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Further report on megaspores from the Triassic of Nidpur, Madhya Pradesh, India

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ABSTRACT. The megaspore assemblage from the Nidpur Triassic beds described in the present article is comprised of four new species belonging to *Duosporites*, *Grambastisporites*, and *Mammilaespora*. They occur as compressions embedded within the siliceous shales. The genus *Duosporites* is being described for the first time from the Indian Triassic while the species of the two remaining taxa, *Grambastisporites* and *Mammilaespora* have been reported earlier from Nidpur beds. Surprisingly however, no representatives of the two above mentioned genera have been so far reported from any other Triassic locality of peninsular India, although some species of *Mammilaespora*, have been reported from Indian Lower Gondwana. *Grambastisporites* seems to be restricted strictly to the Nidpur Triassic. All the megaspores described herein are structurally preserved, showing ornamented sexine and pitted or unpitted nexine. They are significantly distinct from the related, earlier described species. This report shows that the Nidpur Triassic megaspore assemblage was taxonomically diverse, indicating presence of lycopsid-like plants in the area.

KEYWORDS: megaspores, taxonomy, Middle Triassic, Nidpur, India

INTRODUCTION

In the recent past a lot of valuable information has been contributed towards the investigation of megaspores from Gondwana sediments of India. All megaspores have been reported in the dispersed state and are presumed to show affinity with the Selaginellales. However, compared to the vast report on megaspores from the Lower Gondwana sediments, reports of Triassic megaspores from Middle Gondwana of Indian sub-continent are scanty. The first publication on mud-filled casts of Triassic megaspores was published by Sitholey (1943) and two decades later Pant & Srivastava (1964) described a few structurally preserved megaspores from the Salt Range locality in Punjab (now in Pakistan, see Balme, 1970). Two years prior to this report, first record of megaspores from Parsora beds of South Rewa Gondwana basin India, was made by Lele (1962). Later, structurally preserved megaspores, were also reported for the first time from Early Triassic, Maitur Formation in West Bengal by Maheshwari & Banerji (1975). An account of Late Triassic megaspores from the Janar Nala section of South Rewa Gondwana Basin had also been published by Banerji et al. (1978). One year later Pant & Basu (1979) reported structurally preserved megaspores from Middle Triassic, Nidpur beds of Madhya Pradesh, India. In addition to the above, another Triassic megaspore assemblage was reported many years later from the Panchet Formation of East Bokaro Coalfield, India (presumed to be late Early Triassic in age) by Pal et al. (1997). From the above reports it is quite obvious that megaspore producing plants formed an integral part of the Triassic vegetation in peninsular India from Early to the Late Triassic Period. Although heterospory is known to occur in diverse groups of vascular plants like the sphenopsids, noeggerathiopsids, filicopsids and the lycopsids, the megaspore assemblage from the Nidpur beds clearly indicated presence of lycopsid members

as components of the vegetation (Pant & Basu 1979) as *in situ* megaspores of no other group exhibited such pronounced ornamentation in the exine as the lycopsids. The taxonomic diversity of the megaspore assemblages also indicated occurrence of more than one type of lycopsid member in the area but we cannot explain why lycopsid macrofossils have not been so far reported from the Triassic.

In the present article three out of the four megaspore species have been assigned to previously reported genera, described earlier from the Triassic of Nidpur (Pant & Basu 1979) and the fourth taxon is a new species of *Duosporites* Høeg et al. 1955. The morphotaxon *Duosporites* is being reported from Indian Triassic for the first time.

GEOLOGY

The studied material was extracted from shales collected from the Nidpur beds which occur in the Gopad River section in the western part of Singrauli Coalfield, Sidhi District, Madhya Pradesh, India. The sediments which are exposed downstream on the bank of the Gopad River about 2 km NE of Nidpur village (24°7′: 81°52′) are found between two faults, F^2 and F^3 (see Fig. 1, A, B). The area south of the confluence of Sehra Nala with Gopad River has been considered to be the "Nidpur beds" and the area as "Marhwas area" (Tiwari & Ram-Awatar 1989). The Marhwas area is located in the Singrauli basin and the Nidpur beds occupy the western location of the basin. It occurs at the junction of the Damodar, Satpura and Son-Mahanadi grabens.

The dispersed megaspore assemblage belongs to the Triassic Gondwana succession occurring in the South Rewa Gondwana basin in peninsular India. The estimated age correlated on the basis of palaeontological and lithological characters is Middle Triassic (see Table 1, after Ghosh & Banerji 2007). Even the earlier described megaspores from the Nidpur beds have been mentioned as being of Middle Triassic in age (Pant & Basu 1979, Kovach & Batten 1989).

The country around Marhwas and the Nidpur village is flat alluvial plain with exposed Triassic sediments in river cuttings. The Nidpur beds along the Gopad River cuttings contain carbonaceous compressions preserved on

Table 1. A generalized classification of Triassic Gondwana in peninsular India (after Ghosh & Banerji 2007)

Standard scale \ Gondwana basins			Damodar valley basin	Koel valley basin	Rajmahal basin	South Rewa basin	Satpura basin	Pranhitagodavari valley basin	Mahanadi valley basin
Lower jurassic						Hartala Hill beds Tiki Formation			
Triassic	Upper	Rheatian						Dharmaran Formation	Pathargarh beds
		Norian			Dubrajpur Formation			Maleri Formation	
		Carnian	Supra-Panchet Formation	Mahadeva Formation		Parsora Formation	Bagra beds		
	Middle	Ladinian					Denwa Formation	Bhirmaram Formation	
		Anisian				Nidpar beds	Pachmari Formation Almod Formation	Yerrapallii Formation	
	Lower	Sythian	Panchet Formation	Panchet Formation		Panchet Formation		Mangli beds	Sarimunda Hill beds
Upper Permian			Ranigaj Formation	Ranigaj Formation		Pali Formation	Bijori Formation	Kamthi Formation	Hinjrida Ghati/ Kamthi Formation

