Geophytology 42(1): 1-10
January 2013

First record of mites (Acarina) from the Palaeogene sediments of Kutch, western India, with comments on palaeoenvironment: support from palynological evidence

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ABSTRACT

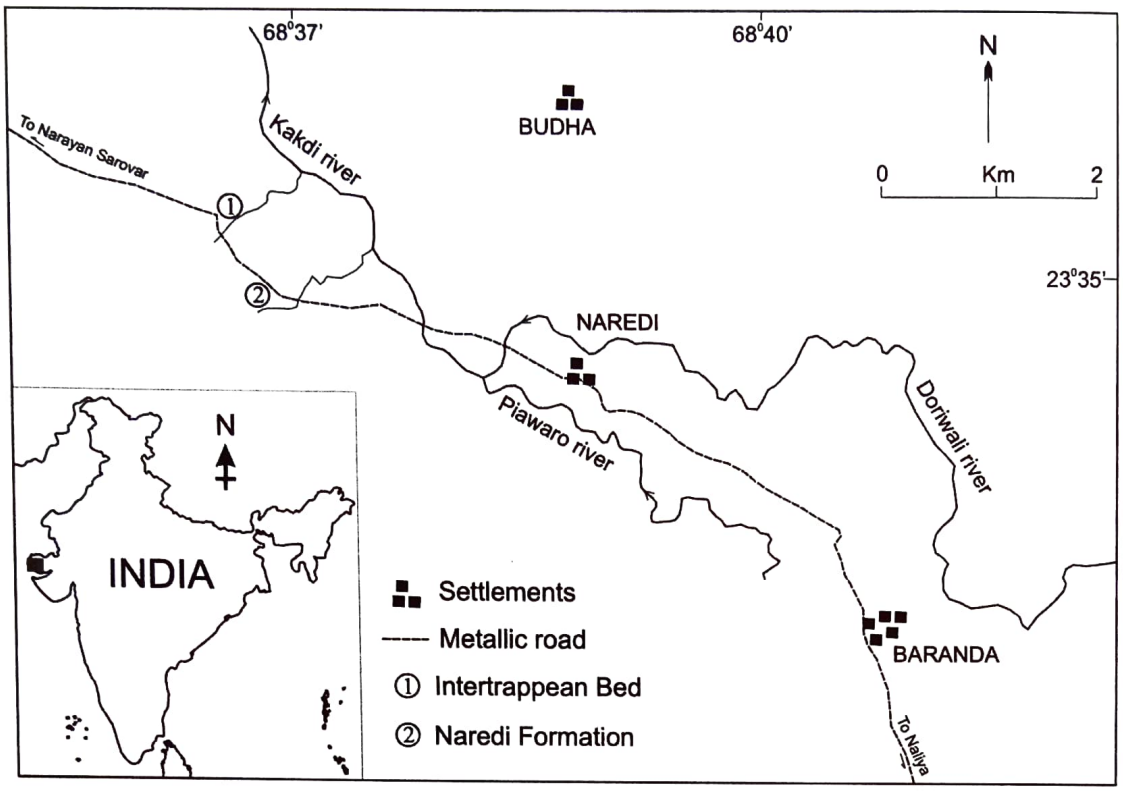
Saxena R. K., Srivastava A. K. & Ranhotra P. S. 2013. First record of mites (Acarina) from the Palaeogene sediments of Kutch, western India, with comments on palaeoenvironment: support from palynological evidence. Geophytology 42(1): 1-10.

Well preserved, microscopic, acarina fossils have been recorded, for the first time, from the Early Palaeogene sediments of Kutch District, Gujarat, western India. Altogether, four completely preserved specimens have been recovered from the Intertrappean bed (Early Palaeocene) and also from the Gypseous Shale Member of Naredi Formation (Early Eocene). The acarien specimens have been identified as *Gamasus*. These acariens and the palynofossils obtained from the same material indicate warm-humid tropical climate.

Key-words: Fossil Acarina, Intertrappean bed, Naredi Formation, Palaeocene-Eocene, Kutch, western India.

INTRODUCTION

The present paper focuses on the well preserved, microscopic mites (Acarina), which have been recovered for the first time, from the sediments of Intertrappean bed and Naredi Formation found exposed near the Naredi Village on Naliya-Narayan Sarovar road in Kutch District, Gujarat, western India (Text-figure 1). The Tertiary stratigraphic sequence, well developed in Kutch, was first classified and mapped by Wynne (1872). Later, Biswas and Raju (1971, 1973) revised Wynne's classification and divided the Tertiary sedimentary sequence of Kutch into eight formations. The base of Tertiary sequence also includes the latest episodes of Deccan volcanic activity and associated intertrappean beds which constitute one of the most important features of the Cretaceous-Early Tertiary geological history of India. Though the Deccan Traps cover a major part of western and central India, the intertrappean beds deposited during the period of quiescence are more important, as they contain wealth of animal and plant fossils, throwing light on their age, depositional environment and climate. In this regard, a good number of plant megafossil and palynofossil records are available from the intertrappean beds of Anjar in eastern Kutch (Guleria & Srivastava 2001, Dogra et al. 2004) and also from Lakshmipur in western Kutch (Samant & Bajpai 2005). Exposures of the intertrappean beds, particularly in the western Kutch are reported at few places only, viz. Lakshmipur, Dayapur and Kora, and were studied for their faunal assemblages by Khanna and Mohan (1965). Recently, Saxena and Ranhotra (2009) published the palynofloral assemblage from the Intertrappean bed found exposed at a new locality near Naredi village in western Kutch. The Naredi is also the type locality of Naredi Formation



