Journal of Scientific Research ISSN 0555-7674
Vol. XXXVIII No. 1, June, 2008

LATE PERMIAN AZONATE AND ZONATE TRILETE SPORES FROM CHHIDRU FORMATION, SALT RANGE, PAKISTAN

[1]Muhammad Zia-ul-Rehman and [2]Khan Rass Masood
Department of Botany, University of the Punjab,
Lahore-Pakistan.

Abstract: Chhidru Formation Salt Range, Pakistan belongs to the Late Permian (Dzulfian) and marks the termination of Paleozoic Era. The Formation conformably overlies the Wargal Formation and is paraconformably overlain by the Mianwali Formation, predominantly consisting of sandstone, mudstone, limestone with shaly streaks. Chhidru Formation was studied at three localities in the Salt Range viz; Nammal, Zaluch and Chhidru Gorges respectively. Extensive palynological studies were undertaken and rich palynoflora was recovered.

The present paper deals with the taxonomy and distribution of only the Azonate and Zonate trilete miospores in the Chhidru Formation. All miospores are classified according to turmal system (Masood et al., 1994). Following spores have been described systematically viz; Leiotriletes adnatoides, L. notatus, L. adnatus, L. parvus, L,. directus, Altitriletes densus, Calamospora diversiformis, C. flexilis, Punctatisporites gretensis P. orbicularis, P. curviradiatus, P. pseudolevatus, Granulatisporites micronodosus, Cyclogranisporites aureus, C. arenosus, Osmundacidites senectus, Converrucosisporites subverrucosis, , Brevitriletes parmatus, Leschikisporites cestus, Acanthotriletes tereteangulatus, Lophotriletes sp. cf. L. granoornatus, Gondisporites sp., Dictyotriletes aules, Camptotriletes warchianus, Densoisporites playfordi, D. complicatus, D. solidus, Nevesisporites fossulatus, Lundbladispora obsoleta, Gondisporites imbricatus, Kraeuselisporites rallus, K. cuspidus and Jayantisporites variabilis. In addition possible palynomorph affinities have been highlighted.

Introduction

Permian Palynology of the Salt Range, Pakistan began when Virkki (1937) studied the lower Gondwana microflora from the samples collected near the base of the Warchha Formation lying 7m 8m above the Early Permian, Tobra Formation at Kathwai, Central Salt Range, Pakistan. Balme (1970) undertook comparatively more extensive work on Permian and Triassic strata of the Salt Range, Surghar Range Pakistan. Subsequently some other workers also contributed (Masood et al 1994). Recently Iqbal (2002) and Malik (2005) undertook detailed research work primarily focusing on the fine resolution Palynology of the Middle Triassic (Tredian Formation) and Early Triassic (Mianwali Formation) strata where as Rehman (2007) worked on the Late Middle Permian (Artinskian) strata (Salt Range).

Zaluch Group of the Salt Range, Pakistan represents one of the reference marine strata of world (P.J. R. G., 1985). Permian system in the Salt Range, Pakistan is represented by Nilawahan and Zaluch Group (Table 1).

1-For Proof and Correspondence: **Khan Rass Masood**

Table 1: Stratigraphic Classification of Permian Formations (Slightly modified after P.J.R.G., 1985).

GROUP	FORMATION	AGE
Zaluch Group (Predominantly Marine)	Chhidru Formation	Dzulfian/Chhidruan
	Wargal Formation	Murgabian
	Amb Formation	Artinskian
Nilawahan Group (Predominantly Continental)	Sardhai Formation	Sakmarian
	Warchha Formation	Sakmarian
	Dandot Formation	Asselian
	Tobra Formation	Asselian

The sedimentary outcrops belonging to Upper Permian age (Chhidru Formation-Dzulfian) are well exposed in the Western Salt Range, Pakistan (Shah, 1977; P.J.R.G., 1985).

Three localities i.e. Nammal, Zaluch and Chhidru Gorges were selected for section measurement and sampling of the Chhidru Formation for the present study. The location of each section is mentioned in fig. 1.

The Formation at all studied localities is divisible in four members viz, Landu, Gulakhel, Thatti and Jallhar, though thickness of each member is variable in each locality Fig. 2 (P.J.R.G., 1985).

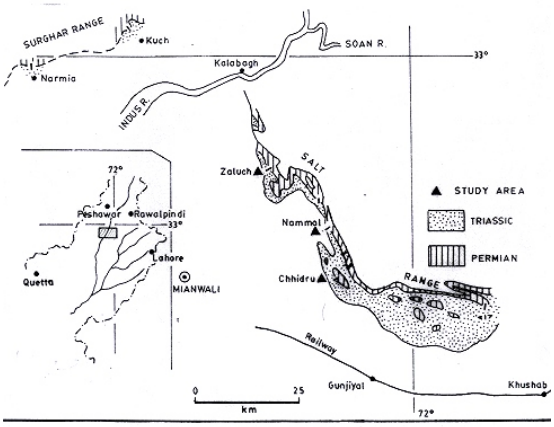


Fig. 1 : Index Map of Pakistan and Examined Localities (Slightly modified after P.J. Group 1985).

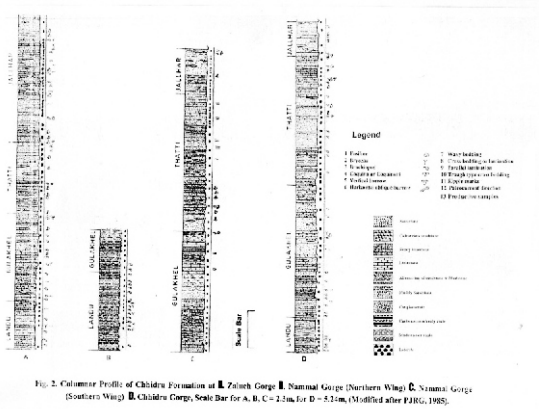


Fig. 2. Columnar Profile of Chhidru Formation at **A.** Zaluch Gorge **B.** Nammal Gorge (Northern Wing) **C.** Nammal Gorge (Southern Wing) **D.** Chhidru Gorge, Scale Bar for A, B, C = 2.5m, for D = 5.24m, (Modified after PJRG, 1985).

