mm):

	Length	Height	Width
Carapace (SUGDMF No. 1132)	1.46	0.91	0.93
Carapace (SUGDMF No. 1156)	1.62	1.02	1.04

Occurrence: Samples JH16-17, 19, 23-26.

***Paracyprretta verruculosa*** (Whatley, Bajpai and Srinivasan 2002) new combination  
Plate 2, figures 5-10

?*Eucypris verruculosa* WHATLEY, BAJPAI and SRINIVASAN 2002a, p. 177, pl. 4, figs. 8,9, 12-19. – WHATLEY, BAJPAI and WHITTAKER 2003b, p. 81-82, figs. 2J-K. KHOSLA and NAGORI 2007b, p. 12, pl. 3, figs. 1-2.

Material: 175 carapace and valves.

**Description:** Carapace large, elongate-subtriangular in lateral outline, with greatest height at anterior cardinal angle; left valve slightly larger than right valve, overlapping along dorsal, posterodorsal and ventral margins; dorsal margin straight sloping down posteriorly; ventral margin concave backwardly; anterior margin broad and obliquely rounded; posterior margin straight in upper part and ventrally rounded in lower part; in dorsal view carapace fusiform, inflated medially, maximum width posterior to middle, ends gradually compressed, anterior being more compressed than posterior. Valve surface ornamented by fine reticulation with scattered papillae; reticulation in marginal region orientated in striations parallel to anterior, ventral and posterior margins. Inner lamella moderately wide. Hinge adont; right valve with a distinct groove between projecting selvage and flange along dorsal margin and correspondingly left valve with a bar formed by projecting flange. Other characters not seen.

**Remarks:** The species was originally described as ?*Eucypris verruculosa* from the Inter-trappean of Chandarki, Gulbarga District. According to Whatley et al. (2002a) the species is not particularly similar to other species of the genus and they included it very tentatively. They even considered the possibility that it might be limnocytherid on the basis of its shape, although there was no evidence from musculature in the types of the species to support this. Whatley et al. (2003b) subsequently recorded the species from the Inter-trappean collections of Sichel Hills housed in The Natural History Museum, London and reported the presence of typical cypridoidean central muscle scars, though very imperfectly preserved in the species. According to them the species is somewhat similar in shape to

certain specimens of *Paracyprretta subglobosa* (Sowerby, in Malcolmson 1840) which they illustrated elsewhere (Whatley et al. 2003c). Our specimens of the species recorded from the Inter-trappean beds of Jhilmili are not only similar to *Paracyprretta* species (viz. *P. elizabethae* Whatley, Bajpai and Whittaker 2003c, *P. jonesi* Bhatia and Rana 1984, *P. subglobosa* Sowerby, in Malcolmson 1840 described from the Inter-trappean beds of India) in outline but are also similar to these in surface ornamentation and hence the species is herein transferred to the genus *Paracyprretta*. The hinge in this species is rather unusual, negative element in smaller valve and positive in larger valve. Other recorded occurrence of the species is from the Inter-trappean beds of Takli, Nagpur (Khosla and Nagori 2007b).

#### Dimensions (mm):

	Length	Height	Width
Left valve (SUGDMF No. 1126)	1.23	0.69	—
Carapace (SUGDMF No. 1157)	0.80	0.48	0.45
Carapace (SUGDMF No. 1158)	0.82	0.51	0.38
Carapace (SUGDMF No. 1159)	0.85	0.54	0.37
Right valve (SUGDMF No. 1160)	0.88	0.51	—

Occurrence: Samples JH17, 20, 24, 25

Genus *Stenocypris* Sars 1889

Type species: *Stenocypris cylindrica* variety *major* Baird 1859

***Stenocypris cylindrica*** (Sowerby in Malcolmson 1840)

Plate 2, figure 11

*Cypris cylindrica* SOWERBY (in Malcolmson 1840), pl. 47, fig. 2.  
*Mongolianella* sp. MATHUR and VERMA 1988, p. 172, pl. 1, figs. 5a, b. – BHATIA, SRINIVASAN, BAJPAI and JOLLY 1990b, p. 118, pl. 1, fig. 6.  
*Candonianella altanica* (Stankevitch, in Stankevitch and Sochava). – BHATIA, SRINIVASAN, BAJPAI and JOLLY 1990b, p. 118, pl. 1, fig. 11.  
*Mongolianella palmosa* Mandelstam. – SAHNI and KHOSLA 1994, p. 458, figs. 2q-r. – KHOSLA and SAHNI 2000, p. 59, figs. 3k-l; 4a-e.  
? *Moenocypris* sp. BHANDARI 1999, p. 8, pl. 2, fig. 11.  
*Mongolianella cylindrica* (Sowerby). – WHATLEY and BAJPAI 2000a, p. 403-404, pl. 6, figs. 1-8. – BAJPAI and WHATLEY 2001, p. 103-104, pl. 3, figs. 6, 9. – WHATLEY, BAJPAI and SRINIVASAN 2002a, p. 176-177, pl. 4, fig. 10. – WHATLEY, BAJPAI and WHITTAKER 2003a, p. 80-83, text-fig. 1, 1-4. – WHATLEY, BAJPAI and WHITTAKER 2003b, p. 82-83, figs. 2L-O, Q-R; 3A-L. – BAJPAI, MOHABEY, KAPOOR and SHARMA 2004, p. 154-155, pl. 2, figs. n-o. – KHOSLA and NAGORI 2005, p. 576, pl. 1, fig. 9. – KHOSLA and NAGORI 2007b, p. 9, pl. 2, figs. 10-11. – SHARMA, BAJPAI and SINGH 2008, p. 180, pl. 2, figs. I-K.