Text-figure 1. Locality map showing sampling sites in Kutch District, Gujarat, India, from where samples yielding fossil acariens were collected.

(Early Eocene) where the type section is exposed in the cliffs along Kakdi Nadi south of Naredi and partly along Guvar stream NNW of Naredi. In the type locality, the Naredi Formation directly overlies the Deccan Traps as observed along the road cutting section about 12.5 km from Narayan Sarovar on Naliya-Narayan Sarovar road. In other places this formation disconformably lies over the Matanomadh Formation. A good amount of palynofloral studies are available from the Naredi Formation (Venkatachala & Kar 1969, Sah & Kar 1970, Kar 1978, 1985) that throw light on the age and depositional environment of the formation as well as climate during that period.

LOCALITY, MATERIAL AND METHOD

The microscopic acarien fossils are found in the samples collected from the Intertrappean bed and the Naredi Formation exposed in western Kutch, Gujarat. The 60 cm thick Intertrappean bed was found exposed about 5 km west of village Naredi, near culvert no. 54/3, on Naliya-Narayan Sarovar Road. The lithology is grey, laminated clay, underlain and overlain by the volcanic traps. Altogether, three samples (Sample Nos. I-1 to I-3) were collected, one each from the base, middle and top of the bed (Plate 1, figure 1). The exposure of the Gypseous Shale Member of the Naredi Formation was found along the road cutting about 12.5 km from Narayan Sarovar on Naliya-Narayan Sarovar road. Five samples (Sample nos. N-1 to N-5) were collected from around 1.5 m thick exposure that overlies the Deccan Trap as observed in the section (Plate 1, figure 2). During collection of samples, special attention was paid to avoid surface contamination or mixing. Depth of weathering was considered important and efforts were made to collect samples from fresh surfaces. Outcrops with weathered or jointed parts,

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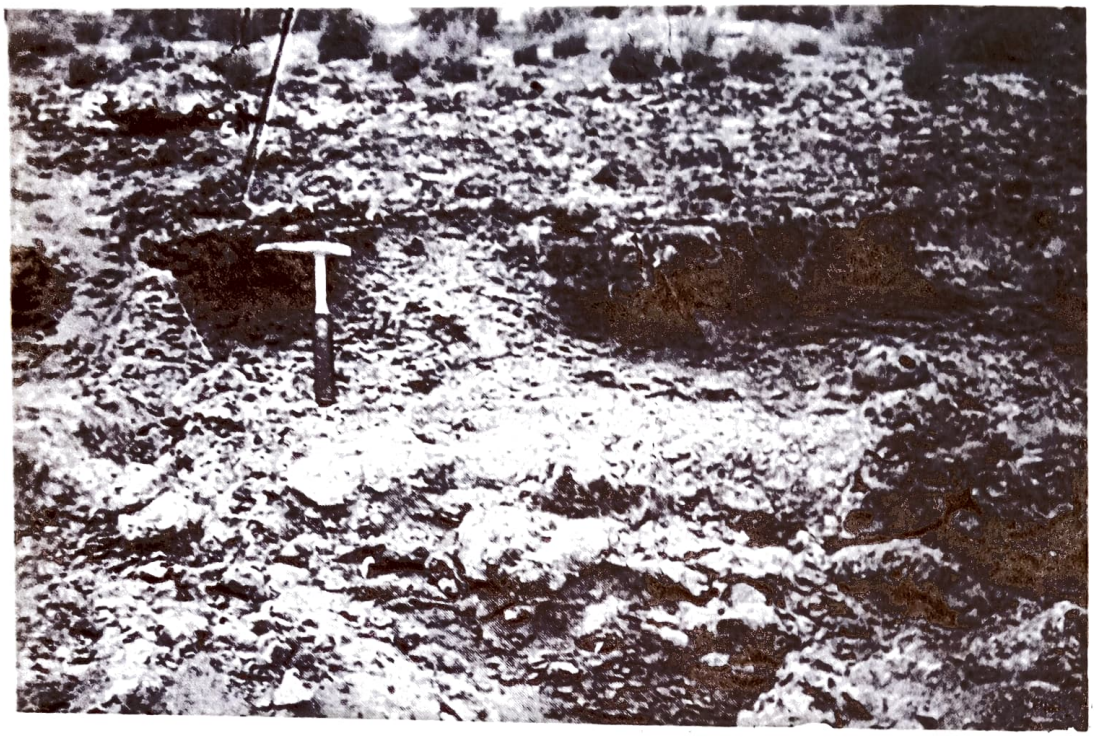
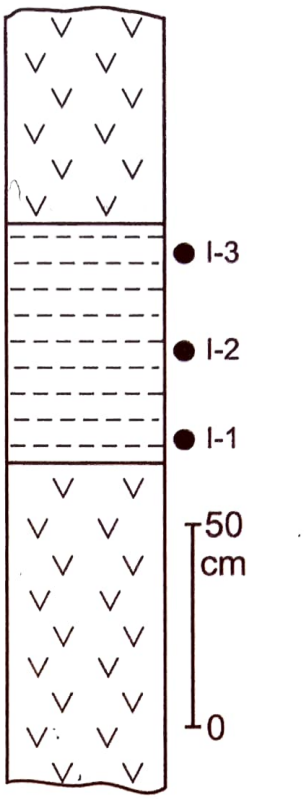
Plate 1