Materials & Methods

Rock samples belonging to the selected localities viz; Nammal, Zaluch and Chhidru Gorges were collected using Jacob's meter stick method (Masood *et al*., 1995) at the distance of one meter (Fig. 2). After using suitable code for each sample, they were subjected to bulk maceration using standard techniques (Phipps and Playford, 1984; Doher, 1980). In general samples were first washed under running water and subsequently treated with HCl, HF and HNO_3 for the removal of Carbonates, silicates and pyrites respectively.

The samples were oxidized with KOH and palynomorphs were separated from the mineral matrix through differential centrifugation by heavy liquid separation (Doher,1980) using $Zncl_2$ as medium. In some cases sieving (25µ sieve) was also

applied. The material was mounted using two mounting media i.e. Cellusize and Canada balsam. Microphotographs were taken with Kyowa Medilux Trinocular microscope under oil immersion objective on Kodak Panchromatic TMX100 ASA (21^{O}DIN). Palynomorph classification is after Balme (1970).

Table 2: Palynotaxomic stratigraphic range of occurrence in Chhidru Formation, Western Salt Range, Pakistan.

LOCALITY/GORGE / MEMBERS / PALYNOMORPHS	ZALUCH				NAMMAL				CHHIDRU			
	LANDU	GULAKHAL	THATTI	JALLHAR	LANDU	GULAKHAL	THATTI	JALLHAR	LANDU	GULAKHAL	THATTI	JALLHAR
Leiotriletes adnatoides Pötonie and Kremp	R	VR	R	R	R	R	VR	R	VR	VR	R	R
Leiotriletes notatus Haquebard		F	C	F	C				R	R		VR
Leiotriletes adnatus Kosanke	C	VR	VR	R	VR	R	R	R	F	F	F	C
Leiotriletes parvus Gunnel			C				C			F		
Leiotriletes directus Balme & Hennelly		R	R	R	R	VR	R			R	R	R
Calamospora diversiformis Balme & Hennelly	A				C				F	A		
Calamospora flexilis Kosanke , 1950	R				R				R			
Punctatisporites gretensis Balme & Hennelly	VR	R	R	R	R	VR	R	VR	R	R	R	R
Punctatisporites orbicularis Kosanke	R	R	R		VR	R	VR	R	R	R	R	VR
Punctatisporites curviradiatus Staplin	C				C				F	A		
Punctatisporites pseudolevatus Hoffmeister, Staplin and Malloy	R	R	VR	R	R	R	VR	R	R	VR	VR	R
Granulatisporites micronodusus Balme and Hennelly			C	C				F			C	F
Cyclogranisporites aureus (Loose) Pötonie & Kremp, 1955	F	C	C			F	F		C	C		
Cyclogranisporites arenosus Madler, 1964							R	R			F	R
Cyclogranisporites sp.									VR			
Osmundacidites senectus Balme, 1970			F				C			C		
Converrucosisporites subverrucosis Bharadwaj			C				A			C		
Brevitriletes parmatus (Balme & Hennelly) Backhouse			F	C				C			F	F
Leschikisporis cestus Segroves											R	
Acanthotriletes tereteangulatus Balme & Hennelly, 1956												
Horriditriletes sp.	C	F	C			A	C		F	F		
Lophotriletes sp. cf. ***L. granoornatus*** Artüz		VR			R	C	R			VR		
Grandispora sp.									VR			
Dictyotriletes aules Rigby							VR			R		
Camptotriletes worchianus Balme			F				A			C		
Perotriletes sp.											VR	
Nevesisporites fossulatus Balme, 1970	F				F				C	C		
Densoisporites solidus Segroves			F	F				F			C	F
Densoisporites complicatus Balme	F	C				F			C	F		
Densoisporites playfordi Balme												
Lundbladispora obsoleta Balme			C				F			F		
Kraevsetisporites rallus Balme 1970		VR				R	R	R		C	F	F
Kraevselisporites cuspidus Balme		F	F			VR	R	C	R	R	F	R
Jayantisporites variabilis (Anderson) Backhouse			C	C				F			F	C
Altitriletes densus Venkatachala & Kar			F	C				C			F	F
Gondisporites imbricatus Segroves	F	F			A				C	F		

LEGEND: VR = Very Rare, R = Rare, C = Common, F = Frequent, A = Abundant

Table 3: Trilete Spores Dimension (s) (µm)

Palynotaxon	Figured Specimen	Total Specimen Counted	Equatorial Diameter		
			Minimum	Maximum	Mean
Leiotriletes adnatoiders Pötonie & Kremp	30X30	27	24	39	31
Leiotriletes notatus Haquebarnd	25X23	18	21	29	24
Leiotriletes adnatus Kosanke	25X25	13	21	28	25
Leiotriletes parvus Gunnel	40X40	21	32	51	42
Leiotriletes directus Balme & Hennelly	30X30	16	23	34	31
Calamospora diversiformis Balme & Hennelly	35X30	20	27	44	32
Calamospora flexilis Kosanke	40X35	24	32	58	43
Granulatisporites micronodosus Balme & Hennelly	38X30	31	31	48	42
Cyclogranisporites sp.	38X31	06	31	39	33
Cyclogranisporites aureus (Loose) Potonie & Kremp	70X51	17	52	75	72
Cyclogranisporites arenosus Madler	50X45	33	42	61	54
Punctatisporites gretensis Balme & Hennelly	71X57	37	54	74	65
Punctatisporites orbicularis	30X28	23	25	36	27
Punctatisporites curviradiatus Staplin	29X27	11	23	34	26
Punctatisporites pseudolevatus Hoffmeister, Staplin & Malloy	60X40	12	53	71	62
Converrucosisporites subverrucosus Bharadwaj	53X51	15	47	60	54