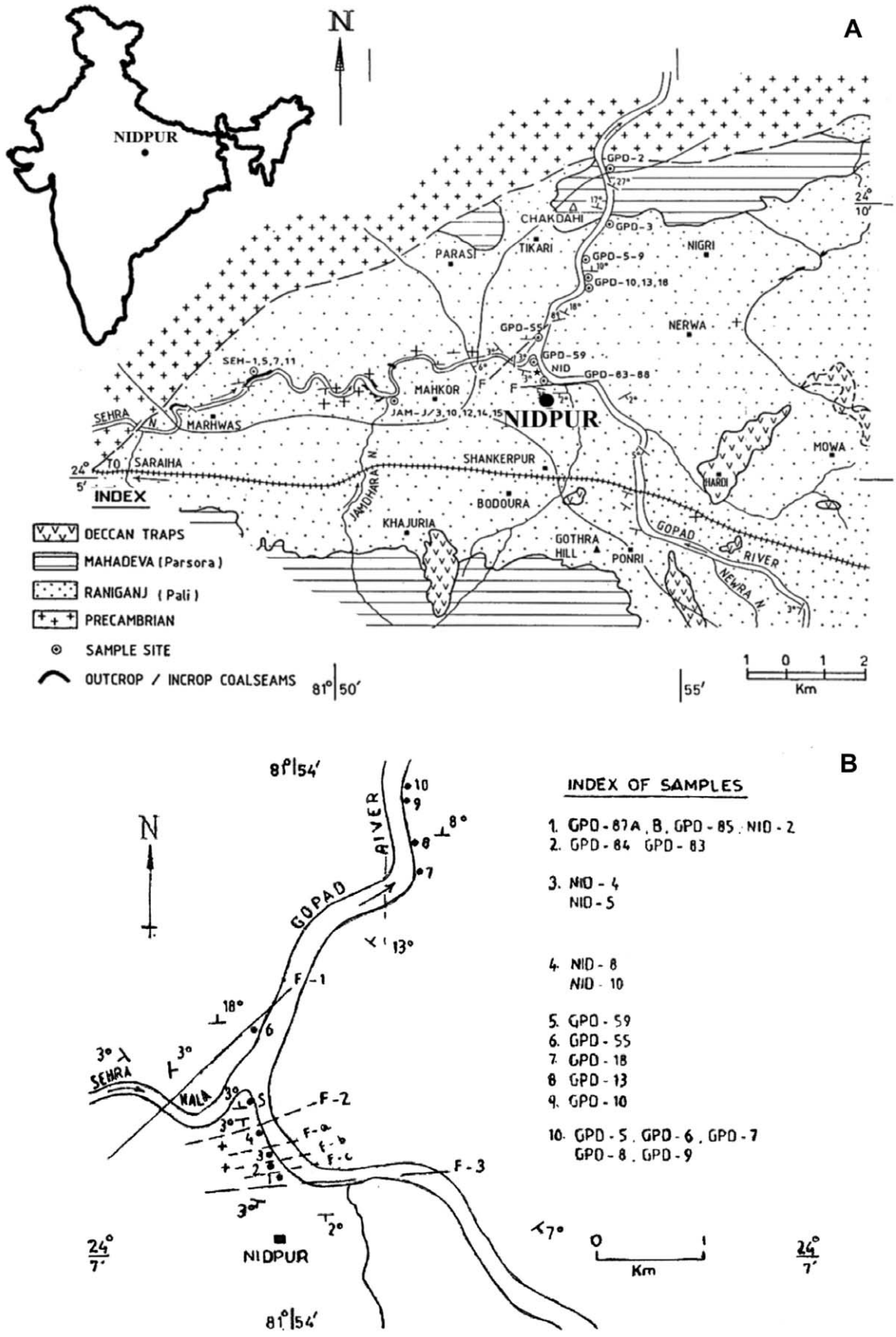

Fig. 1. A. Geological map of north-western part of Singrauli Coalfield showing Marhwas area, where the Nidpur beds (asterisk) are situated. The yielding samples, marked by dot within a circle, are indicated along the traverses taken. NID (asterisk) indicates the position of sample Nos. NID-4,5,8,10 whose details are given in Fig. B (after Raja Rao 1983). **B**. Gopad River section enlarged to show Nidpur beds between Fault F2 and F3; location of yielding samples also depicted (after Raja Rao 1983)

grey coloured, medium grained, micaceous shale (see Majumdar 1981). The heterogeneous nature of plant remains littered on shales of the Nidpur bed appear to indicate an allochthonous mode of deposition rather than an *in situ* burial prior to fossilization.

MATERIAL AND METHODS

Megaspores were extracted out of the rock matrix by the bulk maceration technique wherein large pieces of the siliceous shales were immersed in 40% hydrofluoric acid for 5 to 10 days. On dissolution of the shale substance carbonized residues of the scattered plant remains collected at the bottom of the container. The plant residues were later passed through a 100 mesh sieve to separate larger elements like seeds, microsporangia, cuticles, wood fragments, megaspores etc. from finer microspore material. The sieved residue was repeatedly washed in water before sorting out the compressed fossils under a low power binocular microscope (Olympus SZ 61). The collected megaspores were later dried, measured and photographed. Photographs of the megaspores were taken in dry state under strong unilateral light to show external details like extent and structure of trilete laesurae, arcuate ridges, contact areas, sexine ornamentation etc.

To observe features of inner sac / inner body / nexine, individual megaspores were macerated by Schulze's technique to make spores translucent and aid in separating the nexine from the spore coat. Generally, the inner sac tends to remain attached to sexine along a small area proximally and can be separated only with great difficulty. The semi-translucent macerated megaspores were then mounted on a glass slide in safranin stained glycerin jelly. All photographs were taken in Olympus microscope CH20i by Digital camera DSCW-70.

The megaspores and slide preparations are preserved in the Divya Darshan Pant Museum, Botany Department, Allahabad University, Allahabad, India.

SYSTEMATIC DESCRIPTIONS

According to Tewari (2005), earlier identification of dispersed megaspores was chiefly based on shape, nature of trilete mark and structure of walls. Identification of Lower Gondwana megaspores was made for the first time by Zeiller (1895) and later, on external morphology by Surange et al. (1953). In recent times too, megaspore identification is largely dependant on spore shape, trilete features and structure of wall layers. Two wall layers have been identified – sexine or outer wall layer, which is generally ornamented and nexine or inner wall layer, which is reportedly unornamented (Looy et al. 2005). Although sexine ornamentation is helpful to a large extent in spore identification, features of nexine / mesosporium / inner body / basal lamina are of no less importance because as Høeg et al. (1955) suggested, nexine added more characters towards megaspore taxonomy. Even the presence or absence of pits / cushions and their mode of arrangement provide significant identification characters. Besides, Høeg et al. (1955) also believed that, "a megaspore is not completely known until the mesosporium, if available at all, has been studied." It seems possible that such extended knowledge may have some influence on the classification of megaspores. In support of the above statement Høeg et al. (1955), cited the example of a spore which in the absence of a mesosporium would have been regarded as a species of *Laevigatisporites* Ibrahim 1933, a form genus characterized by its shape and surface ornamentation only.

Even Spinner (1969), considered concentrating on either the surface morphology or that of the inner body (mesosporium) as helpful in megaspore taxonomy but questioned the value of nipple-like projections as sole criterion at generic level. However, contrary to the opinion of Høeg et al. (1955), Glasspool (2003) regarded nexine features quite unimportant in megaspore classification. In his opinion features of inner body / basal lamina / mesosporium or nexine were not suitable as generic or specific criterion because results obtained were inconclusive and inconsistent. He also reiterated that alkali treatment used exclusively in the preparation of Indian megaspores, for revealing features of the inner body, destroyed diagnostic surface features. In the opinion of the present authors however, nexine features are significant characters for megaspore identification and they do not agree with Glasspool (2003) in excluding features of nexine / inner body / basal lamina, from generic or specific diagnosis of a morphotaxon. Moreover, megaspores of Nidpur assemblage are structurally so well preserved that no difficulty was encountered in separating the nexine from sexine sac during megaspore preparation. In fact nexine features of Nidpur megaspores have been very helpful in determining affinities.

Besides nexine, sexine ornamentation has also been considered to be of great significance in megaspore classification and in the present article a variety of ornamentation types ranging

from reticulate, verrucate, connate to spinate types have been reported. In megaspores with spinate sexine, both simple as well as multifurcate spines have been reported. Sexine / exosporium ornamentation pattern in the presently described morphotaxa seems to indicate a close affinity with heterosporous Lycopsida (Pant & Mishra 1986) although no lycopsid megafossil has so far been reported from the Nidpur beds.

Duosporites Høeg, Bose & Manum 1955

Type. *Duosporites congoenesis* Høeg et al. 1955

Duosporites indicus sp. nov.

Pl. 1, figs. 1–6

Holotype. Sl. No. 53,101.

Repository. Divya Darshan Pant Collection, Botany Department, Allahabad University, Allahabad, India.

Epoch. Middle Triassic.

Locality. Nidpur village, Marhwas area, Sidhi District, Madhya Pradesh, India.

Etymology. The specific name *indicus* is after India.

Diagnosis. Megaspore trilete, amb roundly-triangular in proximo-distal orientation. Trilete rays distinctly raised, undulate, extending beyond arcuate rims almost to the equator by folds of sexine. Rays often becoming widest at periphery being about 35 µm wide. Arcuate ridges and contact areas conspicuous, clearly discernible. Arcuate ridge overlapping a narrow groove surrounding the periphery of contact area. Contact areas almost smooth, slightly swollen in proportion to the rest of the wall. Sexine 20–25 µm thick, microreticulate, sexine surface ornamented by coni to verrucae. Nexine subtriangular, thick walled, about ½ the size of entire megaspore, proximally showing impression of trilete mark. Rows of large sized, dark coloured almost circular pits averaging about 14–18 µm in diameter are situated along the rays. Often nexine is folded along outline of attachment area in the form of a border.

Dimensions. Megaspore diameter 400–450 µm, laesura 260–270 µm long, 15 µm wide, at the periphery 35 µm wide, in the mid-way along the ray laesura 25 µm high. Contact face diameter 265 µm, arcuate ridge 10 µm wide and 8 µm high. Proximal and distal ornament 8 µm high, in the base 8–10 µm wide, nexine diameter 225 µm.

Remarks. Although the type species of the genus *Duosporites congoenesis* Høeg et al. 1955 and several other species were earlier reported from Lower Gondwana beds of India (Bharadwaj & Tiwari 1970, Pant & Srivastava 1962, Kar 1968, Lele & Chandra 1974, Pant & Mishra 1986, Tewari & Maheshwari 1992, Jha et al. 2006) the genus is being reported for the first time from Indian Triassic and the Nidpur beds.