Material: 1 carapace.

**Remarks:** The species was initially described as *Cypris cylindrica* by Sowerby (in Malcolmson 1840) from the Inter-trappean beds of the Sichel Hills, Andhra Pradesh. During the last decade Whatley and Bajpai (2000a) recorded the species from the Inter-trappean of Lakshmipur, Kachchh District, and on the basis of thorough study of the collections and registers of The Natural History Museum (NHM), London stated that Kachchh specimens are identical with the types of *Cypris cylindrica* housed there. Whatley and Bajpai recorded the species as *Mongolianella cylindrica* and erected a lectotype and a number of paralectotypes from among Sowerby's syntypes in NHM.

More recently Khosla et al. (2009b) restudied the species from Inter-trappean of Lakshmipur, Kachchh District and observed

that unlike the genus *Mongolianella* Mandelshtam (in Mandelshtam et al. 1956) which was erected on the basis of the distinctive shape of the carapace and the hinge structure, *Cypris cylindrica* is characterized by a very wide inner lamella along anterior margin, with a large vestibulum, uniformly developed straight marginal pore canals all along margin except the dorsal; simple adont hinge; and central muscle scars comprising 6 prominent adductor scars, the topmost being much elongated. On the basis of these characters Khosla et al. (2009b) transferred the species to genus *Stenocypris* Sars 1889.

Besides Lakshmipur, the species occurs in the Inter-trappean of Kora (Bajpai and Whatley 2001), and Anjar (Khosla and Nagori 2005), Kachchh District, Chandarki and Yanagundi, Gulbarga District (Whatley et al. 2002a), Mamoni, Kota District (Whatley et al. 2003a), Takli, Nagpur (Khosla and Nagori 2007b), Phulsagar, Mandla District (Bajpai et al. 2004) and Papro, Lalitpur (Sharma et al. 2008). Further, Whatley and Bajpai (2000a) considered the forms recorded as *?Moenocypris* sp. by Bhandari (1999) from the Eocene of Cambay shales of Gujarat, *Candonianella altanica* by Bhatia et al. (1990b) from the Inter-trappean beds of Mamoni, Kota District, and *Mongolianella palmosa* by Sahni and Khosla (1994) and Khosla and Sahni (2000) from the Lameta Formation of Jabalpur as junior synonyms of this species.

#### Dimensions (mm):

	Length	Height	Width
Carapace (SUGDMF No. 1133)	0.88	0.39	0.43

Occurrence: Sample JH25.

Genus: *Strandesia* Stuhlmann 1888

Type species: *Cypris (Strandesia) mercatorum* Vávra 1895

***Strandesia jhilmiliensis*** Khosla, Nagori, Jakhar and Rathore n. sp.  
Plate 2, figures 12-13; plate 3, figure 1

Material: 25 carapaces.

Name: The species is named after its type locality Jhilmili, Chhindwara District, Madhya Pradesh.

Holotype: Pl. 2, fig. 12.

Paratypes: Pl. 2, fig. 13; pl. 3, fig. 1.

Type locality: Jhilmili, District Chhindwara, Madhya Pradesh, India.

Type horizon: Pink clays and laminated claystones (Sample JH25), Inter-trappean beds (early Danian).

Diagnosis: A moderately large species of *Strandesia* characterized by elongate, subtriangular outline in lateral view and lenoid in the dorsal; dorsal margin arched, subangulate.

Description: Carapace elongate-subtriangular in lateral view, with greatest height about 3/5 of length anterior to middle; left valve slightly overlapping right valve along ventral margin; dorsal margin arched, subangulated, posterodorsal straight sloping down posteriorly, anterodorsal convex; ventral margin straight, slightly concave anteriorly in right valve; anterior margin broad obliquely rounded; posterior margin narrowly rounded; mid-anterior and mid-posterior apex below mid-height; in dorsal view carapace lenoid, ends pointed. Valve surface smooth. Internal characters not seen.

#### Dimensions (mm):

	Length	Height	Width
Holotype, carapace (SUGDMF No. 1134)	0.90	0.53	0.50
Paratype I, carapace (SUGDMF No. 1161)	0.86	0.51	0.48
Paratype II, carapace (SUGDMF No. 1162)	0.89	0.50	0.53

Discussion: *Strandesia jhilmiliensis* Khosla, Nagori, Jakhar and Rathore n. sp. closely resembles *Strandesia indica*, a Recent species described by Hartmann (1964) from the Pond at Ernakulam, Travancore and several other places in India. *S. indica*, however, differs from the present species in having asymmetrically arched dorsal margin lacking subangulation anterior to middle. This is first record of occurrence of *Strandesia* from the Deccan Inter-trappean beds of Peninsular India.

Occurrence: Samples JH25-26.