Acanthotriletes tereteangulatus Balme & Hennelly	27X27 30X26 32X30	27	24	42	32
Horriditriletes tereteangulatus Balme & Hennelly	70X69 39X35				
Dictyotriletes aules Rigby	41X40	19	33	51	44
Leschikisporis cestus Segroves	30X30	37	24	39	32
Brevitriletes parmatus (Balme & Henneley)Backhouse	33X30	22	23	38	29
Perotriletes sp.	38X32	07	31	39	36
Nevesisporites fossulatus Balme	35X35	16	29	44	33
Densoisporites solidus Segroves	142X138	32	122	161	148
Osmundacidites senectus Balme	90X72	24	70	110	86
Altitriletes densus Venktachala & Kar	30X30	10	22	36	31
Lophotriletes granornatus Aurtz	30X28	05	25	36	31
Gondisporites imbricatus Segroves	35X32	19	29	43	34
Lundbladispora osoleta Balme	50X45	37	31	57	42
Kraesuselisporites rallus Balme 1970	56X37	41	34	59	45
Kraeuselisporites caspidatus Balme	55X50	24	44	75	56
Densisporites complicatus Balme	48X40	17	34	63	47
Camptotriletes warchianus Balme	46X35	44	32	54	43
43Jayantisporites variabilus Anderson Backhouse	42X42	36	30	57	44
Grandispora	87X80	09	79	92	84
Densoisporites playfordii Balme	64X54	14	52	68	51

Anteturma SPORITES H. Potonie, 1893

Turma TRILETES (Reinsch) Dettman, 1963

Suprasub turma ACAVITITRILETES Dettman, 1963

Sub turma AZONOTRILETES (Luber) Dettman, 1963

Infra turma LAEVIGATI (Bennie & Kidson) Potonie, 1956

Genus *LEIOTRILETES* Naumova, 1939 ex Ischenko, 1954

Type species: *Leiotriletes sphaerotriangulatus* Potonie and Kremp

Leiotriletes adnatoides Potonie & Kremp

Pl. 1 Fig. 1

Occurrence: cf. Table 2

Dimension: cf. Table 3

Description: Miospore, trilete, amb triangular, angles rounded, sides straight to very slightly concave, lete open, ends of laesurae extended almost up to angles, commissure smooth to slightly dentate, contact area distinct, marked by dark exinal band around "Y" radii, exine laevigate to infrapunctate, up to 01µm thick.

Discussion: In many cases such specimens due to partial granulate nature of exine under oil immersion objective (Smith and Butterworth, 1967) have been treated as *Granulatisporites.* The present specimen in few cases also exhibited same trends, but this may be attributed to the post depositional changes in the exine structure. Another close comparison can be made with identical taxon illustrated by Peppers (1970) from the Illinois Coal Basin, USA. The Chhidruan specimen, however, has more prominent contact area.

Possible Affinities: Pteridophytic.

Slide No.: ZGC 31, NGC 52, CGC 29.

L. notatus Hacquebard

Pl. 1 Fig. 2

Occurrence: cf. Table 2

Dimension: cf. Table 3

Description: Miospore, trilete, amb triangular, angles rounded, sides slightly convex to concave, lete distinct, arms of laesurae extending up to angles, lete closed, labra indistinct, morphology of commissure not detectable, exine laevigate, infragaranulate to infrapunctate up to 1.5µm thick.

Discussion: *Leiotriletes levis* appears to have some superficial resemblance to the specimen under discussion due to the common morphographic feature like over all amb and exine texture but due to lack of well developed labra, the Pakistani sporomorph seems to be different.
Possible Affinities: Pteridophytic.
Slide No.: ZGC 05, NGC 18, CGC 23.

L. adnatus Kosanke
Pl. 1 Fig. 3

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb triangular, angles rounded, sides concave, lete distinct, arms of laesurae never reaching ¾ radius, labra faintly developed up to 4µm broad, 1.5µm high with sinuous margins, contact area distinct appearing in the form of pseudotorus around Y-marking. Exine up to 1µm thick, laevigate to infrapunctate gradually becoming more transparent and thin in the interradial area.

Discussion: Proper focusing on spore exine permits sharper delineation of the thickened triangular area at the vertex. This taxon, which is not only 05µm smaller than the original specimen, also possesses distinctive features of sharp labra with sinuous margins and the presence of a pseudotorus.
Possible Affinities: Pteridophytic.
Slide No.: ZGC 50, NGC 34, CGC 82.

L. parvus Gunnel
Pl. 1 Fig. 4

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb triangular, angles broadly to moderately rounded, sides straight to slightly concave, lete distinct, close, labra absent, arms of laesurae never extending ½ radius, pointed, commissure although is not visible but seems to be smooth to partly sinuous, contact area indistinct. Exine laevigate to infrapunctate, about 1µm thick on the proximal and distal hemispheres, 2-3µm thick around the periphery forming pseudocollar.

Discussion: This specimen was quite common in the Landu Member of the Chhidru Formation where as in other members especially Jallhar, it occurred in the form of tetrads.
Possible Affinities: Pteridophytic.
Slide No.: ZGC 24, NGC 41, CGC 26.

L. directus Balme & Hennelly
Pl. 1 Fig. 5

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb broadly triangular, angles pointed or slightly rounded, lete not prominent, usually masked by a prominent raised intexinal flap. The detailed morphographic features of laesurae and labra are therefore not readable. Exine psilate, may be pitted, 1.5-2.0µm thick.

Discussion: under low power objective the exine is perfectly laevigate or chagrenate. In some specimens however by switching over to oil immersion objective, pitted or foveolate nature of exine become evident. In our opinion such variations are sufficient for transferring the specimens under discussion to the genus *Microfoveolatisporis* although some authors (Backhouse, 1991) ignored it.
Possible Affinities: Pteridophytic.
Slide No.: ZGC 10, NGC 36, CGC 90.

Genus *CALAMOSPORA* Schopf (In Schopf, Wilson & Bentall), 1944
Type species: ***Calamspora hertungiana*** Schopf, Wilson & Bentall, 1944
Calamspora diversiformis Balme & Hennelly
Pl. 1 Fig. 6

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb circular to sub circular, usually deformed, arms of laesurae small, extending 1/3 to 1/2 radius, commissure often open, but may also be closed, contact area indistinct in the figured specimen. Exine less than 01µm thick infra or intragranulate with frequent concentric and random folds, imparting wrinkled appearance.

Discussion: Genus *Calamospora* was originally meant for spores isolated from Carboniferous sediments (Schopf, Wilson and Bentall, 1944), subsequently the diagnosis expanded to include spores from Permian and Triassic strata (Balme, 1970; Iqbal, 2002) The present sporomorph resembles as regards the morphology of exine and lete. The Chhidruan sporomorph can be compared with *Calamospora landianus* (Balme 1970 p. 321, pl. 1, fig. 16-17) but the later is much larger in size.
Possible Affinities:
Equisetales/Calamitales
Slide No.: ZGC 07, NGC 17, CGC 25.