Comparison. The new species is represented by two complete specimens and a number of incomplete ones, but shows distinct characters of *Duosporites.* The new species, *D. indicus* differs from the type species *D. congoenesis* Høeg et al. 1955 in having a thick, triangular, peripherally folded nexine showing a uniseriate row of large sized pits. In *D. congoenesis*, nexine is translucent and rounded with a regular row of pits along trilete mark (see Table 2).

Duosporites indicus sp. nov. is also comparable to *D. multipunctatus* Høeg & Bose 1960 in having a subtriangular nexine but differs in lacking triangularly arranged multiseriate pits along branches of trilete mark. Our new species also resembles *D. irregularis* Bharadwaj & Tiwari 1970, which reportedly has a similar sub-triangular nexine but differs from it by having massive and irregularly arranged pits on nexine. Another comparable species *D. dijkstrae* Bharadwaj & Tiwari 1970 remotely resembles *D. indicus* sp. nov., in having a roundly triangular nexine but differs in bearing biseriately arranged pits along trilete mark. Two more species of *Duosporites*, *D. nitens* and *D. vulgatus* (Pant & Srivastava 1962) resemble *D. indicus* sp. nov. in a number of features but show significant difference in size and morphology. *Duosporites nitens*, is of much larger size (636–1050 µm in diameter) and shows indistinct contact areas, and *D. vulgatus* differs in having a nexine bearing multiseriate row of pits. *D. neerjaiae* Tewari & Maheshwari 1992 is also comparable to *D. indicus* sp. nov. in having a triangular, thick walled nexine but the pits are numerous and irregularly arranged around trilete mark. Still another species *D. inequalis*, reported by Pant & Mishra (1986), differs from *D. indicus* sp. nov. in having unequal trilete rays and in the arrangement of pits on the nexine.

Table 2. Comparison of species of *Duosporites* Høeg, Bose & Manum 1955

Species of *Duosporites*	Age & type locality	Megaspore shape & size	Trilete mark & laesurae	Arcuate ridge & contact area	Sexine ornamentation	Nexine shape & size	Cushions / pits
D. congoensis Høeg et al. 1955 Type species	Permian; Luena Kisulu, Belgian Congo	Sub-spherical to slightly triangular, 350–850 µm in diameter	Conspicuous; undulate, extending up to equator	Distinct; conspicuous	Granulose; granules 1 µm in diameter	Circular; ca. ½ of the spore diameter, translucent	Uniseriately arranged
D. multipunctatus Høeg & Bose 1960	Permian; Luena Kisulu, Belgian Congo	Sub-circular; 378–495 µm in diameter	Well defined; straight-slightly sinuous, extending beyond arcuate ridges	Low; well- defined	Verrucose; verrucae 4–8 µm high	Sub-triangular; —	Multiseriately arranged
D. irregularis Bharadwaj & Tiwari 1960	Permian; South Karanpura Coalfield, India	Sub-triangular; 250–350 µm in diameter (dry), 420–510 µm in diameter (wet)	Raised; sinuous extending beyond the contact mark	Raised; —	Verrucose; verrucae 4–8 µm high	Sub-triangular; 200–230 µm in diameter	Irregularly arranged
D. dijkstrae Bharadwaj & Tiwari 1960	Permian; Rio Grande do Sul, Brazil	Sub-triangular; 496–636 µm in diameter(dry), 636–840 µm in diameter (wet)	Distinct; extending across contact mark	Low; distinct	Granulose; —	Roundly-triangular; ⅓ of spore diameter, translucent	Biseriately arranged
D. katrinalaensis Bharadwaj & Tiwari 1960	Permian; Jharia Coalfield, India	Triangular to sub-triangular; 340–480 µm in diameter(dry), 500–700 µm in diameter (wet)	Distinct; straight, narrow, pointed at periphery	Indistinct; not visible	Finely verrucose; verrucae 2–4 µm in diameter	Sub-triangular; large, folded	Irregularly arranged
D. vulgatus Pant & Srivastava 1962	Permian; Rio Grande do Sul, Brazil	Roundly-triangular; 380–560 µm in diameter (dry), 483–789 µm in diameter (wet)	Distinctly raised; —	Raised; well defined	Granulose; —	Roundly-triangular; 381–483 µm in diameter, thin, translucent	Irregularly arranged in three rows
D. nitens Pant & Srivastava 1962	Permian; Santa Catarina Coalfield, Brazil	Circular to sub-circular; 636–1050 µm in diameter (dry), 636–1196 µm in diameter (wet)	Distinct; falling short of equator	Raised; indistinct	Granulose; —	Rounded; more than ½ the spore sac diameter, thin, translucent	Uniseriately arranged
D. inequalis Pant & Mishra 1986	Lower Gondwana; Birsinghpur Coalfield, India	Roundly-triangular; 535–640 µm in diameter (wet)	Distinct; sinuous, of unequal length	—; —	Granulose to verrucose; verrucae 10 µm high	Roundly-triangular; 300 µm in diameter, membranous	Arranged triangularly
D. neerjaiae Tewari & Maheshwari 1992	Early Permian; Mohpani Coalfield, India	Triangular; 468×442 µm in diameter (dry)	Distinct; straight, of unequal length	ill-developed; prominent	Verrucose, verrucae 7–13 µm × 3–7 µm	Triangular; 384 × 244 µm in diameter, transparent, thick walled	Irregularly arranged
D. indicus sp. nov.	Middle Triassic; Nidpur, India	Roundly-triangular; 400–450 µm in diameter (dry and wet)	Distinctly raised; undulate, extending beyond arcuate ridge	Distinct; conspicuous	Conate – verrucose; coni 8 × 8–10 µm	Sub-triangular; 225 µm in diameter, thick walled	Uniseriately arranged

A comparable species *Gundalaspora spinosa* Jha et al. 2006 is larger (500–530 µm in diameter.), and has tri-radiate ridges that end at arcuate ridges. Sexine ornamentation is also different in the two taxa, while it is conate to verrucate in *D. indicus* sp. nov., it is reportedly spinate in *G. spinosa*. The pits in *G. spinosa* are arranged trigonally around the trilete mark.

Grambastisporites Pant & Basu 1979

Type. *Grambastisporites nidpurensis* Pant & Basu 1979

Grambastisporites major sp. nov.

Pl. 1, figs. 7–12

Holotype. Sl. No. 53,151.

Repository. Divya Darshan Pant Collection, Botany Department, Allahabad University, Allahabad, India.

Epoch. Middle Triassic.

Locality. Nidpur village, Marhwas area, Sidhi District, Madhya Pradesh, India.

Etymology. The specific name *major* is after the large size.

Diagnosis. Megaspores trilete, amb circular to sub-circular, trilete rays discernible, about ½ the length of radius, straight to undulate, not reaching the equator, laesurae appearing equally thickened all along. Arcuate ridges and contact areas obscure. Sexine about 25 µm thick, showing evenly distributed spines with bases connected by a weak reticulum on contact areas and entire distal face. Muri appearing spinulose along spore margin, spine apices blunt, straight or curved. Spines or muri of sexine also showing fine microreticulations. Nexine smaller than sexine sac, membranous, circular or oval, pitted. Pits (7 µm in diameter) irregularly arranged along tri-radiate mark.

Dimensions. Megaspore diameter 570–590 µm, laesura 185–190 µm long, 30 µm wide, in the mid-way along the ray laesura 15 µm high. Contact face diameter 345 µm, proximal and distal ornament 18–25 µm high and 10–12 µm wide in the base, nexine diameter 315 µm.

Comparison. Specimens of the new species are abundantly represented in the megaspore assemblage from Nidpur. The macerate yielded more than twenty spores, out of which ten are almost complete and the rest incompletely preserved. The new species *Grambastisporites major* closely resembles the type species *G. nidpurensis*, earlier described from Nidpur beds, in having a similar shape, obscure arcuate ridges and contact areas, microreticulate sexine and in having a rounded nexine showing pits. It however differs in size, being almost 1.5 times larger as *G. nidpurensis* which is about 400 µm in diameter. Moreover, the trilete rays in *G. nidpurensis* are longer, running almost ¾ the length of spore radius. The diameter of nexine in *G. nidpurensis is* larger. However, despite these dissimilarities spores of the two species showed similarity in sexine structure. In both the species muri appear peripherally spinulose but the spines are longer in *G. nidpurensis*, up to 27 µm (see Table 3).