Genus *Zonocypris* Müller 1898

Type species: *Zonocypris madagascarensis* 1898

***Zonocypris spirula*** Whatley and Bajpai 2000

Plate 3, figures 2-3

*Zonocypris spirula* WHATLEY and BAJPAI 2000a, p. 396-397, pl. 3, figs. 1-7, 9. – WHATLEY, BAJPAI and SRINIVASAN 2002a, p. 173, pl. 3, figs. 6-7. – WHATLEY BAJPAI and WHITTAKER 2002, p. 168, pl. 1, figs. 11-12. – KHOSLA, NAGORI and MOHABEY 2005, p. 139, pl. 1, figs. 13-14. – KHOSLA and NAGORI 2005, p. 576, pl. 1, fig. 19. – KHOSLA and NAGORI 2007a, p. 217, pl. 2, figs. 4-5. – KHOSLA and NAGORI 2007b, p. 9, pl. 2, figs. 5-6. – SHARMA, BAJPAI and SINGH 2008, p. 182, pl. 2, figs. O-P.

Material: 38 carapaces and valves.

Remarks: The species has been recorded from the Inter-trappean beds of Lakshmipur (Whatley and Bajpai 2000a), Kora (Whatley et al. 2002) and Anjar (Khosla and Nagori 2005), Kachchh District, Yanagundi, Gulbarga District (Whatley et al. 2002a), Mohgaon-Haveli, Chhindwara District (Khosla and Nagori 2007a) and Takli, Nagpur (Khosla and Nagori 2007b), Papro, Lalitpur (Sharma et al. 2008) and the Lameta Formation of Dongargaon, Chandrapur District (Khosla et al. 2005). The species has characteristic ornamentation comprising a single rib spirally coiled on valve surface, and strongly tumid, fusiform dorsal outline.

#### Dimensions (mm):

	Length	Height	Width
Carapace (SUGDMF No. 1135)	0.34	0.21	0.27
Carapace (SUGDMF No. 1163)	0.35	0.22	0.29

Occurrence: Samples JH25-26.

***Zonocypris viriensis*** Khosla and Nagori 2005

Plate 3, figures 4-6

*Zonocypris spirula* WHATLEY and BAJPAI 2000a, pl. 3, figs. 7, 9 (not pl. 3, figs. 1-6).

*Zonocypris viriensis* KHOSLA and NAGORI 2005, p. 578, pl. 1, figs. 20-22.

Material: 506 carapaces and valves.

Remarks: The species was described from the Inter-trappean beds of Anjar, Kachchh District by Khosla and Nagori (2005). They also assigned the form initially considered as a juvenile form of *Zonocypris spirula* by Whatley and Bajpai (2000a, pl. 3, figs. 7, 9), from the Inter-trappean beds of Lakshmipur, Kachchh District to this species. *Zonocypris viriensis*, however, is readily differentiated from *Zonocypris spirula* by its surface

ornamentation, which comprises numerous fine striations concentrically arranged in the peripheral region and irregularly disposed in the middle.

*Dimensions (mm):*

	Length	Height	Width
Carapace (SUGDMF No. 1136)	0.34	0.24	0.27
Carapace (SUGDMF No. 1164)	0.35	0.22	0.26
Carapace (SUGDMF No. 1165)	0.35	0.24	0.26

*Occurrence:* Samples JH16-19, 21-23, 25.

*Zonocypris* sp.

Plate 3, figure 7

*Material:* 1 carapace.

*Remarks:* The species resembles *Zonocypris viriensis* Khosla and Nagori 2005 described from the Inter-trappean beds of Anjar, Kachchh District and also recorded in great abundance herein from Jhilmili in surface ornamentation but readily differs in having triangular lateral outline, with height about 3/4 of length.

*Dimensions (mm):*

	Length	Height	Width
Carapace (SUGDMF No. 1166)	0.40	0.30	0.30

*Occurrence:* Sample JH19.

Subfamily CYPRIDOPSINAE Kaufmann 1900

Genus *Cypridopsis* Brady 1868

Type species: *Cypris vidua* Müller 1776

*Cypridopsis hyperectyphos* Whatley and Bajpai 2000

Plate 3, figures 8-11

*Cypridopsis hyperectyphos* WHATLEY and BAJPAI 2000a, p. 397-398, pl. 4, figs. 4-10. - BAJPAI and WHATLEY 2001, p. 96, pl. 1, figs. 6-8. - WHATLEY, BAJPAI and SRINIVASAN 2002a, p. 174, pl. 3, figs. 11-13. - WHATLEY, BAJPAI and WHITTAKER 2003a, p. 80, pl. 1, figs. 12-13. - KHOSLA, NAGORI and MOHABEY 2005, p. 141, pl. 2, figs. 3-4. - KHOSLA and NAGORI 2005, p. 574, pl. 1, fig. 17. - KHOSLA and NAGORI 2007b, p. 9, pl. 2, fig. 9. - SHARMA, BAJPAI and SINGH 2008, p. 178-180, pl. 2, figs. A-C.

*Material:* 431 carapaces and valves.

## PLATE 1

1-6. *Neocyprideis raoi* (Jain 1978)

- 1 female carapace (SUGDMF No. 1117), right valve view, ×79.
- 2 female left valve (SUGDMF No. 1144), internal view, ×87.
- 3-4 female right valve (SUGDMF No. 1119); 3, internal view, ×90; 4, central muscle scars enlarged.
- 5 female carapace (SUGDMF No. 1118), dorsal view, ×73.
- 6 male carapace (SUGDMF No. 1145), dorsal view, ×71.

7-11. *Limnocythere deccanensis* Khosla, Nagori and Mohabey 2005

- 7 carapace (? juvenile) (SUGDMF No. 1131), right valve view, ×100.
- 8 carapace (SUGDMF No. 1146), left valve view, ×95.
- 9 carapace (? juvenile) (SUGDMF No. 1147), dorsal view, ×96.
- 10 carapace (SUGDMF No. 1148), right valve view, ×93.
- 11 left valve (? juvenile) (SUGDMF No. 1149), internal view, ×106.