C. flexilis Kosanke, 1950
Pl. 1 Fig. 7

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb sub-circular, tetrad mark prominent, exinal folds frequent, cresentric or semi-cresentric in outline, lete up to ¼ radius, almost straight, extremities pointed, labra well developed, dark, 2.5-4.0µm wide, running parallel to the laesurae, contact area not very clear, exine 1 µm thick, infrapunctate under oil immersion objective.

Discussion: The closest comparison can be made with *Calamospora minutus* Bharadwaj 1957, but the Chhidruan miospores has thin exine. However, one of the specimens illustrated by Bharadwaj (1957, pl 22, Fig 9) possesses numerous folds make much thinner exine. *Calamospora straminea* Wilson & Kosanke (1944) has approximately the comparable gross morphology, but the later exhibit more pronounced labra.
Possible Affinities:
Equisetales/Calamitales.
Slide No.: ZGC 02, NGC 06, CGC 07.

Infra turma APICULATI (Bennie & Kidston) Pötonie, 1956
Subinfra turma GRANULATI
Dybova & Jachowicz, 1957
Genus: *PUNCTATISPORITES*
(Ibrahim) Pötonie & Kremp, 1955
Type species: ***Punctatisporites punctatus*** (Ibrahim) Pötonie & Kremp, 1955
Punctatisporites gretensis
Balme & Hennelly
Pl. 1 Fig. 8, 9

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb circular to sub circular, lete indistinct, arms of laesurae always extending beyond ¾ reaching equator. Labra indistinct, commissure closed, exine infrapunctate to intrapunctate, differentially thickened, usually exhibiting several exinal folds of various dimensions.

Discussion: This taxon was observed almost in all samples of Chhidru Formation. It has also been recorded from the Permian Collie Basin of Western Australia (Backhouse 1991).
Possible Affinities: Pteridophytic.
Slide No.: ZGC 43, NGC 56, CGC 03.

P. orbicularis Kosanke
Pl. 1 Fig. 12

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb circular to sub circular, lete faintly visible, labra distinct 2-4µm broad, 1.5-3.0µm thick.

Discussion: This specimen compares well with an identical taxon reported by Peppers, (1970, p. 84, pl. 2, fig. 4) from the Carbondle and Spoon Formations, Illinois Basin USA. The Salt Range specimen is more thin and transparent in appearance. We have some reservations in retaining it in the genus *Punctatisporites* because one of the foremost requirements of being *Punctatisporites* is the possession of infra or intrapunctate or even granulate, dark colored exine with prominent Y-marking. The present specimen amicably well fulfills only one requirement that is the presence of faintly developed Y-marking blended with infrapunctate exine.
Possible Affinities: Pteridophytic.
Slide No.: ZGC 02, NGC 13, CGC 08.

P. curviradiatus Staplin
Pl. 1 Fig. 10, 11

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb rounded triangular, lete faintly developed, arms of laesurae always extending up to equator, pointed. Labra weakly developed, 2µm board, 2µm high. Exine infra to intrapunctate up to 2µm thick, exhibiting variously displaced minor unfoldings.

Discussion: *Punctatisporites curviradiatus* and *Punctatisporites atrifucatus* Staplin appears to be synonyms, as the differentiation is purely based on size range which is not much different. Nevertheless, *P. curviradiatus* appears to be preserved in off polar compressions and due to this feature the laesurae overlap each other presenting a new combination of characters.
Possible Affinities: Pteridophytic.
Slide No.: ZGC 04, NGC 21, CGC 04.

P. pseudolevatus Hoffmeister, Staplin & Malloy
Pl. 1 Fig. 13
Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb broadly triangular or sub circular, usually distorted due to compressional folds. Lete distinct, arms of laesurae always reaching equator, commissure closed, labra weakly developed, visible only upon carefully LO analysis exine up to 3µm thick, intrapunctate to intragranulate.

Discussion: Most of the specimens of this taxon were observed in polar compressions with the exine of the distal hemisphere partly or totally removed. This may indicate the secondary or tertiary shift of the microfossil to different depositional sites under varying levels of turbulence.
Possible Affinities: Pteridophytic.
Slide No.: ZGC 10, NGC 09, CGC 90.

Genus: *GRANULATISPORITES*
(Ibrahim) Schopf, Wilson & Bentall, 1944
Type species: ***Granulatisporites granulatus*** Ibrahim, 1933
Granulatisporites micronodusus Balme & Hennelly
Pl. 1 Fig. 14

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb triangular, angles pointed to rounded, sides straight with a tendency to become convex. Arms of laesurae straight and extending to equator, labra not prominent but may be observed upon carefully LO analysis under oil immersion. Exine about 1µm thick and bearing grana about 2µm in diameter.

Discussion: In some areas the grana acquired shape of verrucae because of partial corrosion and post depositional alterations. We were able to observe the original grana only in few cases.

Possible Affinities: Pteridophytic.

Slide No.: ZGC 54, NGC 57, CGC 80.

Genus *CYCLOGRANISPORITES*
Pötonie & Kremp, 1954
Type species: ***Cyclogranisporites leopoldi*** (Kremp) Pötonie & Kremp, 1954
Cyclogranisporites aureus (Loose) Pötonie & Kremp, 1955
Pl. 1 Fig. 15

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb circular to sub circular, in polar view may be oblong oval in proximo-lateral compression. Contact area indistinct, lete distinct, arms of laesurae extending upto the equator or sometimes may project on to the distal hemisphere. Labra distinct 3-5µm broad 3µm high, straight or sinuous. Exine infra or intragranulate on both sides, 2µm thick.

Discussion: *Cyclogranosporites aureus* isolated from Chhidru Formation is significantly larger in size than those reported from other parts of the world. Another distinguishing feature is the tendency of exine of the distal hemisphere to become partly or strongly verrucate in nature. We observed several hundreds of specimens as single grain mounts and concluded that this discrepancy in the ornamentation of exine was because of the post depositional hazards.
Possible Affinities: Pteridophytic.
Slide No.: CGC 06.