Mammilaespora Pant & Srivastava 1961

Type. *Mammilaespora superba* Pant & Srivastava 1961

Mammilaespora nidpurensis sp. nov.

Pl. 2, figs. 1–7

Holotype. Sl. No. 53,251.

Repository. Divya Darshan Pant Collection, Botany Department, Allahabad University, Allahabad, India.

Epoch. Middle Triassic.

Locality. Nidpur village, Marhwas area, Sidhi District, Madhya Pradesh, India.

Etymology. The specific name *nidpurensis* has been given after the Nidpur village.

Diagnosis. Megaspores trilete, amb circular to rounded triangular in proximo-distal orientation. Trilete rays not reaching the equator, sinuous, length unequal, two of approximately similar length and the third shorter. Width of laesurae similar. Arcuate ridges and contact areas obscure. Sexine about 25 µm thick, showing distally furcate processes having pointed tips. Processes usually more than once forked, distributed unevenly on spore surface, but repeatedly forked and dense along spore periphery. Processes sparse and less furcate towards centre on both proximal and distal faces. Nexine subtriangular, membranous, unpitted showing distinct trilete mark.

Dimensions. Megaspore diameter 400–470 µm, two longer laesura 170 µm, shorter 90 µm

long, 15–17 µm wide, in the mid-way along the rays laesura 9–10 µm high. Proximal and distal ornament 20–30 µm high and in the base 5–10 µm wide, nexine diameter 250 µm.

Comparison. Megaspores of *Mammilaespora nidpurensis* sp. nov. are well represented in the Nidpur beds (more than twenty five specimens). Most of them showed well preserved structural details. *Mammilaespora nidpurensis* sp. nov. differs from the type species *M. superba* Pant & Srivastava 1961, described from Talchir coalfield, India, in being larger (*M. superba* is 276 µm in diameter), and in having longer appendages (3–5 µm in *M. superba*, see Table 4). *Mammilaespora nidpurensis* sp. nov. also differs from *M. waltonii* Pant & Srivastava 1962, a species described from Brazil and Mhukuru coalfield, Tanganyika, in having an unpitted, trianguloid nexine. The nexine in *M. waltonii* is reportedly rounded, two layered and pitted. *M. nidpurensis* sp. nov. is also comparable to *M. sidhiensis* Pant & Basu 1979 and *M. grandis* Pant & Mishra 1986, reported earlier from the Indian sub-continent. While the former species *M. sidhiensis* is of Triassic age and has been described from the Nidpur beds (Pant & Basu 1979) the latter species *M. grandis* has been reported from the Lower Gondwana sediments of Singrauli Coalfield. Both are larger compared to *M. nidpurensis* sp. nov., *M. sidhiensis* is reportedly about 660 µm in diameter, and the size of *M. grandis* ranges between 520–800 µm. Moreover, *M. grandis* has longer appendages (40–80 µm), and in contrast to the subtriangular nexine in *M. nidpurensis* sp. nov., it is reportedly rounded in both *M. grandis and M. sidhiensis*. Moreover, the nexine of *M. grandis* has been reported as being both pitted as well as unpitted but nexine in the new species is always unpitted.

Remarks. It may be mentioned at the outset that Glasspool (2000) reassigned megaspores of *Mammilaespora sidhiensis* Pant & Basu 1979 to *Singhisporites* (Potonié) Glasspool 2000 as *S. sidhiensis* (Pant & Basu) comb. nov. on the basis of sexine characters. In our opinion, features of nexine / mesosporium / inner body are important diagnostic characters that cannot be overlooked in assigning a taxon under a particular genus and its description should not be excluded from the diagnosis. We therefore, do not agree with Glasspool's (2003) assignment of *Mammilaespora sidhiensis* to *Singhisporites* (Potonié) Glasspool as *S. sidhiensis* comb. nov., on the basis of sexine characters only, rather, we advocate its retention in *Mammilaespora* to which it was assigned initially by Pant & Basu (1979).

Mammilaespora royi sp. nov.

Pl. 3, figs. 1–10

Holotype. Sl. No. 53,201.

Repository. Divya Darshan Pant Collection, Botany Department, Allahabad University, Allahabad, India.

Epoch. Middle Triassic.

Locality. Nidpur village, Marhwas area, Sidhi District, Madhya Pradesh, India.

Etymology. The specific name *royi*, has been given after the reputed palynologist Prof. S.K. Roy.

Diagnosis. Megaspore trilete, amb circular to roundly triangular in proximo-distal orientation, trilete rays clearly discernible, laesurae sinuous reaching up to the periphery of the contact area which usually is defined by low arcuate ridges or differential ornamentation. Sexine proximally reticulate, lumina angular, muri raised. Distally sexine showing uniformly distributed simple or branched appendages of varied length, having blunt to acute distal endings. Frequently two or more adjacent appendages becoming fused throughout their entire length or only at tips and bases. Density of appendages highest along margin of spore showing a tendency to form zona-like structure at equator. Nexine thin, roundly-triangular, pitted. Pits uni to biseriate along sides of trilete mark, pit diameter 9 µm.

Dimensions. Megaspores diameter 620–650 µm, laesura 300–310 µm long, 15–20 µm wide, in the mid-way along the rays laesura 12 µm wide. Arcuate ridge 30–45 µm wide, distal appendage 40–75 µm high, in the base 8–15 µm wide, nexine diameter 350 µm.

Comparison. Megaspores of this new species are not as abundantly represented in the macerates as *M. nidpurensis* (seven specimens, only two complete). Megaspores of *Mammilaespora royi* sp. nov., differ from spores of *M. nidpurensis* in being larger, having apically blunt sexine appendages, and roundly-triangular pitted nexine (see Table 4). Megaspores

Table 3. Comparison of species of *Grambastisporites* Pant & Basu 1979

Species of *Grambastisporites*	Age & type locality	Megaspore shape & size	Trilete mark & laesurae	Arcuate ridge & contact area	Sexine ornamentation	Nexine shape & size	Cushions / pits
G. nidpurensis Pant & Basu 1979 Type species	Middle Triassic; Nidpur, India	Circular – sub-triangular; 400 µm in diameter (dry & wet)	Distinctly raised; straight, unevenly wide, extending nearly up to the periphery	Obscure; ill-defined	Reticulate, showing finer reticulum over raised ridges and depressions	Rounded; 315 µm in diameter (occupying ½ of spore sac), thin, granular	Irregularly arranged
G. major sp. nov.	Middle Triassic; Nidpur, India	Circular – sub-circular; 570–590 µm in diameter (dry & wet)	Less distinct; straight – undulate extending up to ½ the length of radius	Obscure; faintly visible	Spinose; basally forming reticulum	Circular-oval; 300 µm in diameter (occupying ¾ of spore sac), membranous	Irregularly arranged

Table 4. Comparison of species of *Mammilaespora* Pant & Srivastava 1961

Species of *Mammilaespora*	Age & type locality	Megaspore shape & size	Trilete mark & laesurae	Arcuate ridge & contact area	Sexine ornamentation	Nexine shape & size	Cushions / pits
M. superba Pant & Srivastava 1961 Type species	Lower Gondwana; Talchir Coalfield, India	Roundly-triangular; 276 µm in diameter (dry), 365 µm in diameter(wet)	Faintly distinct; almost straight, extending slightly more than ½ the spore radius	Indistinct; —	Rounded processes, divided apically into a number of mammilate lobes	Roundly triangular; 243 µm in diameter	Absent
M. waltonii Pant & Srivastava 1961	Lower Gondwana; Mhukuru Coalfield, Tanganyika, Africa	Almost rounded; 432–791 µm in diameter (dry), 509–992 µm in diameter (wet)	Distinct; straight, sometimes extending up to equator	Generally distinct but sometimes obscure; —	Branched processes; some spores showing a flange ca. 90 µm wide	Rounded; double layered, 432–560 µm in diameter	Present, irregularly arranged
M. sidhiensis Pant & Basu 1979	Middle Triassic; Nidpur, India	Circular or sub-circular; 660 µm in diameter	Indistinct; faintly undulate	Obscure; ill-defined	Surface microreticulate showing branched processes having distally furcate tips	Rounded; small, 290 µm in diameter	Absent
M. grandis Pant & Mishra 1986	Lower Gondwana; Singrauli Coalfield, India	Circular; 520–800 µm in diameter(dry), 575–1185 µm in diameter (wet)	Distinct; straight to slightly sinuous, extending up to ⅔ of spore radius	Absent; not delimited	elongated appendages having two –many blunt mammillate apical lobes	—; 520 µm diameter, translucent	Present or absent
M. nidpurensis sp. nov.	Middle Triassic; Nidpur, India	Circular – roundly-triangular; 400–470 µm in diameter (dry & wet)	Distinct; sinuous of unequal length, not extending up to equator	Faintly discernible; less distinct	Distally furcate processes having pointed tips; processes 20–30 µm high	Sub-triangular; 250 µm in diameter, membranous	Absent
M. royi sp. nov.	Middle Triassic; Nidpur, India	Circular – roundly-triangular; 620–650 µm in diameter (dry & wet)	Distinct; sinuous, extending up to periphery of contact area	Distinctly low; distinct	Differential ornamentation, proximally reticulate, distally showing simple – branched appendages having blunt – acute apices; appendages 40–75 µm high	Roundly-triangular; 350 µm in diameter, thin	Present, uni – biseriately arranged