12-14. *Frambocythere tumiensis anjarensis* Bhandari and Colin 1999

- 12 female carapace (SUGDMF No. 1127), right valve view, ×108.
- 13 female carapace (SUGDMF No. 1150), dorsal view, ×94.
- 14 male carapace (SUGDMF No. 1151), dorsal view, ×109.

15. *Gomphocythere paucisulcatus* Whatley, Bajpai and Srinivasan 2002

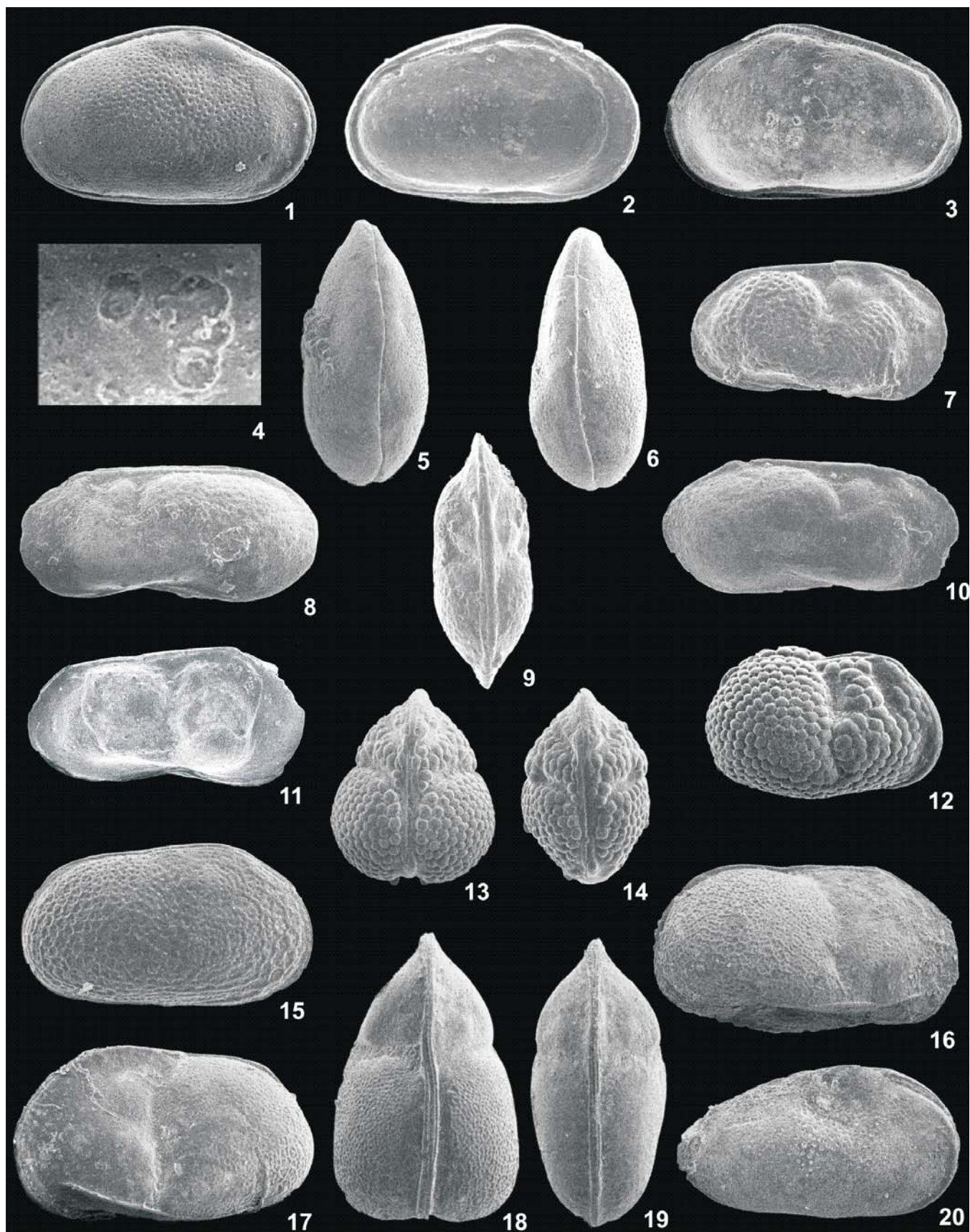
Carapace (SUGDMF No. 1128), right valve view, ×79.

16-19. *Gomphocythere strangulata* (Jones 1860)

- 16 female carapace (SUGDMF No. 1129), right valve view, ×67.
- 17 female carapace (SUGDMF No. 1152), left valve view, ×65.
- 18 female carapace (SUGDMF No. 1153), dorsal view, ×58.
- 19 male carapace (SUGDMF No. 1154), dorsal view, ×60.

20. ? *Buntonia* sp

Carapace (SUGDMF No. 1155), right valve view, ×77.



**Remarks:** The species has been widely recorded from the Inter-trappean beds of Lakshampur (Whatley and Bajpai 2000a), Kora (Bajpai and Whatley 2001) and Anjar (Khosla and Nagori 2005), Kachchh District, Yanagundi, Gulbarga District (Whatley et al. 2002a), Mamoni, Kota District (Whatley et al. 2003a), Takli, Nagpur (Khosla and Nagori 2007b), Papro, Lalitpur (Sharma et al. 2008) and the Lameta Formation of Dongargaon, Chandrapur District (Khosla et al. 2005). The species is readily differentiated from other species of *Cypridopsis* by its strongly inflated and almost circular outline in dorsal and ventral views. In some specimens length equals width.