C. arenosus Madler, 1964
Pl. 1,2 Fig. 16,1

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb circular to sub circular, periphery finally notched usually preserved in off polar compressions, lete distinct, arms of laesurae straight always extending up to equator, exine 2-4 µm thick, sculptured proximally and distally with closely spaced but clearly separated grana. Grana circular or rounded polygonal in organization, basal diameter 0.75 1.0µm, height up to 1.5 - 2µm.

Discussion: This sporomorph was always observed in circular to sub-circular form despite having preserved in a variety of depositional forms.
Possible Affinities: Pteridophytic.
Slide No.: ZGC 01, NGC 11, CGC 14.

Genus: *OSMUNDACIDITES* Couper, 1953
Type species: ***Osmundacidites wellmanii*** Couper, 1953
Osmundacidites senectus Balme, 1970
Pl. 2 Fig. 2

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb circular to sub circular, usually deformed due to compressional folds, periphery notched. Tetrad scar distinct, arms of laesurae extending ¾ radius. Labra distinct, 3-5µm broad, 1-2µm high. Exine sculptured with coni, baculae and impersistent grana.

Discussion: As quoted by Balme (1970), *Osmundacidites senectus* from the lower Triassic of Western Australia was originally distinguished from *Osmundacidites wellmanii* Couper on the basis of its final and more regular sculptural elements. The Chhidruan specimen however was quite distinct in having predomination of verrucae over other structural elements. This character is strong enough to warrant a new species, but unfortunately few specimens were available for detailed morphological comparisons.
Possible Affinities: Pteridophytic (Osmundaceae).
Slide No.: ZGC 34, NGC 44, CGC 51.

Subinfra turma VERRUCATI
Dybova & Jachowicz, 1957

Genus *CONVERRUCOSISPORITES*
Pötonie & Kremp, 1954
Type species: ***Converrucosisporites triquetrus*** (Ibrahim) Pötonie & Kremp
Converrucosisporites subverrucosis Bharadwaj
Pl. 2 Fig. 3

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb rounded triangular to sub circular, laesurae indistinct, amb of laesurae straight almost reaching the spore margin, labra indistinct. Spores often broken or torn apart, intexinal folds frequent. Exine verrucate, 1µm thick, verrucae more prominent raised and well developed in the interradial area on the distal hemisphere. verrucae 2-4µm apart, 2µm high.

Discussion: *Converrucosisporites subverrucosis* is a typical lower to middle Carboniferous sporomorph of the European and North America sediments (Peppers 1970; Goubin 1965; Bharadwaj 1974). This paper reports the first occurrence of this taxon in the Permian of Pakistan.
Possible Affinities: Filicopsida.
Slide No.: ZGC 23, NGC 50, CGC 26.

Genus: *BREVITRILETES* Bharadwaj & Srivastava, 1969
Type species: ***Brevitriletes communis*** Bharadwaj & Srivastava, 1969
Brevitriletes parmatus (Balme & Hennely) Backhouse
Pl. 2 Fig. 4

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb circular to sub circular, laesurae straight extending ¾ or full length of spore radius. Labra indistinct, exine up to 01µm thick distally ornamented with low rounded verrucae largest near distal pole. In few specimens verruceae were mamillate with short, narrow, truncate spines (on top of verrucae). Verrucae upto 3µm in diameter, 2µm high at distal pole becoming gradually smaller near the equator. Equatorial area possesses comparatively small verrucae intermixed with grana.

Discussion: *Brevitriletes parmatus* is a typical Gondwanaland palynomorph, confined usually in the late Permian sediments (Segroves, 1970; Masood *et al.,* 2000).
Possible Affinities: Filicopsida?
Slide No.: ZGC 44, NGC 52, CGC 72.

Genus: *LESCHIKISPORIS* Pötonie, 1958
Type species: ***Leschikisporis aduncus*** (Leschik) Pötonie
Leschikisporis cestus Segroves
Pl. 2 Fig. 5

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb circular to sub circular, laesurae distinct, arms straight, one arm of laesurae usually shorter than remaining two, arms of laesurae extending ½ or ¾ spore radius. Exine 2-3µm thick with thickness sometimes greatest in the area of the tetrad scar. Exine exhibiting mixture of ornamentational pattern including grana, verrucae and rugulae.

Discussion: It is extremely difficult to differentiate such specimens of this species from the genus *Verrucosisporites* as verrucae predominate in both cases. The differentiation can only be made upon careful L-O analysis under oil immersion objective to differentiate grana from rugulae authentically. This is the first record of this genus in the Permian of Salt Range.
Possible Affinities: Pteridophytic.
Slide No.: CGC 38.

Subinfra turma NODATI
Genus *ACANTHOTRILETES*
Naumova, 1939 ex Ischenko, 1954
Type species: *Acanthotriletes tereteangulatus* Balme & Hennelly, 1956
Acanthotriletes tereteangulatus
Balme & Hennelly, 1956
Pl. 2 Fig. 6, 7

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb triangular, angles rounded or slightly wedge shaped, sides straight or slightly concave, laesurae indistinct, arms straight to sinuous extending almost to equator, indistinct "Kyrtome" present in some specimen, exine less than 1µm thick bearing cones and spines, 1-4µm high and 0.5 to 2.0µm apart.

Discussion: Although in abundance quantitatively, very few specimen of this taxon were recovered in complete or unbroken form. *Acanthotriletes tereteangulatus* is a typical Uppermost Permian sporomorph recorded in many Gondwanaland countries e.g. Australia (Segroves 1970; Foster 1979; Backhouse 1991).
Possible Affinities: Lycopsida?
Slide No.: ZGC 10, NGC 27, CGC 30.

Genus: *LOPHOTRILETES*
(Naumova) Pötonie & Kremp, 1954
Type species: ***Lophotriletes globosus***
(Ibrahim) Pötonie & Kremp, 1954
Lophotriletes sp. cf. ***L. granoornatus***
Artüz
Pl. 2 Fig. 9

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb broadly triangular, angles rounded, sides straight to convex. Tetrad marking indistinct, commissure closed. Labra indistinct. Exine variously sculptured including coni and spinae. Coni uniformly distributed on the distal surface, less frequent on proximal face. They are of variable size up to 3µm long and from less than 1.0µm to 3.5µm in basal diameter.