of *M. royi* sp. nov., also differ from the type species *M. superba* Pant & Srivastava 1961, described from the Talchir coalfield, in India. The species *M. superba* is smaller (256 µm in diameter), bearing much shorter appendages (3–5 µm high). *M.royi* sp. nov. differs from *M. sidhiensis* in having distinctly raised arcuate ridges and a large sized pitted nexine. Arcuate ridges in *M. sidhiensis* are almost obscure, and nexine is smaller (290 µm in diameter) and unpitted. In *M. waltonii* Pant & Srivastava 1962, described from Brazil and Mhukuru coalfield, Tanganyika, the sexine appendages are shorter (10–40 µm) and apically pointed, and the nexine is double layered with outer layer showing irregularly arranged pits. The species *M. grandis* Pant & Mishra 1986, reported from the Lower Gondwana, Singrauli Coalfield, Madhya Pradesh, India differs from *M. royi* sp. nov. in lacking distinctly raised arcuate ridges and in having a nexine which may or may not be pitted. The nexine in *M. royi* sp. nov is always pitted. Megaspores of *M. royi* sp. nov. are also comparable to spores of *Singhisporites* Bharadwaj & Tiwari 1970, as both have contact areas defined by low arcuate ridges or differential ornament pattern but they differ in sexine pattern and nexine structure. In the type species *S. surangei*, sexine is covered with fleshy, simple or furcated, flat or ribbon-like processes of various shapes and sizes and the nexine is also different. It is not pitted. In *M. royi* sp. nov. the nexine is pitted.

DISCUSSION

Prior to this report many important contributions have been made towards the study of Mesozoic dispersed megaspores from the Indian Gondwana sediments (Sukh-Dev 1961, Singh et al. 1964; Maheshwari & Banerji 1975, Banerji et al. 1978, Pant & Basu 1979, Banerji et al. 1984, Pal 1991, Pal et al. 1997, Jana & Ghosh 1997, Pal & Sannigrahi 2002, Jana 2004) and from the Triassic succession of peninsular India alone, five different well diversified megaspore assemblages have been reported by Ghosh & Banerji (2007). Megaspores have only occasionally been involved in biostratigraphic zonation although Kovach & Batten (1989) have reported a number of species proving useful for stratigraphic zonation and correlation particularly in Europe. Out of the five assemblages reported from the Triassic succession of peninsular India (Ghosh & Banerji 2007) two belong to Lower Triassic of Panchet Formation and two to Upper Triassic of Tiki Formation. Both formations are characterized by many common genera like, *Banksisporites* Dettmann 1961, *Biharisporites* Potonié 1956, *Maiturisporites* Maheshwari & Banerji 1975 and *Verrutriletes* van der Hammen 1954. In addition to common genera, both Lower and Upper Triassic successions also revealed genera that were confined to respective successions only. Among them are genera like, *Jhariatriletes* Bharadwaj & Tiwari 1970, a tetralete form and *Umiaspora* Singh et al. 1964, known only from Lower Triassic assemblages, while genera like *Nathorstisporites* Jung 1958, *Triletes* Reinsch 1881, *Bokarosporites* Bharadwaj & Tiwari 1970, *Horstisporites* Potonié 1956, *Hughesisporites* Potonié 1956, *Bacutriletes* van der Hammen 1954, *Erlansonisporites* Potonié 1956, *Minerisporites* Potonié 1956, *Maexisporites* Potonié 1956, *Aneuletes* Harris 1961 are known from Upper Triassic Formations only.

Compared to the above assemblages however, the Middle Triassic megaspore assemblage from Nidpur beds is reportedly characterized by genera like *Grambastisporites* Pant & Basu 1979, *Trikonia* Pant & Basu 1979, *Mammilaespora* Pant & Srivastava 1961, *Lagenicula* Bennie & Kidston 1886 and *Banksisporites* Dettmann 1961. All the above except for *Banksisporites* Dettmann 1961, have so far not been reported from either Lower or Upper Triassic successions of peninsular India and are unique to the Nidpur beds alone. Besides the above mentioned taxa, another morphotaxon *Duosporites* Høeg et al. 1955, described in the present article, has not been reported so far from any of the Triassic Formations in India but for the Nidpur beds. Interestingly however, the genus *Banksisporites* (*Srivastavaesporites*) Dettmann 1961, is common in all the Triassic Formations, including Nidpur beds. According to Ghosh and Banerji (2007) the megaspore distribution pattern indicated prevalence of endemic taxa upto Middle Triassic (Nidpur beds) beginning from the Lower Triassic and occurrence of cosmopolitan genera like *Erlansonisporites*, *Horstisporites* etc. from Upper

Triassic. The present studies also reveal that though the megaspores described so far from the Nidpur beds included both lageniculate as well as non-lageniculate forms (Pant & Basu 1979), the assemblage seemingly exhibited less diversity as compared to the assemblages of Panchet (Lower Triassic) and Tiki Formation (Upper Triassic).

At the outset we may mention that the genus *Duosporites* is new to the Nidpur Triassic and is also being reported for the first time from Indian Triassic. The morphotaxon however, is not new to the Lower Gondwanas of the Indian sub-continent as several species of *Duosporites* have earlier been described from various Permian Formations of India (Pant & Srivastava 1961, Kar 1968, Bharadwaj & Tiwari 1970, Lele & Chandra 1974, Pant & Mishra 1986,Tewari & Maheshwari 1992, Glasspool 2003). Besides the Indian Permian, the genus has also been reported from the Carboniferous, Early Permian and Permian of Argentina, Tchad., Brazil, Central and South Africa (Pant & Srivastava 1961, Glasspool 2003). Compared to the widespread distribution of *Duosporites* in the Lower Gondwanas, its occurrence in the Triassic appears to be sparse, with a single species being reported from the Nidpur beds.

Species of other genera like *Mammilaespora* and *Grambastisporites*, have been reported earlier from here (Pant & Basu 1979). Interestingly, all above genera except *Grambastisporites,* have previously been reported from Indian Gondwanas (see Pant & Srivastava 1961, Kar 1968, Bharadwaj & Tiwari 1970, Lele & Chandra 1974, Maheshwari & Banerji 1975, Banerji et al. 1978, Pant & Basu 1979, Pant & Mishra 1986, Pal et al.1997, Tewari et al. 2004, 2009) and its non-representation in other Triassic Formations of peninsula India suggest an endemic nature of the same.

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REFERENCES

BALME B.E. 1970. Palynology of Permian and Triassic strata in the Salt Range and Surghar Range, West Pakistan. Univ. Kansas Press.

BANERJI J., JANA B.N. & MAHESHWARI H.K. 1984. The fossil flora of Kachchh – II, Mesozoic megaspores. The Palaeobotanist, 33: 190–227.

BANERJI J., KUMARAN K.P.N. & MAHESHWARI H.K. 1978. Upper Triassic *sporae dispersae* from the Tiki Formation: Megaspores from the Janar Nala Section, South Rewa Gondwana Basin. The Palaeobotanist, 25: 1–26.

BENNIE J. & KIDSTON R. 1886. On the occurrence of spores in the Carboniferous Formation of Scotland. Proc. R. Phys. Soc. Edinb., 9: 82–117.

BHARADWAJ D.C. & TIWARI R.S. 1970. Lower Gondwana megaspores – A monograph. Palaeontographica, B,129: 1–70.