**Dimensions (mm):**

	Length	Height	Width
Carapace (SUGDMF No. 1123)	0.63	0.46	0.58
Carapace (juvenile) (SUGDMF No. 1167)	0.43	0.30	0.37
Carapace (juvenile) (SUGDMF No. 1168)	0.45	0.30	0.35
Carapace (SUGDMF No. 1169)	0.62	0.46	0.59

**Occurrence:** Samples JH16-21, 23-26.

Subfamily EUCYPRIDINAE Bronstein 1947

Genus *Eucypris* Vavra 1891

Type species: *Monoculus virens* Jurine 1824

*Eucypris pelasgikos* Whatley and Bajpai 2000

Plate 3, figure 12

*Candona altanulaensis* Szczechura and Blaszyk. - BHATIA, PRASAD and RANA 1990a, pl. 3, fig. 3. - BHATIA, PRASAD and RANA 1996, p. 302, pl. 3, fig. 3.

*Eucypris pelasgikos* WHATLEY and BAJPAI 2000a, p. 400-402, pl. 5, figs. 7-15. - BAJPAI and WHATLEY 2001, p. 102-103, pl. 2, fig. 15; pl. 3, figs. 1-3. - WHATLEY, BAJPAI and SRINIVASAN 2002b, p. 111-112, pl. 2, fig. 11. - BAJPAI, MOHABEY, KAPOOR and SHARMA 2004, p. 152-154, pl. 2, figs. k-l. - KHOSLA, NAGORI and MOHABEY 2005, p. 143, pl. 3, figs. 2-3. - KHOSLA and

NAGORI 2005, p. 574, pl. 1, fig. 12. - KHOSLA and NAGORI 2007b, p. 12, pl. 2, figs. 18-19.

**Material:** 1 carapace.

**Remarks:** This species has been previously recorded from the Inter-trappean beds of Lakshampur (Whatley and Bajpai 2000a), Kora (Bajpai and Whatley 2001) and Anjar (Khosla and Nagori 2005), Kachchh District, Mohagaonkala (Mohagaon-Kalan), Chhindwara District (Whatley et al. 2002b), Takli, Nagpur (Khosla and Nagori 2007b) and the Lameta Formation of Dongargaon, Chandrapur District (Khosla et al. 2005). Whatley et al. (2002b) also assigned *Candona altanulaensis* recorded by Bhatia et al. (1990a and 1996) from the Inter-trappean beds of Takli, Nagpur to *Eucypris pelasgikos*. It is a very large species with distinctly umbonate dorsal margin at mid-length and anteroventral angulation in the left valve where it pronouncedly overlaps the right valve.

**Dimensions (mm):**

	Length	Height	Width
Carapace (SUGDMF No. 1125)	0.83	0.48	0.42

**Occurrence:** Sample JH26.

Subfamily CYCLOCYPRIDINAE Zenker 1854

Genus: *Cyclocypris* Brady and Norman 1889

Type species: *Cypris globosa* Sars 1863

*Cyclocypris amphibolos* Whatley, Bajpai and Srinivasan 2002

Plate 3, figures 13-14

*Cyclocypris amphibolos* WHATLEY, BAJPAI and SRINIVASAN 2002a, p. 182-184, pl. 6, figs. 6-18. - WHATLEY, BAJPAI and WHITTAKER 2002, p. 170-172, pl. 2, figs. 12-15. - WHATLEY, BAJPAI and WHITTAKER 2003a, p. 84, pl. 1, figs. 8-9. - KHOSLA, NAGORI and MOHABEY 2005, p. 143-144, pl. 3, figs. 7-8. -

## PLATE 2

1. *Centrocypris megalopos* Whatley and Bajpai 2000

Right valve (SUGDMF No. 1120), lateral view, ×84.

2. *Heterocypris* sp.

Carapace (SUGDMF No. 1130), right valve view, ×40.

3-4. *Paracypretta jonesi* Bhatia and Rana 1984

3 carapace (SUGDMF No. 1132), right valve view, ×44.

4 carapace (SUGDMF No. 1156), dorsal view, ×35.

5-10. *Paracypretta verruculosa* (Whatley, Bajpai and Srinivasan 2002)

5 left valve (SUGDMF No. 1126), lateral view, ×50.

6 carapace (SUGDMF No. 1157), right valve view, ×76.

7 carapace (SUGDMF No. 1158), dorsal view, ×68.

8 carapace (SUGDMF No. 1159), left valve view, ×67.

9-10 right valve (SUGDMF No. 1160); 9, internal view, ×74; 10, hinge enlarged ×110.