1. Intertrappean Bed exposed along Naliya-Narayan Sarovar Road (near culvert no. 54/3), western Kutch, Gujarat, India. 2. Naredi Formation (Gypseous Shale Member) exposed at 1 km south of Locality A.





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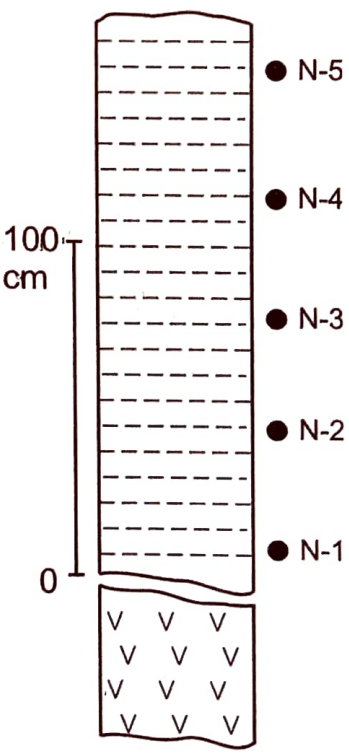

2

Volcanic Trap Grey clay Sample positions

Plate 1

containing extraneous matter, were scrupulously avoided. Only pieces of rocks were collected while powdery material was rejected. During maceration also, all care was taken to avoid contamination. Though the samples were chemically treated for the extraction of palynoflora but along with the spores and pollen, two samples from the Intertrappean bed and one sample from Naredi Formation yielded the microscopic acarien fossils. Altogether, four acarien specimens, three from the Intertrappean bed and one from the Naredi Formation, have been recovered.

The samples were treated with hydrochloric acid, hydrofluoric acid and nitric acid followed by 10% solution of potassium hydroxide. The material was finally washed with water through 400 mesh sieve. The slides were prepared in the polyvinyl alcohol and mounted in canada balsam. The slides of the figured specimens are preserved in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow, India.

SYSTEMATIC PALAEONTOLOGY

Class: Arachnida

Order: Acarina

Superfamily: Parasitoidea

Family: Gamasidae

Subfamily: Gamasinae

***Gamasus* sp.**

Plate 2, figures 1A-B, 2A-B, 3A-B, 4A-B

Description: There are four acarien bodies. These are very thin and transparent and for this reason surface details are not preserved. However, their preservation in different positions is helpful in defining their morphological features. Acariens are microscopic with their length and width ranging from 166 to 183 μm and 65 to 75 μm, respectively. They are elongated and pyriform in shape, infiltrated with granules of the matrix. Dorsal side with the chitinous demarcations into metacephalum and notogaster extremely indistinct. Anterior margin of the trunk is somewhat projecting forwards. Surface setae, seen in laterally preserved specimen, slender, moderately long and needle shaped, most of them lost. Genital plate obscure, part of chelate mouth appendage distinct, legs incompletely preserved with tibia, tarsus and pretarsus, pretarsus with claws, third and fourth legs discernible but not preserved completely, terminal segments of the hind and third legs slender, tibia short, as long as tarsus, pretarsus about one and half times long as tarsus and claw segment is not very well preserved.

Remarks: Fossil arthropods in India are mainly known by insects. They are found as impressions of different types of wings and body fossils (Srivastava 1998). The acid resistant body fossils are extremely rare. Kumar and Kumar (1999, 2001) described microscopic, wingless, ectoparasitic anopluran insects of Phthiraptera and an endoparasitic worm of Acanthocephala from the Triassic sediments of Satpura Gondwana Basin, Central India. However, these records of anoplurans have been questioned by Dalgleish et al. (2006). Kumar and Kumar (1999, 2001) suggested that such insects were surviving on the hairs of dinosaurs. However, re-examination of the same specimens (preserved in the museum of the Birbal Sahni Institute of Palaeobotany, Lucknow) by us suggests that they are comparable with mites. Since anopluran insects survive only on human hair, their existence in Triassic Period is completely ruled out. Mani (1944), for the first time, described acarien fossil, *Gamasus fossilis* from the material collected by Prof.