DETTMANN M.E. 1961. Lower Mesozoic megaspores from Tasmania and South Australia. Micropaleontology, 7: 71–86.

GHOSH A.K. & BANERJI J. 2007. Biostratigraphic significance of megaspores from the Triassic sequence of peninsular India: Application in Stratigraphy and Paleoceanography. Narosa.

GLASSPOOL I.J. 2000. Megaspores from the Permian Lower Whybrow coal seam, Sydney Basin, Australia. Rev. Palaeobot. Palynol., 110: 209–227.

GLASSPOOL I.J. 2003. A review of Permian Gondwana megaspore, with particular emphasis on material collected from coals of the Witbank Basin of South Africa and the Sydney Basin of Australia. Rev. Palaeobot. Palynol., 124: 227–296.

van der HAMMEN T. 1954. Principios para la nomenclatura palinológica sistematica. Boletin Geologico, 2(2): 3–21.

HARRIS T.M. 1961. The Yorkshire Jurassic Flora-I. Thallophyta-Pteridophyta. British Museum (Nat. Hist.), London.

HØEG O.A. & BOSE M.N. 1960. The *Glossopteris* flora of Belgian Congo, Ann. Mus. R. Congo Belg. Terv. Sci. Geol., 32(8): 1–109.

HØEG O.A., BOSE M.N. & MANUM S. 1955. On double walls in fossil megaspores, with description of *Duosporites congoensis* n. gen., n. sp. Nytt. Mag. Bot., 4: 101–107.

IBRAHIM A.C. 1933. Sporeformen des Aegirhorizontes des Ruhrreviers. Diss. Technische Hochschuhle Berlin.. Würzburg/Berlin.

JANA B.N. 2004. Palaeopalynology of Kachchh – I: Mesozoic Megaspores: 221–227. In: Srivastava P.C. (ed.), Vistas in Palaeobotany and Plant Morphology: Evolutionary and Environmental Perspectives. Professor D.D. Pant Memorial volume.

JANA B.N. & GHOSH A.K. 1997. A megaspore assemblage from Athgarh Formation and its bearing

on the age of the formation. The Palaeobotanist, 46(1,2): 149–155.

JHA N., TEWARI R. & SALEEM M. 2006. Occurrence of Megaspores in the Lower Gondwana Sediments of the Gundala Area, Godavari Graben, A.P., India. Journ. Palaeont. Soc. India, 51(2): 37–41.

JUNG W. 1958. Zur Biologie und Morphologie einiger disperser Megasporen, vergleichbar mit solchen von *Lycostrobus scotti*, aus dem Rhät-Lias Frankens. Geol. Bl. No – Bayer, 8(3): 114–130.

KAR R.K. 1968. Palynology of the Barren Measure Sequence from Jharia Coalfield, Bihar, India – 3. Studies on the megaspores. The Palaeobotanist, 16(3): 292–300.

KOVACH W.L. & BATTEN D.J. 1989. Worldwide stratigraphic occurrences of Mesozoic and Tertiary megaspores. Palynology, 13: 247–277.

LELE K.M. 1962. Studies in the Middle Gondwana flora 3. Platyspermic seeds and megaspore impressions from the South Rewa Gondwana basin. The Palaeobotanist, 11(1, 2): 13–18.

LELE K.M. & CHANDRA A. 1974. Studies in the Talchir Flora of India 9. Megaspores from the Talchir Formation in the Johila Coalfield, (M.P.), India. The Palaeobotanist, 21: 238–247.

LOOY C.V., COLLINSON M.E., van KONIJNENBURG-van CITTERT J.H.A., VISSCHER H. & BRAIN P.R. 2005. The ultrastructure and botanical affinity of end-Permian spore tetrads. Int. J. Plant Sciences, 166(5): 875–887.

MAHESHWARI H.K. & BANERJI J. 1975. Lower Triassic Palynomorphs from the Maitur Formation, West Bengal, India. Palaeontographica, B, 152: 149–190.

MAJUMDAR M. 1981. Geology of Bhadoura-Tansar area; north-western part of Singrauli Coalfield, Sidhi District, Madhya Pradesh. Geol. Surv. India, Progress Rep., 1–15.

PAL P.K. 1991. Megaspores from the Upper Triassic beds of Giar, Tiki Formation, India. Global Environment and Diversification of plants through Geological time. Professor Birbal Sahni Centenary International Conference, Allahabad (Late Abstract).

PAL P.K., & SANNIGRAHI A. 2002. Megaspores from the Upper Triassic sequence of Son Valley Basin and their stratigraphic significance. National Conference on Biodiversity – Past and Present. Palaeob. Soc. Lucknow, (Abstract), p. 49.

PAL P.K., GHOSH A.K. & SANNIGRAHI A. 1997. Megaspores from the Panchet Formation of East Bokaro Coalfield, India. Journ. Palaeont. Soc. India, 42: 61–69.

PANT D.D. & BASU N. 1979. On some megaspores from the Triassic of Nidhpuri, India. Rev. Palaeobot. Palynol., 28: 203–221.

PANT D.D. & MISHRA S.N. 1986. On Lower Gondwana megaspore from India. Palaeontographica, B, 198: 13–73.

PANT D.D. & SRIVASTAVA G.K. 1961. Structural studies on Lower Gondwana megaspores. Part I. Specimens from Talchir Coalfield, India. Palaeontographica, B, 109: 45–61.

PANT D.D. & SRIVASTAVA G.K. 1962. Structural studies on Lower Gondwana megaspores. Part II. Specimens from Brazil and Mhukuru Coalfield, Tanganyika. Palaeontographica, B, 111: 97–110.

PANT D.D. & SRIVASTAVA G.K. 1964. Further observations on some Triassic plant remains from the Salt Range, Punjab. Palaeontographica, B,114: 79–93.

POTONIÉ R. 1956. Synopsis der Gattungen der *Sporae dispersae,* 1. Beiheft Geol. Jb., 23: 1–103.

RAJA RAO C.S. 1983. Coalfields of India, III.coal resources of Madhya Pradesh, Jammu and Kashmir. Bull. Geol. Surv. India, Ser. A, 45: 119–129.

REINSCH P.F. 1881. Neue Unterschungen über die Mikrostruktur der Steinkohle des Karbon, der Dyas und Trias. Leipzig.

SINGH H.P., SRIVASTAVA S.K. & ROY S.K. 1964. Studies on the Upper Gondwana of Cutch – I. Mio- and macrospores. The Palaeobotanist, 12(3): 182–306.

SITHOLEY R.V. 1943. Plant remains from the Triassic of Salt Range in the Punjab. Proc. Nat. Acad. Sci. Indian, 13: 300–327.

SPINNER E. 1969. Preliminary studies of the megaspores from the type Formation, Quebrada del Type. La Rioja, Argentina. Pollen Spore, 11: 669–685.

SUKH-DEV. 1961. The fossil flora of the Jabalpur Series 3. Spores and pollen grains. The Palaeobotanist, 8: 43–56.

SURANGE K.R., SINGH P. & SRIVASTAVA P.N. 1953. Megaspores from West Bokaro Coalfield (Lower Gondwana) of Bihar. The Palaeobotanist, 2: 9–17.

TEWARI R. 2005. Morphological evolution of Indian Gondwana megaspore. Abstract Volume – Diamond Jubilee National Conference, 15–16 November 2005, BSIP Lucknow.

TEWARI R. & MAHESHWARI H.K. 1992. Megaspores from Early Permian India. Geophytology, 21: 1–19.

TEWARI R., RAJNIKANT A. & JHA N. 2004. Permian Gondwana megaspores from Wardha Basin, India, 53: 35–50.

TEWARI R., MEHROTRA N.C., MEENA K.L. & PILLAI S.S.K. 2009. Permian megaspore from Kuraloi Area, Ib-River Coalfield, Mahanadi Basin, Orissa. Journ. Geol. Soc. India, 74: 669–678.

TIWARI R.S. & RAM-AWATAR. 1989. Palynodating of Nidpur beds, Son Graben, Madhya Pradesh. The Palaeobotanist, 38: 105–120.

ZEILLER R. 1895. Note sur flore fossil des gisements houillers de Rio Grande do sul. Bull. Soc. Geol. Fr., Sr. III 23: 601.

PLATES

Plate 1

Duosporites indicus sp. nov.