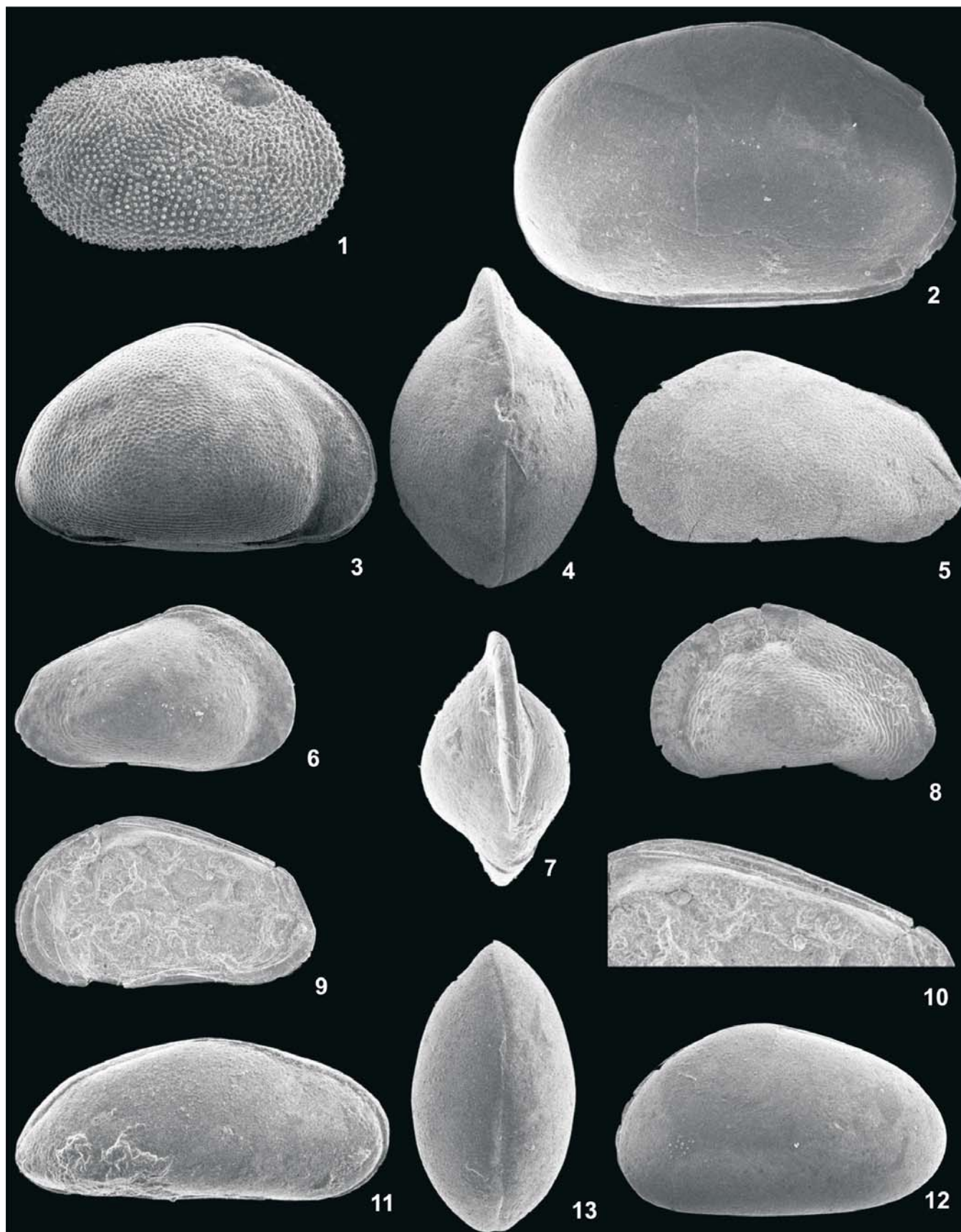
11. *Stenocypris cylindrica* (Sowerby in Malcolmson 1840)

Carapace (SUGDMF No. 1133), right valve view, ×76.

12-13. *Strandesia jhilmiliensis* Khosla, Nagori, Jakhar and Rathore, n. sp.

12 holotype, carapace (SUGDMF No. 1134), left valve view, ×66.

13 paratype I, carapace (SUGDMF No. 1161), dorsal view, ×62.



KHOSLA and NAGORI 2007a, p. 219, pl. 3, figs. 8-11. - KHOSLA and NAGORI 2007b, p. 12, pl. 3, figs. 8-10.

**Material:** 44 carapaces and valves.

**Remarks:** The species has previously been recorded from the Inter-trappean beds of Yanagundi, Gulbarga District (Whatley et al. 2002a, 2002), Kora, Kachchh District (Bajpai and Whatley 2001) and Mamoni, Kota District (Whatley et al. 2003a), Mohgaon-Haveli, Chhindwara District (Khosla and Nagori 2007a), Takli, Nagpur (Khosla and Nagori 2007b) and the Lameta Formation of Dongargaon, Chandrapur District (Khosla et al. 2005). Its diagnostic characters are: medium size; irregularly subovate in lateral outline and regularly fusiform in dorsal view; anterior margin broad, symmetrically rounded; posterior margin more narrowly rounded; dorsal margin convex anterodorsally but straighter, sloping posteriorly; ventral margin slightly concave; surface with numerous minute papillae.

**Dimensions (mm):**

	Length	Height	Width
Carapace (SUGDMF No. 1121)	0.58	0.38	0.37
Carapace (SUGDMF No. 1170)	0.58	0.29	0.37

**Occurrence:** Samples JH25-26.

Genus: *Cypria* Zenker 1854

Type species: *Cypris exculpta* Fischer 1854

***Cypria cyrtonidion*** Whatley and Bajpai 2000

Plate 3, figures 15-16

*Cyprois* sp. BHATIA and RANA 1984, p. 33, pl. 2, fig. 12. – MATHUR and VERMA 1988, p. 173, pl. 1, figs. 1-2.