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Plate 2

Gamasus sp. from the Intertrappean Bed. 1A-B. Slide no. 13531/9A. 2A-B. Slide no. 13531/9B. 3A-B. Slide no. 13528/6) and Gypseous Shale Member of the Naredi Formation 4A-B. Slide no. 14106/10) in western Kutch, Gujarat, India.

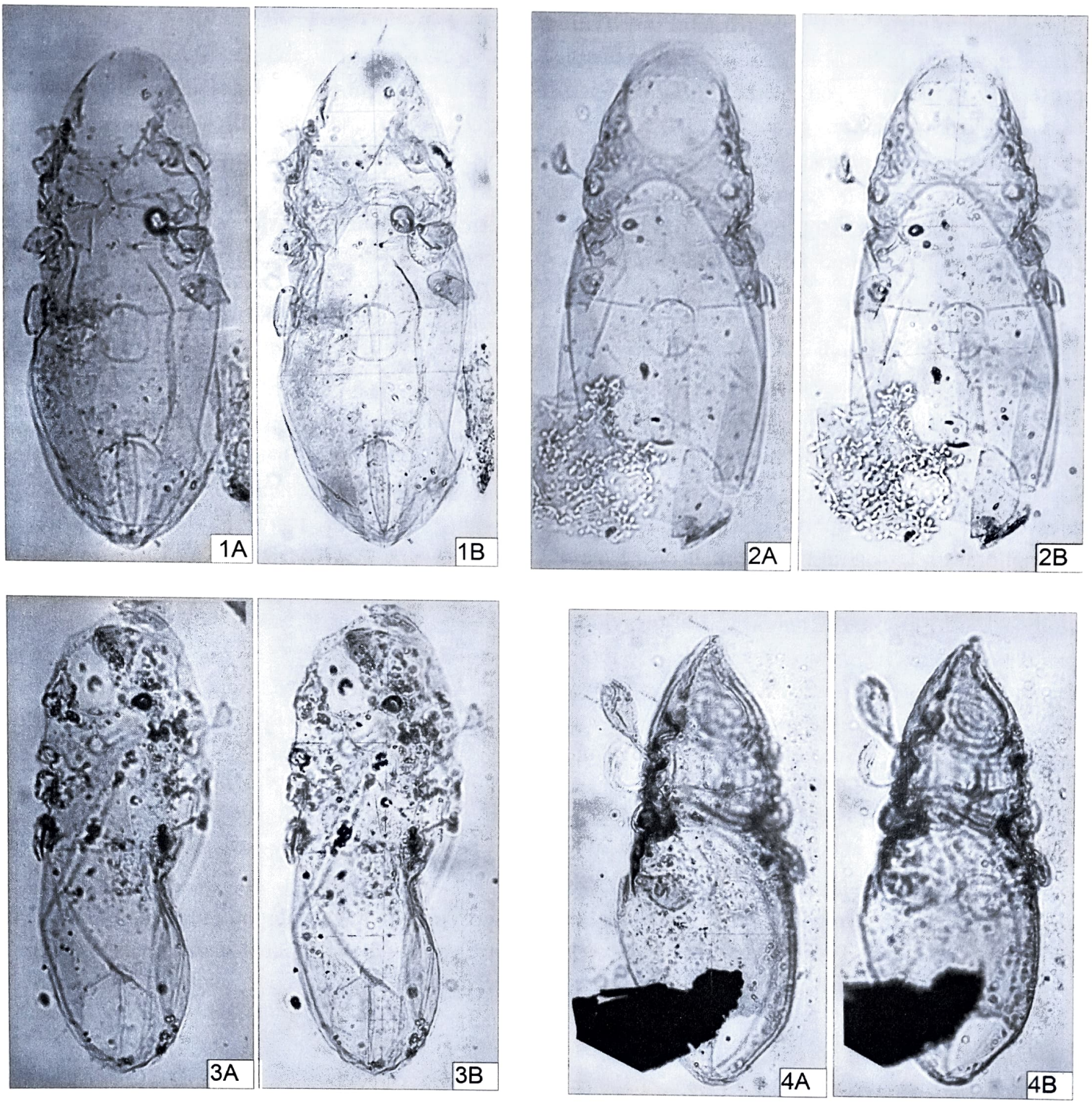

Plate 2

Birbal Sahni from the intertrappean beds of Worli Hill, Mumbai, western India. This acarien specimen is well preserved and shows well defined morphological features. The present specimens are similar to the Mani's specimen in having elongate, pyriform, minute body covered with long, needle shaped setae. However, it is difficult to compare present specimen in view of the fact that type specimen is not available for further examination.