1,2. Proximal and distal views respectively, of a dry megaspore, Holotype, Slide No. 53,101
3. Holotype mounted in water to show sexine ornamentation along periphery
4. Portion of megaspore margin in fig. 3, further magnified to show sexine ornamentation
5. Megaspore in fig. 3, showing partially dissolved sexine ornamentation after maceration
6. Subtriangular nexine dissected out of megaspore in fig. 5, showing a single row of large, rounded pits along trilete mark

Grambastisporites major sp. nov.

7,8. Distal and proximal views respectively, of a dry megaspore, Holotype, Slide No. 53,151
9. Megaspore in fig. 7, photographed during the process of maceration
10. A portion of the margin of spore in fig. 9, magnified to show sexine ornamentation
11. A portion of spore margin in fig. 9, highly magnified to show micro-reticulation on spines
12. Nexine of megaspore in fig. 7, showing several irregularly arranged pits along trilete mark

Scale bar: 1,2,3,5,12 – 100 µm; 4,6,11 – 50 µm; 7,8,9 – 150 µm; 10 – 60 µm

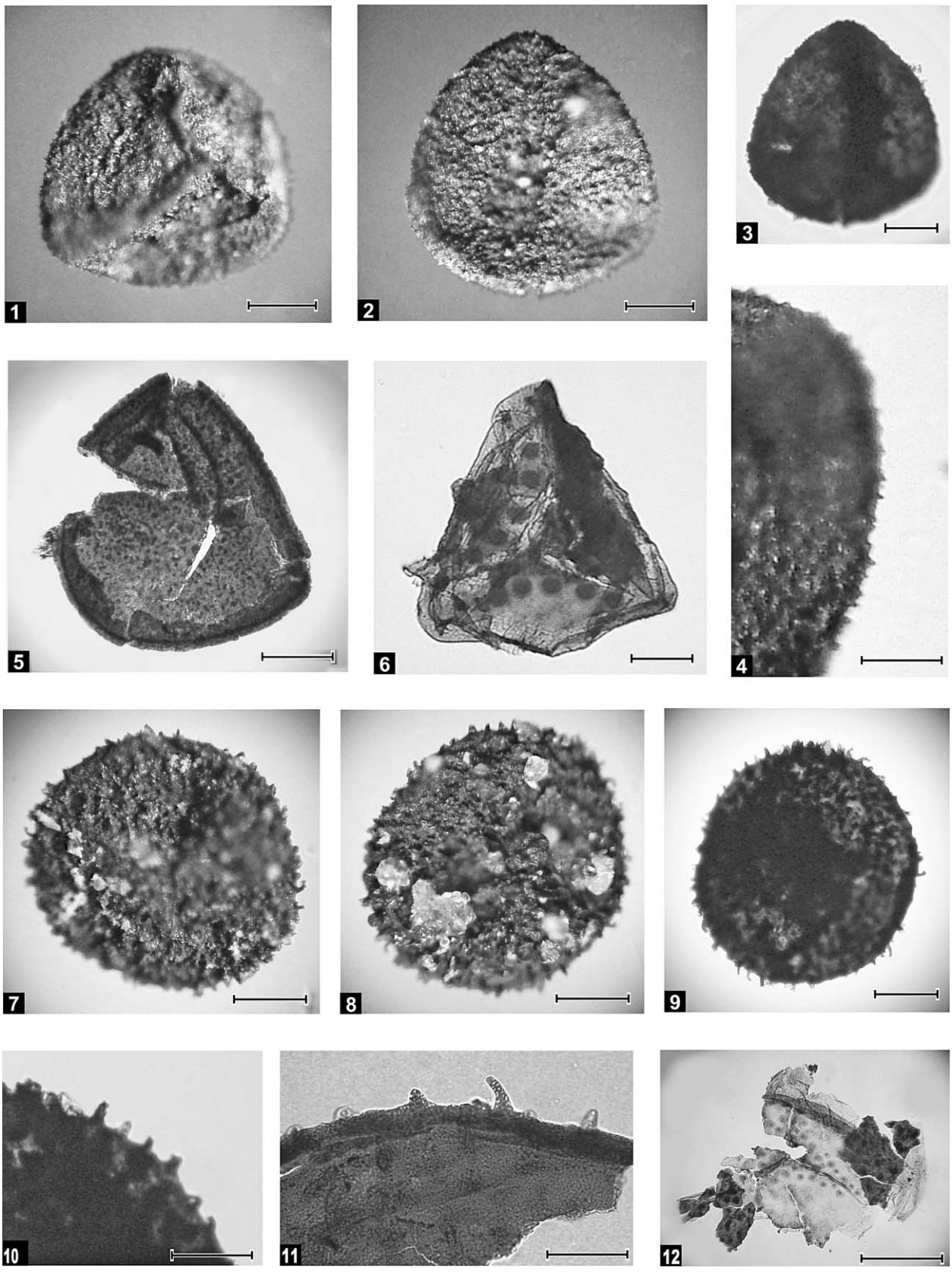
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Plate 2

Mammilaespora nidpurensis sp. nov.

1,2. Distal and proximal views respectively, of a dry megaspore showing sexine ornamentation of mammillate type, Holotype, Slide No. 53,251

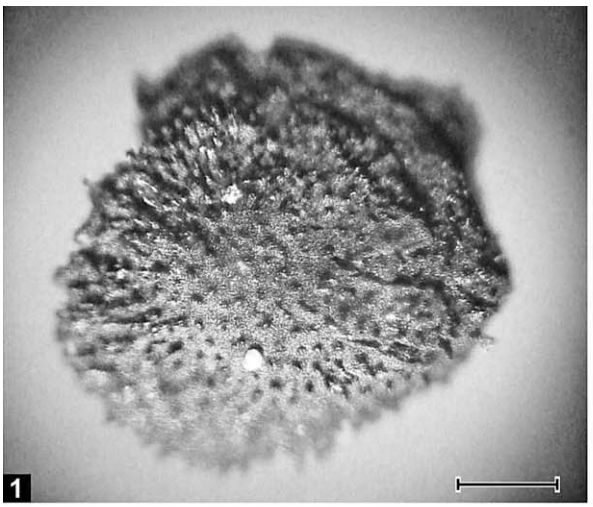
3. Proximal view of another dry megaspore showing sinuous laesurae and mammillate sexine sculpturing, Slide No. 53,252

4. Megaspore in fig. 2, photographed during maceration showing a darkened central area, lighter peripheral region and distinct marginal processes

5,6. Peripheral portions of macerated megaspore in fig. 4, magnified in fig. 5 and further magnified in fig. 6 to show forked processes in sexine ornamentation

7. Ruptured subtriangular, unpitted nexine of megaspore in fig. 4, showing part of nexine sac filled with simple microspores