Discussion: The Chhidruan specimens are tentatively assigned to *Lophotriletes granoornatus* because the preservational status of most of the specimens was poor to very poor, however the present specimen seems to confirm more closely to the specimen illustrated by Peppers (1970, p. 95, pl. 5, fig. 18-23) from the Pennsylvanian Coals of Illinois Basin, USA.
Possible Affinities: Filicales.
Slide No.: ZGC 15, NGC 03, CGC 20.

Genus *GRANDISPORA* (Hoffmeister, Staplin & Malloy) Neves & Owens, 1966
Type species: ***Grandispora spinosa*** (Hoffmeister, Staplin & Malloy) Neves & Owens, 1966
Grandispora sp.
Pl. 2 Fig. 12

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, cavate, amb sub-circular to rounded triangular. Exine cavate with exoexine enclosing a thin intexine. Laesurae distinct, arms of laesurae sinuous and extending to the edge of intexine. In the figured specimen only two arms are visible, arms of laesurae including elevated lips 3-6µm broad and extending to or nearly periphery of the spore. Exoexine less than 1µm thick and microreticulate on distal surface of spore, exoexine bearing irregularly disposed spines and cones 2.0-3.5µm high, 1-2µm in basal diameter and 2-5µm apart. Sometimes 0.5µm thick, smooth and with marginal folds.

Discussion: the present specimen has close resemblance with *Grandispora dwythensis* Hart with the exception of thick peripheral exine collar which is the

characteristic feature of Hart (1964) specimen. Insufficient specimens are available for systematic study of this taxon.
Possible Affinities: Lycopsida?
Slide No.: CGC 15.

Infra turma MURONATI Dybova & Jachowiz, 1957
Genus: *DICTYOTRILETES* (Ibrahim) Pötonie & Kremp, 1955
Type species: ***Dictyotriletes bireticulatus*** (Ibrahim) Pötonie & Kremp, 1955
Dictyotriletes aules Rigby
Pl. 2 Fig. 10

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb triangular, angles rounded, sides straight to slightly convex, distal face hemispherical, proximal face pyramidal, laesurae extending ¾ spore, radius bordered by narrow raised labra. Exoexine 1-2µm thick, proximally and equatorially laevigate, distally sculptured with a fine imperfect, highly irregular reticulum. Muri ca. 01µm wide enclosing a lumina 2-4µm in maximum diameter. Reticulum degenerates to become irregular rugulae and grana towards equator in some specimens.

Discussion: This paper reports the first record of this taxon in the Salt Range (Pakistan). It is also abundantly found in the early and Late Permian of Western Australia (Backhouse, 1991).
Possible Affinities: Filicopsida ?
Slide No.: NGC 46, CGC 16.

Genus: *CAMPTOTRILETES* (Naumova) Pötonie & Kremp, 1954
Type species: ***Camptotriletes corrugatus*** (Ibrahim) Pötonie & Kremp, 1954
Camptotriletes warchianus Balme
Pl. 2 Fig. 13

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, amb triangular, angles rounded, sides straight to slightly concave, tetrad scar faintly visible. Arms of laesurae extends almost to angles, commissure open, exine up to 4µm thick, infrapunctate to finally cristate or weakly verrucate both on proximal and distal sides. In few specimens baculae were also observed.

Discussion: This taxon was formulated by Balme (1970). As quoted by him it is not easy to identify a specimen with morphological features typical for this taxon. This is primarily because of variability in the form of its sculptural elements. Some specimens may also be accommodated in *Lophotriletes* whereas others exhibit affinities for *Converrucosisporites.*
Possible Affinities: Ferns.
Slide No.: ZGC 31, NGC 49, CGC 19.
Supra subturma LAMINATITRILETES Smith & Butterworth, 1967
Sub turma ZONOLAMINATI TRILETES Smith & Butterworth, 1967
Infra turma CINGULATI Smith & Butterworth, 1967
Genus: *DENSOISPORITES* Weyland & Krieger, 1953
Type species: ***Densoisporites velatus*** Weyland & Krieger, 1953
Densoisporites playfordi Balme
Pl. 3 Fig. 2

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, cavate, cingulate, amb rounded triangular, laesurae faint to distinct extending almost to the equator, exoexine 3-5µm thick, infrapunctate to infragranulate with a spongy texture and thickened equatorially in a narrow rim, which is 3-6µm wide. Intexine thin, smooth, may be laevigate with three apical papillae and attached to the exoexine in the area of

proximal pole.

Discussion: Scythian Assemblages of Western Australia has rich population of *Densoisporites playfordi* Balme (Masood *et al.,* 1991), where as Early Triassic Assemblages from Tasmania (Playdford, 1965) contain this sporomorph.
Possible Affinities: Lycopsida (Seleginellales).
Slide No.: ZGC 26, NGC 02, CGC 73.

D. complicatus Balme
Pl. 2, 3 Fig. 15, 1

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, cavate, cingulate, amb triangular, angles sharply rounded, laesurae clearly defined, sometimes may be distorted due to partial corrosion and abnormal compression. Laesurae extending to equatorial margins, bordered by narrow, sinuous labra. Exoexine ca. 3µm thick, on distal face which has a fine spongy texture, especially around the equator. Exine of proximal face laevigate but bearing fine plications, radiating from the proximal pole. Exoexine thickened equatorially into a rim 3-4µm wide in polar view. Intexine 1µm thick infrapunctate to infragranulate sometimes associated with clearly defined apical papillae.

Discussion: This zonate taxon is confined only to the upper part of the Wargal Formation (Balme, 1970) and lower to middle part of the Chhidru Formation in the Salt Range.
Possible Affinities: Lycopsida (Seleginellales).
Slide No.: ZGC 22, NGC 25, CGC 14.

D. solidus Segroves
Pl. 2 Fig. 16

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, cavate, cingulate, amb subcircular, rarely rounded triangular, tetrad scar indistinct, arms of laesurae extending almost up to the spore periphery, labra weakly developed. Exine cavate, consisting of cingulate exoexine, enclosing a thick walled intexine. Distal face of spore hemispherical, proximal face pyramidal, exoexine spongy up to 2µm thick on distal and proximal faces. Structure less portion of cingulum usually confined to a conspicuous, irregular peripheral zone. Intexine 1-2µm thick, smooth walled, expanded, weakly folded, apical papillae not observed.