CLIMATE, HABITAT AND AGE

The interpretation of the climatic relation of the fossil acariens and their age are based on the palynofloral assemblage recovered from these deposits and by linking their affinity with the modern families. The presence of some key spore-pollen taxa within the palynofloral assemblage also throws light on the age of deposits. The palynoflora of the Intertrappean bed studied by Saxena and Ranhotra (2009) includes pteridophytic spores, angiospermous pollen and fungal remains (Plate 3, figures 1-20). Among pteridophytes, the spores identified as *Dictyophyllidites laevigatus* and *Intrapunctisporis intrapunctis* show their affinity to modern families Matoniaceae and Schizaeaceae respectively, which are chiefly tropical. Whereas the spores affiliated to Polypodiaceae, Osmundaceae and Azollaceae are cosmopolitan. Among angiosperms, the pollen having their affinity to modern herbs, such as Poaceae, Liliaceae, Typhaceae, Asteraceae and Brassicaceae, are cosmopolitan and range from tropical to temperate climatic conditions. The pollen of tree taxa, *Palmidites plicatus* and *Lakiapollis ovatus*, are attributed to families Arecaceae and Bombacaceae respectively. Arecaceae represents subtropical to tropical climate whereas Bombacaceae is a tropical rain-forest element (Table 1). Overall assemblage from the Intertrappean bed also includes vesicular-arbuscular mycorrhizal fungi as well as other fungal remains such as *Polycellaesporonites* (cf. *Alternaria* sp.), *Frasnacritetrus* (cf. *Tetraploa* sp.), *Phragmothyrites* sp., etc. This suggests warm tropical climatic conditions prevailing during the course of deposition that changed from semi-arid to humid. Similar palynofloral studies were also carried out on the acarien yielding Gypseous Shale Member of the Naredi Formation and the palynoflora recovered have good amount of fungal elements, viz. *Palaeomycites* sp., *Frasnacritetrus* spp., *Inapertisporites kedvesii* and *Polycellaesporonites* spp. The spores-pollen are represented by *Monolites mawkmaensis, Spinainperturites densispinus, Monocolpopollenites kutchensis, Inaperturo-pollenites* sp., *Retipilonapites arcotensis, Graminidites media, Tripilaorites triangulus*, etc. In one of the samples, pollen of Asteraceae and Caryophyllaceae type were recovered in bunches. Besides, the algal spores were also recovered (Plate 4, figures 1-15). Presence of terrestrial angiosperms and pteridophytes, along with good assemblage of fungal elements, indicates presence of good ground vegetation cover under warm and humid

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Plate 3

Palynoassemblage from the Intertrappean Bed. 1. *Compositoipollenites argutus* Sah 1967, slide no. 13526/10. 2. *Typha* type pollen, slide no. 13533/24. 3. *Ladakhipollenites minutus* (Sah & Kar 1970) Mathur & Jain 1980, slide no. 13529/11. 4. *Compositoipollenites conicus* Sah 1967, slide no. 13530/3. 5. *Lakiapollis ovatus* Venkatachala & Kar 1969, slide no. 13531/15. 6. *Azolla* sp., slide no. 13530/17. 7. *Dictyophyllidites laevigatus* Kar 1985, slide no. 13528/10. 8. *Graminidites media* Cookson 1947, slide no. 13534/25. 9. *Triangulotricolporites triangulus* Kar 1985, slide no. 13529/12. 10. *Polypodiaceaesporites intrapunctatus* Kar & Jain 1981, slide no. 13528/4. 11. *Matanomadhiasulcites* sp., slide no. 13529/5. 12. *Palaeomycites acinus* (Srivastava 1968) Kalgutkar & Jansonius 2000, slide no. 13535/15. 13. *Frasnacritetrus conatus* Saxena & Sarkar 1986, slide no. 13528/4. 14. *Palaeomycites horneae* (Kidston & Lang 1921) Kalgutkar & Jansonius 2000, slide no. 13534/9. 15. *Parmathyrites* sp., slide no. 13535/1.16. *Polycellaesporonites* sp., slide no. 13533/23. 17. *Polycellaesporonites alternariatus* (Kalgutkar & Sigler 1995) Kalgutkar & Jansonius 2000, slide no. 13527/8. 18. *Phragmothyrites lutosus* (Dilcher 1965) Kar & Saxena 1976, slide no. 13530/13. 19. *Inapertisporites ovalis* Sheffy & Dilcher 1971, slide no. 13537/6. 20. *Dictyosporites tirumalacharii* (Ramanujam & Ramachar 1980) Kalgutkar & Jansonius 2000, slide no. 13536/18.