*Cypria cyrtonidion* WHATLEY and BAJPAI 2000a, p. 404, pl. 6, figs. 9-14. – BAJPAI and WHATLEY 2001, p. 101-102, pl. 2, figs. 7-9. – WHATLEY, BAJPAI and SRINIVASAN 2002a, p. 184, pl. 6, fig. 19. – WHATLEY, BAJPAI and SRINIVASAN 2002b, p. 112-113, pl. 2, fig. 13. – KHOSLA, NAGORI and MOHABEY 2005, p. 144, pl. 3, figs. 9-10. – KHOSLA and NAGORI 2005, p. 574, pl. 1, fig. 10. – KHOSLA and NAGORI 2007a, p. 219-220, pl. 3, figs. 12-13. – KHOSLA and NAGORI 2007b, p. 14, pl. 3, figs. 11-12. – SHARMA, BAJPAI and SINGH 2008, p. 182, pl. 1, fig. O.

**Material:** 45 carapaces and valves.

**Remarks:** The species has been widely recorded from the Inter-trappean beds of Lakshmipur (Whatley and Bajpai 2000a), Kora (Bajpai and Whatley 2001) and Anjar (Khosla and Nagori 2005), Kachchh District, Yanagundi and Chandarki, Gulbarga District (Whatley et al. 2002a), Mohagaonkala (Mohgaon-Kalan), (Whatley et al. 2002b) and Mohgaon-Haveli (Khosla and Nagori 2007a), Chhindwara District, Takli, Nagpur

## PLATE 3

1. *Strandesia jhilmiliensis* Khosla, Nagori, Jakhar and Rathore, n. sp.

Paratype II, carapace (SUGDMF No. 1162), right valve view, ×68.

2-3. *Zonocypris spirula* Whatley and Bajpai 2000

2 carapace (SUGDMF No. 1135), right valve view, ×116.

3 carapace (SUGDMF No. 1163), dorsal view, ×100.

4-6. *Zonocypris viriensis* Khosla and Nagori 2005

4 carapace (SUGDMF No. 1136), right valve view, ×112.

5 carapace (SUGDMF No. 1164), dorsal view, ×98.

6 carapace (SUGDMF No. 1165), left valve view, ×107.

7. *Zonocypris* sp.

Carapace (SUGDMF No. 1166), right valve view, ×85.

8-11. *Cypripopsis hyperectyphos* Whatley and Bajpai 2000

8 carapace (juvenile) (SUGDMF No. 1167), left valve view, ×86.

9 carapace (juvenile) (SUGDMF No. 1168), dorsal view, ×73.

10 carapace (SUGDMF No. 1123), right valve view, ×76.

11 carapace (SUGDMF No. 1169), dorsal view, ×69.

12. *Eucypris pelagicos* Whatley and Bajpai 2000

Carapace (SUGDMF No. 1125), right valve view, ×78.

13-14. *Cyclocypris amphibolos* Whatley, Bajpai and Srinivasan 2002

13 carapace (SUGDMF No. 1121), right valve view, ×85.

14 carapace (SUGDMF No. 1170), dorsal view, ×79.

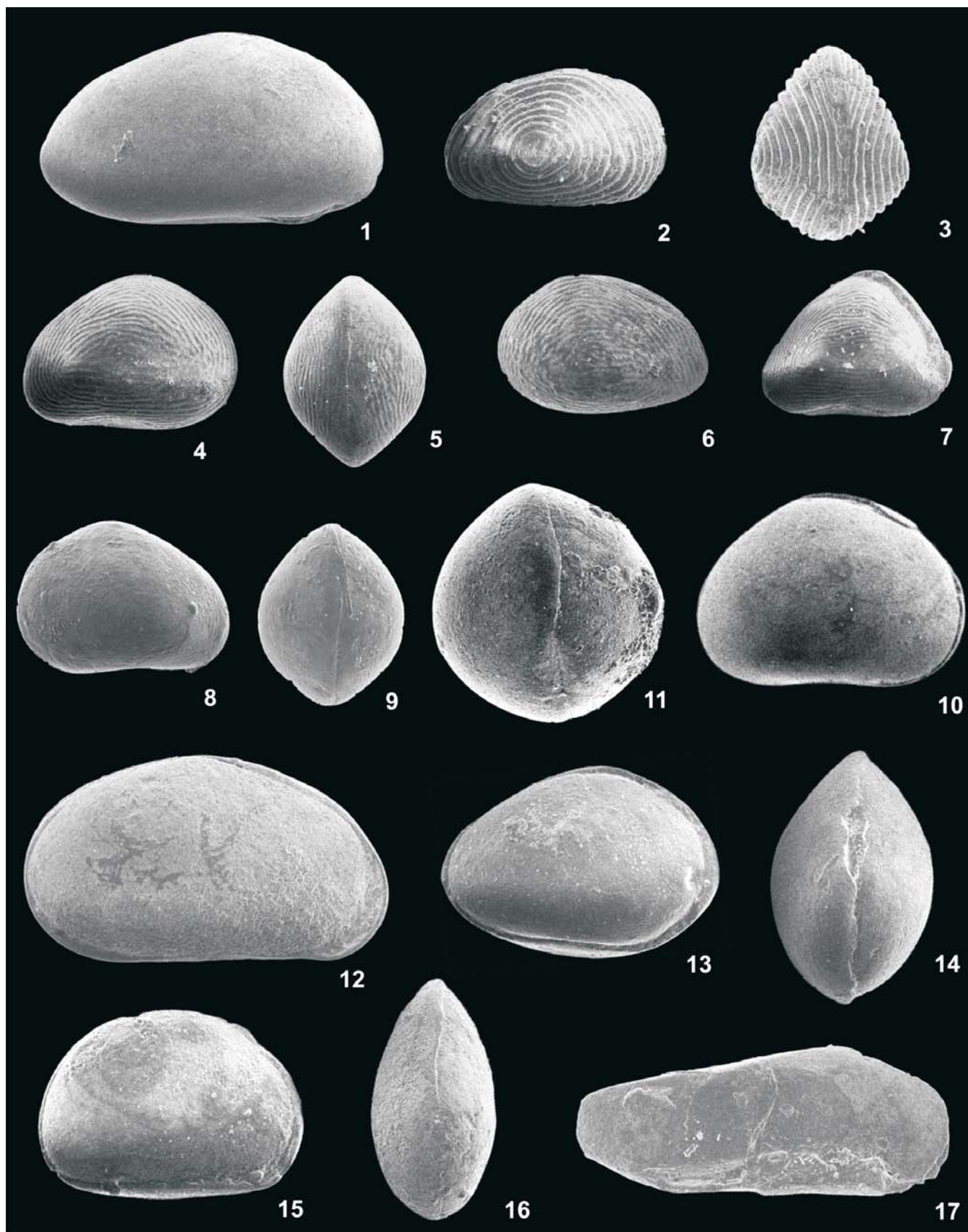
15-16. *Cypria cyrtonidion* Whatley and Bajpai 2000