Discussion: *Densoisporites solidus* appears to be similar to *D. poatinaensis* Playford in gross morphology but is considerably smaller in size.
Possible Affinities: Lycopsida (Seleginellales).
Slide No.: ZGC 54, NGC 43, CGC 87.

Genus: *NEVESISPORITES* de Jersey & Paten, 1964
Type species: ***Nevesisporites vallatus*** (de Jersey & Paten) Morbey, 1964
Nevesisporites fossulatus Balme
Pl. 2 Fig. 14

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, exine thick at equator. Amb circular with a tendency of becoming rounded triangular, laesurae distinct, arms of laesurae almost reaching equator. Commissure protected by undulating labra, thick exine around equator exhibit sharply defined trend forming crrasituate which is upto 5µm thick. Although proximal face exine is always thin as compared to distal face exine, but this can only be verified under careful L-O analysis and may not be detected in the photomicrograph provided.

Discussion: The specimens isolated from Chhidru Formation have also been previously reported by Balme (1970). He

reported this taxon from the Tredian Formation, Western Salt Range (Pakistan). Surprisingly this taxon has not been reported by Iqbal (2002) who undertook an extensive and comprehensive study on the Tredian Formation, Salt Range, Pakistan.
Possible Affinities: Lycopsids.
Slide No.: ZGC 05, NGC 09, CGC 01.

Genus: *ALTITRILETES* Venkatachala & Kar, 1968
Type species: ***Altitriletes* densus** Venkatachala & Kar
Altitriletes densus Venkatachala & Kar
Pl. 2 Fig. 8

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, cavate, amb circular to rounded triangular, laesurae indistinct, bordered by thickened sinuous labra with weak or pronounced rounded or subrounded, thickenings at the distal extremities. Exine upto 3µm thick often bearing large folds, laevigate or differentially infragranulate.

Discussion: In the Chhidruan specimens the typical angular thickenings at the tips of laesurae a characteristic feature of this genus were not prominent. This taxon is widely distributed in the late Carboniferous of Europe and North America (Backhouse 1991). This is the first record of this taxon in Pakistan.
Possible Affinities: Ferns.
Slide No.: ZGC 55, NGC 56, CGC 72.

Suprasub turma
PERINOTRILETES (Erdtman) Dettman, 1963
Infra turma CINGULATI (Pötonie & Klaus) Dettman, 1963
Genus: *LUNDBLADISPORA* (Balme) Playford, 1963
Type species: ***Lundbladispora willmotti*** Balme, 1962
Lundbladispora obsoleta Balme
Pl. 3 Fig. 3, 4

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, cavum distinct, amb rounded triangular, lete sharply delineated. Laesurae extending to equatorial margin, labra faintly visible, straight, sinuous or highly curved depending upon preservational status of specimen. Exine around equator forming raised flat cingulum 8-2µm wide, distal exoexine up to 4µm thick, exine of proximal face always thinner. Distal hemisphere bearing conical processes up to 2µm high and 2-4µm in basal diameter. Sculpturing elements thereby populated around cingulum. Intexine not clearly defined, tightly occupying the exoexinal cavity.

Discussion: *Lundbladispora obsoleta* is common to very rare in the early Triassic Mianwali Formation (Malik, 2005). It differs from *Lundbladispora willmotii* by its broader and strongly pronounced cingulum, more sharply triangular amb, and slightly coarser, spongeous nature of exoexine.
Possible Affinities: Lycopsida (Seleginellales).
Slide No.: ZGC 34, NGC 39, CGC 61.

Genus: *GONDISPORITES* Bharadwaj, 1962
Type species: ***Gondisporites raniganjensis*** Bharadwaj
Gondisporites imbricatus Segroves
Pl. 3 Fig. 10

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, cavate, amb circular to sub circular or rounded triangular, periphery usually dentate. Exine strongly cavate consisting of azonate exoexine enclosing a thin intexine, tetrad scar faintly developed. Labra distinct, 3-5µm broad, straight to sinuous, arms of laesurae straight to sinuous extending to the inner margin of zona. Distal surface intragranulose

bearing cones and baculae, 2-4µm high, 1-2µm in basal diameter, 2-3µm apart. Sculptures almost absent on distal face of zona. Proximal surface of spore intra granulose and without sculpture.

Discussion: With the exception of smooth unfolded intexine the present sporomorph fulfils all the requirements to warrant its inclusion in *Gondisporites imbricatus*. This is the first record of this taxon from the Paleozoic strata of the Salt Range.
Possible affinities: Filicopsida ?.
Slide No.: ZGC 03, NGC 21, CGC 62.

Infra turma CINGULICAVITI Smith & Butterworth, 1967
Genus: *KRAEUSELISPORITES* (Leschik) Jansonius, 1962
Type species: ***Kraeuselisporites dentatus*** Leschik
Kraeuselisporites rallus Balme
Pl. 3 Fig. 5

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, cavate, zonate, amb rounded triangular, periphery notched, laesurae distinct extending to the inner margin of zona, sometime traceable on to the zona itself, commissure protected by strong sinuous labra. Exoexine 1µm thick chagrenate with thin translucent spinose zona, 20-25 spines project beyond zona in polar view. Spines about 1µm in basal diameter, 2.5-3.0µm long. Exine of distal hemisphere ornamented with irregular spines, exine of proximal face free of spines almost laevigate, Intexine sub-circular almost entirely filling the exoexinal cavity.

Discussion: Balme (1970) also isolated this taxon from Chhidru Formation in very low numbers.

Possible affinities: Lycopsida.
Slide No.: ZGC 54, NGC 24, CGC 67.

K. cuspidus Balme
Pl. 3 Fig. 6

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, cavate, zonate, amb sharply rounded triangular, periphery notched, laesurae distinct, projecting upto zona, sometime traceable on the zona itself, commissure bordered by weak, slightly sinuous labra, exoexine 1µm thick chagrenate with thin translucent spinose zona, zona very much narrow having very low population of spines. Spines about 1µm in basal diameter, 2.5-3.0µm long. Distal surface sculptured irregular with spines, similar to those on zona, but proximal face free of spines. Intexine sub-circular almost entirely filling the exoexinal cavity.