Table 1. Botanical affinities of palynofossils from the Intertrappean Bed and present day distribution of the families

Botanical Groups/Families	Palynotaxa	Present day distribution
Pteridophyta		
Azollaceae	*Azolla* sp.	Cosmopolitan, abundant in tropical regions, small, floating, aquatics.
Matoniaceae	*Dictyophyllidites laevigatus*	Chiefly tropical
Schizaeaceae	*Intrapunctisporis intrapunctis, Lygodiumsporites lakiensis*	Chiefly tropical
Osmundaceae	*Todisporites major*	Cosmopolitan, terrestrial to subaquatic ferns
Polypodiaceae	*Monolites singhii, Polypodiaceaesporites intrapunctatus*	Cosmopolitan, prefers shady habitat
Angiospermae		
Poaceae	*Graminidites media*	Cosmopolitan, mainly herbs
Arecaceae	*Palmidites plicatus*	Tropical-subtropical
Liliaceae	*Matanomadhiasulcites* sp.,	Cosmopolitan, abundant in warm-temperate and tropical regions
Typhaceae	*Typha* type pollen	Cosmopolitan, perennial herbs of open marshes
Asteraceae	*Compositoipollenites argutus, C. conicus*	Cosmopolitan herbs, grow in all habitats
Brassicaceae	*Ladakhipollenites minutes*	Cosmopolitan, primarily in northern hemisphere
Bombacaceae	*Lakiapollis ovatus*	Tropical