Scale bar: 1,2,3,4 – 100 µm; 5,7 – 50 µm; 6 – 40 µm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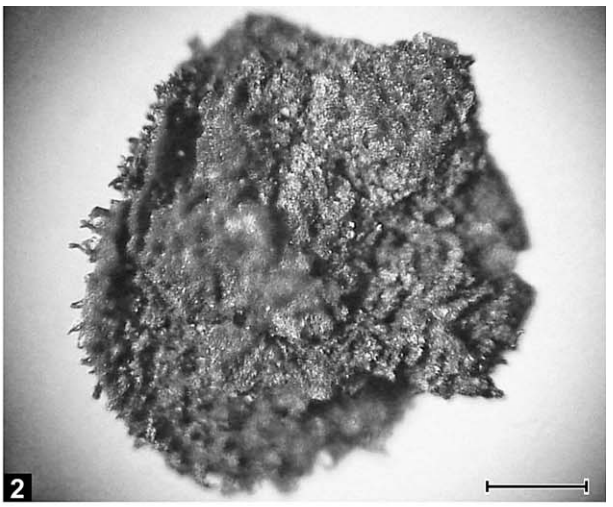
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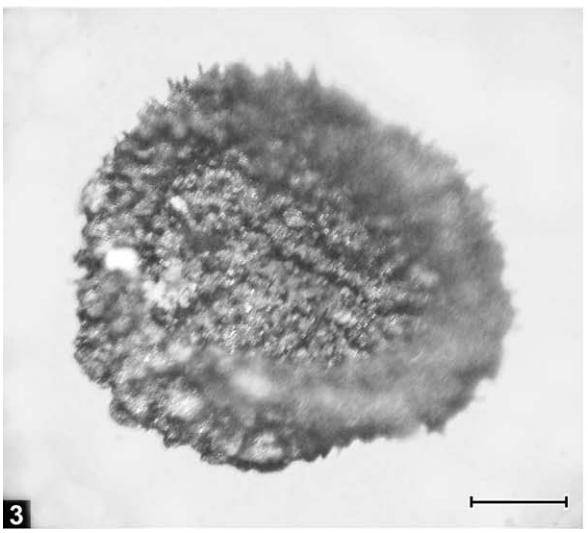
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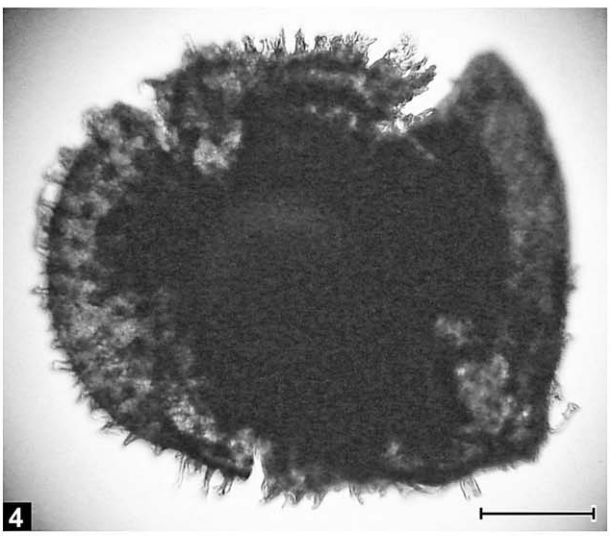
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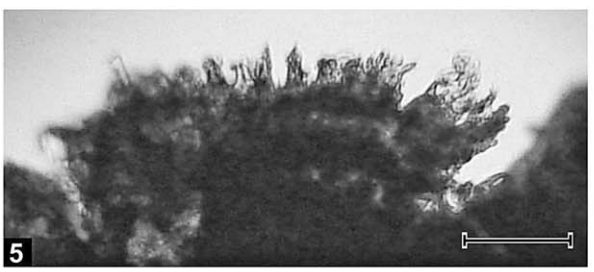
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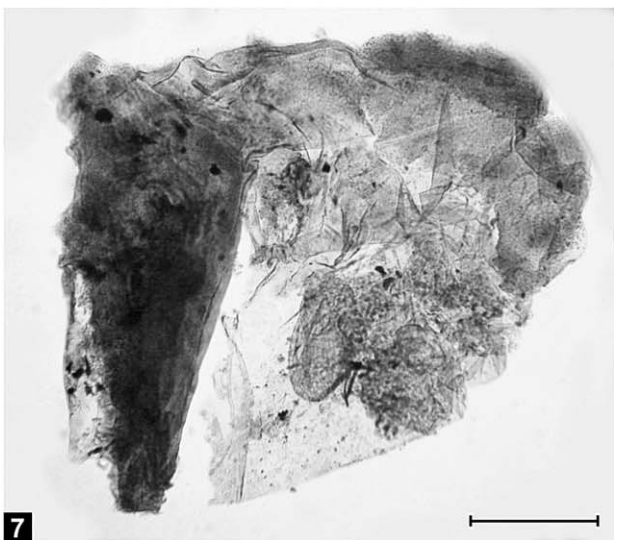
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Plate 3

Mammilaespora royi sp. nov.

1,2. Proximal and distal views respectively, of a dry megaspore showing trilete mark and contact areas in fig. 1 and sexine sculpturing in fig. 2, Holotype, Slide No. 53,201

3. Macerated spore in fig. 1, showing marginal process of sexine appearing to be arranged in the form of a zona around equator

4. Portion of margin of spore in fig. 3, magnified to show furcate, basally fused, marginal appendages

5. Over-macerated megaspore in fig. 3, showing few resistant marginal appendages and many stumps of dissolved ones

6. Portion of over macerated spore margin in fig. 5, magnified to show remaining appendages, Slide No. 53,201

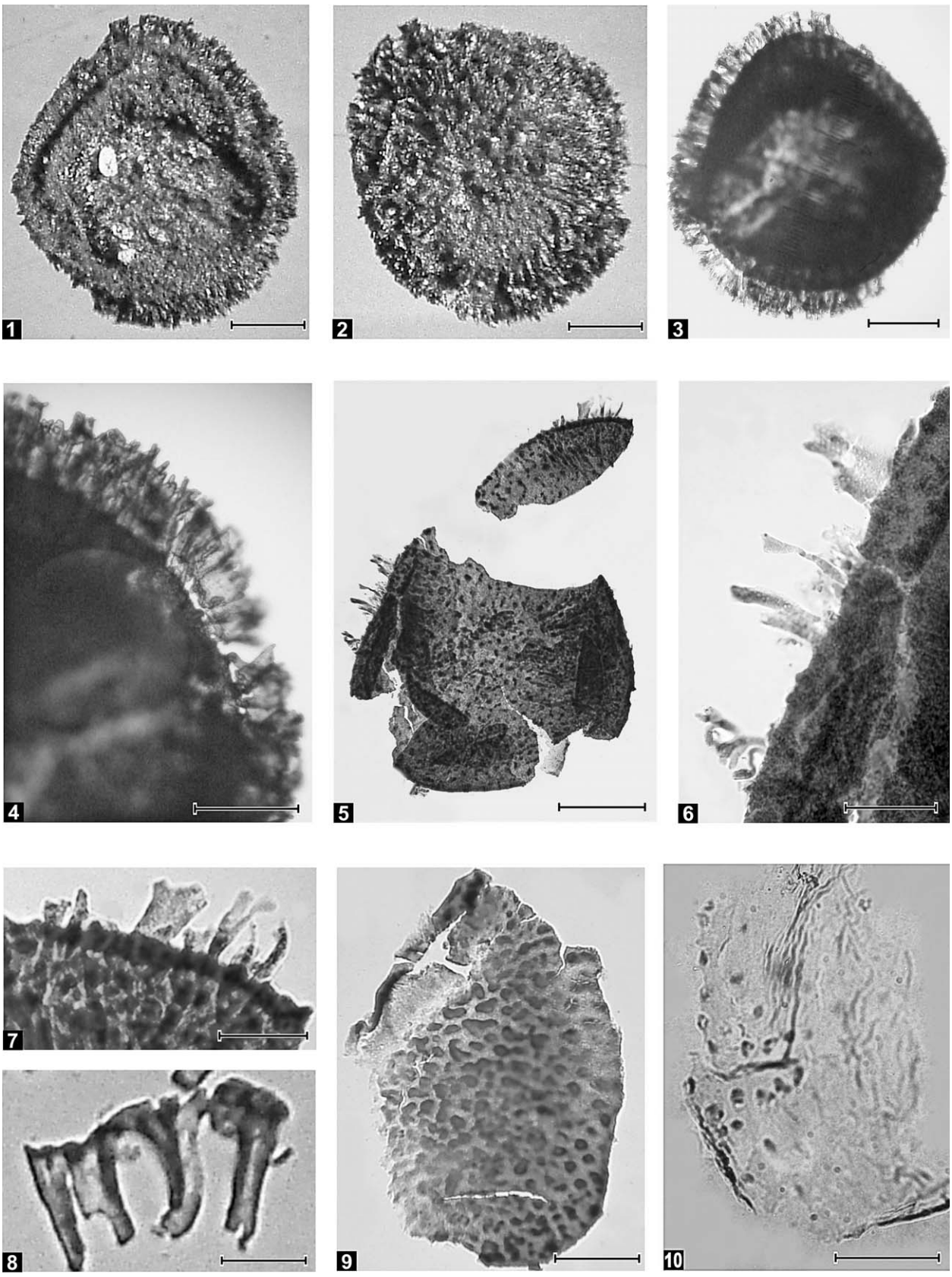
7. Another portion of megaspore margin in fig. 5, magnified to show peripheral multi-furcate appendages

8. Magnified view of some marginal appendages detached from spore margin in fig. 5

9. Magnified view of a contact area of megaspore in fig. 3, showing sexine reticulation and a single sinuous laesura

10. Magnified view of portion of nexine sac of megaspore in fig. 3, showing pits along the trilete rays

Scale bar: 1,2,3,5 – 200 µm; 4,9,10 – 100 µm; 6 – 50 µm; 7 – 60 µm; 8 – 25 µm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