15 carapace (SUGDMF No. 1122), right valve view, ×84.

16 carapace (SUGDMF No. 1171), dorsal view, ×80.

17. *Darwinula torpedo* Whatley, Bajpai and Srinivasan 2002

Carapace (SUGDMF No. 1124), left valve view, ×82.



(Khosla and Nagori 2007b), Papro, Lalitpur (Sharma et al. 2008) and the Lameta Formation of Dongargaon, Chandrapur District (Khosla et al. 2005). Also, Whatley et al. (2002a and b) assigned *Cypriois* sp. recorded from the Inter-trappean beds of Nagpur by Bhatia and Rana (1984) and Kota by Mathur and Verma (1988) to this species.

The species is subquadrate to subcircular in lateral outline with left valve larger than right valve overlapping all around the periphery except dorsally where right valve overreaches left valve.

#### Dimensions (mm):

	Length	Height	Width
Carapace (SUGDMF No. 1122)	0.56	0.40	0.22
Carapace (SUGDMF No. 1171)	0.54	0.38	0.29

Occurrence: Samples JH17, 19.

Superfamily DARWINULOIDEA Brady and Norman 1889

Family DARWINULINIDAE Brady and Norman 1889

Genus: *Darwinula* Brady and Robertson 1885

Type species: *Darwinula oviformis* Mandelstam 1947

***Darwinula torpedo*** Whatley, Bajpai and Srinivasan 2002  
Plate 3, figure 17

*Darwinula torpedo* WHATLEY, BAJPAI and SRINIVASAN 2002a, p. 165–166, pl. 1, figs. 1–7. - KHOSLA and NAGORI 2007a, p. 211, pl. 1, fig. 1. - KHOSLA and NAGORI 2007b, p. 5–6, pl. 1, figs. 1–3.

Material: 1 carapace.

**Remarks:** *Darwinula torpedo* has been described from the Inter-trappean beds of Yanagundi, Gulbarga District by Whatley et al. (2002a). The species also occurs in the Inter-trappean beds of Mohgaon-Haveli, Chhindwara District (Khosla and Nagori 2007a) and Takli, Nagpur (Khosla and Nagori 2007b). It is a medium sized species characterized by elongate, subcylindrical lateral outline; anterior margin narrowly rounded, with apex below mid-height; posterior margin more broadly rounded to subtruncate, apex at or above mid-height; dorsal margin straight to very gently convex; ventral margin slightly concave; valve surface smooth.

#### Dimensions (mm):

	Length	Height	Width
Carapace (SUGDMF No. 1124)	0.80	0.33	0.18

Occurrence: Sample JH19.

## CONCLUSIONS

1. The Deccan Inter-trappean beds of Nagpur, Chhindwara and Mandla regions were earlier assigned a Maastrichtian age based on freshwater ostracodes. The recent discovery of planktic foraminifera with lacustrine to brackish-marine ostracode assemblages in the Inter-trappean of Jhilmili by Keller et al (2009b) has provided the first definite age control and revealed these Inter-trappean beds as early Danian Zone P1a in age.

2. Jhilmili Inter-trappean beds are reminiscent of the shallow-marine Inter-trappean sediments of the Rajahmundry quarries on the east coast of India where similar early Danian Zone P1a planktic foraminiferal assemblages have been identified between the lower trap of C29R and the upper trap of C29R-C29N transition age, correlative with the Ambenali and Mahalabeshwar formations, respectively.

3. The available ostracode evidence suggests that the Inter-trappean sediments of Unit 3 were accumulated in a lake / pool environment. The planktic foraminifera were carried to Jhilmili by repeated incursions of transgressive marine waters from the east coasts through the Godavari-Pranhita rift zone visualized by Sahni (1983) and other workers. These incursions resulted in the formation of estuarine or shallow coastal marine environment at Jhilmili.

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