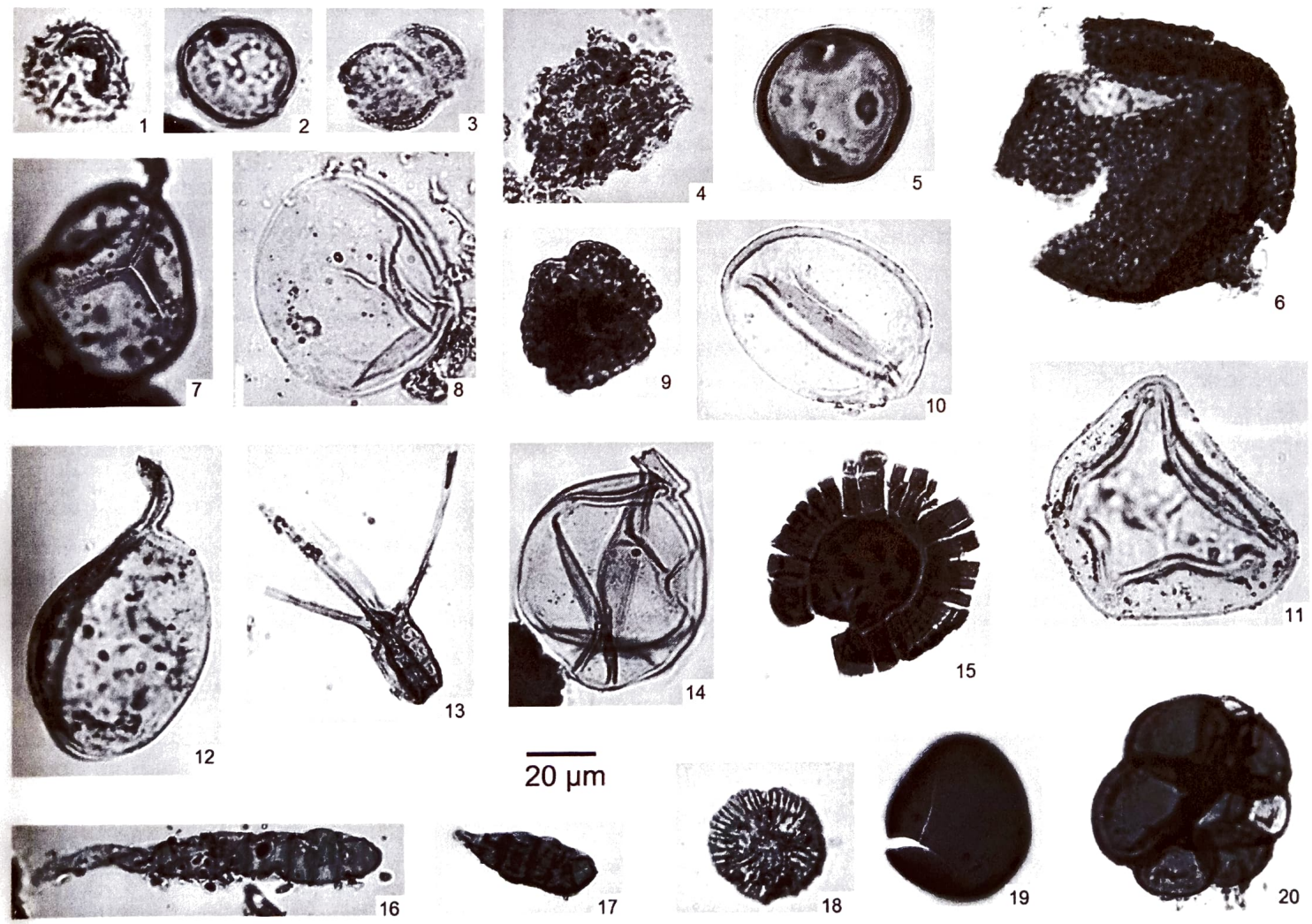

Plate 3

conditions that supported the symbiotic as well as saprophytic relationship with these fungi (Table 2). In other palynofloral assemblages from different exposures and subsurface samples of the Naredi Formation, earlier carried out by Venkatachala and Kar (1969), Sah and Kar (1970) and Kar (1978, 1985), it has been observed that the palynoflora recovered from the Intertrappean bed extends into the Naredi Formation also, with various other palynomorph types, viz. *Cyathidites, Gleicheniidites, Biretisporites, Dandotiaspora, Deltoidospora, Foveosporites, Osmundacidites, Laevigatosporites, Seniasporites, Podocarpidites, Laricoidites, Tripilaorites, Clavatipollenites, Arecipites, Proxapertites, Dracaenoipollis, Neocouperipollis, Spinizonocolpites, Spinainperturites, Marginipollis, Ailanthipites, Monocolpopollenites, Inaperturopollenites, Retipilonapites, Araliaceoipollenites*, etc., showing floral diversification. The other palynomorphs recorded from the Naredi Formation include pollen having affinity with mangrove vegetation, e.g. Sonneratiaceae, Rhizophoraceae, Barringtoniaceae, Nypaceae, etc. and also to chiefly tropical families, e.g. Aracaceae, Clusiaceae, Bombacaceae, Mimosaceae, Schizaeaceae, Ceratopteridaceae, Matoniaceae, etc. These assemblages strongly support the warm tropical climatic conditions during the deposition of beds.

As the acariens are reported from the Intertrappean bed as well as from the Naredi formation, it can be surmised that these acariens also thrived in the warm tropical climate under semi-arid to humid conditions. This is the first report of fossil acariens from the Tertiary of Kutch, western India. But the mites (Acarina) have been reported previously by other workers also. In India, Mani (1944) reported similar acarina types from Tertiary deposits of Worli Hills of Mumbai and named them *Gamasus fossilis*. However, the study by Mani (loc. cit.) did not throw light on the behaviour, habitat and climatic relationship of the fossil acariens. Recently acarina types are also found trapped along with other

Table 2. Botanical affinities of palynofossils from the Naredi Formation and present day distribution of the families

Botanical Groups/Families	Palynotaxa	Present day distribution
Pteridophyta		
Polypodiaceae	*Monolites mawkmaensis*	Cosmopolitan
Angiospermae		
Proteaceae	*Tripilaorites triangulus*	Cosmopolitan
Poaceae	*Graminidites media*	Cosmopolitan, mainly herbs
Arecaceae	*Monocolpopollenites kutchensis*	Tropical-subtropical
Incertae sedis	*Inaperturopollenites punctatus*	-
Families from previous works		
Sonneratiaceae	*Sonneratioipollis bellus*	Tropical
Rhizophoraceae	*Pellicieroipollis langenheimii*	Tropical
Barringtoniaceae	*Marginipollis kutchensis*	Tropical
Nypaceae	*Spinizonocolpites echinatus*	Tropical
Bombacaceae	*Lakiapollis ovatus*	Tropical

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Plate 4

Palynoassemblage from the Naredi Formation. 1-2. *Tripilaorites triangulus* (Sah & Kar 1970) Kar 1985, slide no. 14105/3. 3. *Podocarpidites* sp., slide no. 14105/1. 4. *Spinainperturites densispinus* Venkatachala & Rawat 1972, slide no. 14107/2. 5. *Graminidites media* Cookson 1947, slide no. 14103/4. 6. *Monocolpopollenites kutchensis* (Venkatachala & Kar 1969) Saxena 2010, slide no. 14105/9. 7. *Inaperturopollenites punctatus* (Saxena 1979) Saxena & Bhattacharyya 1987, slide no. 14106/7. 8. *Retipilonapites arcotensis* Ramanujam 1966, slide no. 14103/1. 9. *Polycellaesporonites* sp., slide no. 14106/14. 10, 12. *Palaeomycites robustus* (Kar 1979) Kalgutkar & Jansonius 2000, slide no. 14106/6 (30), 14106/5 (32). 11. *Monolites mawkmaensis* Sah & Dutta 1966, slide no. 14105/2. 13. *Frasnacritetrus indicus* Saxena & Khare 1992, slide no. 14105/4. 14. *Frasnacritetrus conatus* Saxena & Sarkar 1986, slide no. 14105/7. 15. *Inapertisporites kedvesii* Elsik 1968, slide no. 14104/3.

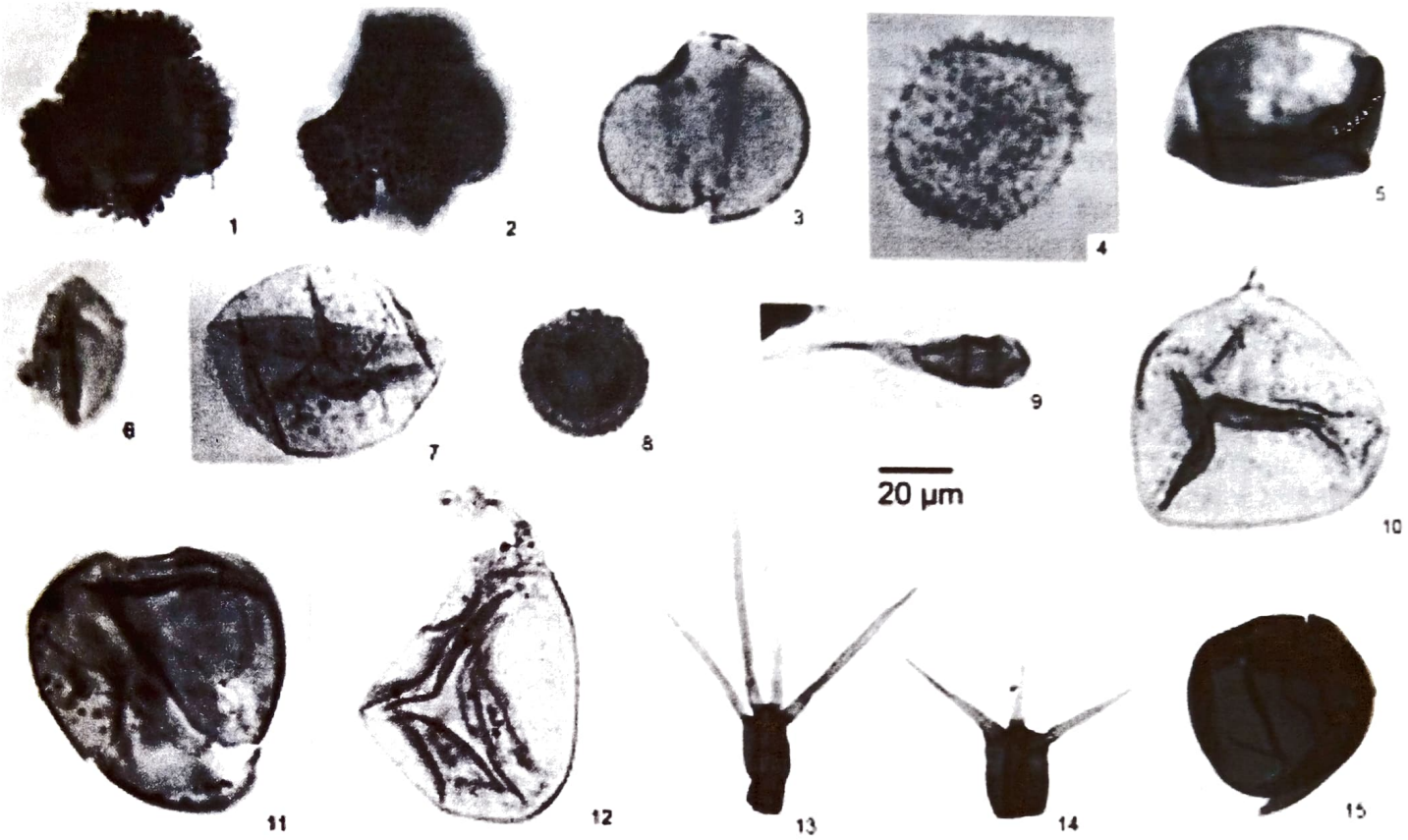

Plate 4

microfossil types in the amber of Middle Miocene age from western Amazonia (Antoine et al. 2006). The study also includes palynological assemblage recovered from the amber and, on that basis, the authors suggested warm tropical climate where these acariens thrived.

The affinity of these recovered fossil acariens with the other acarina types shows that most of them are very small to microscopic. Some of them are errant, of which some are found under stones, in soil, water, even on the bark and leaves of trees. Some are also found on old dried edible things and putrescent animal matters. While others are parasites living on skin and flesh of various animals. On that basis, it can be said that the recovered fossil acariens might have lived / fed on the plants / animals as parasites.

The recovered fossil mites can be assigned to Early Palaeocene to Early Eocene based on some key palynofossils from the Intertrappean bed and Naredi Formation. *Matanomadhiasulcites* and *Lakiapollis* are typical Palaeocene-Early Eocene elements and do not occur in older sediments. These taxa are common in Matanomadh Formation (Palaeocene) of Kutch (Saxena 1979). *Monolites singhii, M. mawkmaensis, Polypodiaceaesporites intrapunctatus, Compositoipollenites argutus, C. conicus, Graminidites media,* etc. are long ranging taxa and are found in younger sediments as well. However, they do not extend to the sediments older than Palaeocene (Saxena & Ranhotra 2009).

ACKNOWLEDGEMENT

The authors are grateful to the Director, Birbal Sahni Institute of Palaeobotany, Lucknow (India) for permission to publish the paper.

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