Discussion: In Western Australia this taxon is known only from the Scythian strata (Playford, 1965).
Possible affinities: Lycopsida.
Slide No.: ZGC 01, NGC 54, CGC 69.

Genus: *JAYANTISPORITES* Lele & Makada, 1972
Type species: ***Jayantisporites pseudozonatus*** Lele & Makada
Jayantisporites variabilis (Anderson) Backhouse
Pl. 3 Fig. 7, 8

Occurrence: cf. Table 2
Dimension: cf. Table 3
Description: Miospore, trilete, zonate, amb rounded triangular, periphery notched, tetrad scar distinct. Arms of laesurae straight, labra indistinct. Exoexine infragranulate up to 1µm thick, zona regular, 5-9µm wide composed of series of connected spinose elements. Exine of the distal hemisphere connate or echinate. Spines 1-2µm in basal diameter up to 06µm high. Coni 2-5µm in basal diameter and 4-8µm high, 2-10µm apart. Broader spines sometimes display cavities within overall fibrous texture.

Proximal face devoid of spines. Intexine less than 0.5µm thin often indistinguishable but sometimes slightly separated from exoexine.

Discussion: The zona of *Jayantisporites variabilus* appears to be derived from a fused row of spines.
Possible Affinities: Lycopsida (Seleginellales).
Slide No.: ZGC 40, NGC 56, CGC 79.

Acknowledgements

The work reported in this paper is a part of Ph.D thesis of the first author submitted to the University of the Punjab, Lahore (Pakistan) under the supervision of Khan Rass Masood (Corresponding author).

Literature Cited

Backhouse, J. (1991). Permian palynostratigraphy of the Collie Basin, Western Australia. *Review of Palaeobotany and Palynology,* **67:** 237-314.

Balme, B.E. (1970). Palynology of Permian and Triassic strata in the Salt Range and Surghar Range, West Pakistan. *In*: Kumel, B., Teichert, C. (eds.), Stratigraphic Boundary Problems Permian and Triassic of West Pakistan. University of Kansas Special Publication, **4**: 305-453.

Bharadwaj, D. C. (1957). The palynological investigations of the Saar coals (part 1-Morphography of Sporae dispersae). *Palaeontographica, Abt. B., Bd.* **101**: 73-125.

Bharadwaj, D.C. (1974). Permian palynostratigraphy in India. B: Palynology of Proterophyte and palaeophyte. *Proceedings of 3rd International Palynological Conference,* Moscow: 125-129.

Doher, L.I. (1980). Palynomorphs preparation procedures currently used in paleontology and stratigraphy Laboratories *U.S. Geological Survey, U.S.G.S. Pub.,* **830**: 1- 29.

Foster, C. B. (1979). Permian plant microfossils of the Blair Athol Coal Measures, Baralaba Coal Measures, and Basal Rewan Formation of Queensland. *Geological Survey of Queensland, Publication* 372, Paper **45**: 1-244.

Goubin, N. (1965). Description et reparition des principaux pollenites Permiens, Triasiques et Jurassiques des sondages du Basin de Morondava (Madagascar): *Revue Inst. Francaise Petrole*, **20** (10): 1415-1461.

Hart, G.F. (1964). A review of the classification and distribution of the Permian miospore: *Disaccate Striatiti:* C.R. Ve Congr. interratl. Strat. *Geol. Carb. Paris*, 1171-1199.

Iqbal, F. (2002). Palynology of the Middle Triassic (Nammal Gorge) Strata, Western Salt Range, Pakistan. *Ph.D thesis, Unpub. Univ. Punjab*. 199 pp.

Malik, T. (2005). Palynology of Early Triassic Strata (Mianwali Formation Nammal Gorge Section), Western Salt Range, Pakistan. *Unpub. Ph.D Thesis, Univ. Punjab,* 199p.

Masood, K. R., Khalid, A. N., Qureshi, K. A. and Hussain, Z. (1995). Further observations on Fossil Fungi (VA Mycorrhizae) from the Permian of Salt Range, Pakistan. *Pakistan Journal of Geology*, **3** (2): 7-10.

Masood, K.R., Qureshi, K.A., Sabri, S.N. and Hussain, Z. (1991). Middle Triassic Flora and Climatic changes in the Western Salt Range, Pakistan, based on Palynological data. *Acta Scientica*, **1**(2): 79-84.

Masood, K. R., Qureshi, K. A. and Hussain, Z., (1994.) Early Permian (Asselian) Miospore assemblage from Burikhel Coal Field, Salt Range, Pakistan. *Pakistan Journal of Geol*ogy, **2**(2): 50-64.

Masood, K. R., Qureshi, K. A., Iqbal, F. and Ahsan, N. (2000). Paleozoic Palynology (Permian) Of the Salt Range, Pakistan. "A Review", 3rd South Asia Geological Congress, Lahore, Pakistan, Abstract: *Abst. Geosas III.* PP. 153.

Peppers, R. A. (1970). Correlation and Palynology of coals in the Carbondale and Spoon Formations (Pennsylvanian) of the Northeastern Part of the Illinois Basin. *Illinois State Geological Survey Bull*. **93**: 1-139.

Phipps, G. and Playford, G. (1984). Techniques for extraction of palynomorphs from sediments. *Paper Department of Geology, University of Queensland,* **11**(1): 1-33.

P.J.R.G. (Pakistani Japanese Research Group) (1985). Permian and Triassic system in the Salt Range and the Surghar Range, Pakistan. *In*: Nakazawa, K., Dickins, J.M. (Eds.), *The Tethys*, pp. 221-312.

Playford, G. (1965). Plant microfossils from Triassic sediments near Poatina, Tasmania: *Jour. Geol. Soc. Australia.* **12**: 173-210.

Rehman, S. (2007). Palynostratigraphy of Middle Permian Sediment (Amb Formation-Artinskian) Salt Range, Pakistan. *Unpub. Ph.D Thesis, Univ. Punjab,* 199p.

Schopf, J. M., Wilson, L. R. and Bentall, R. (1944). An annotated synopsis of Paleozoic fossil spores and the definition of generic groups. *Illinois Geol. Survey Rept. Inv.* **91**: 1-73.

Segroves, K.L. (1970). Permian spores and pollen grains from the Perth Basin, Western Australia. *Grana*, **10**(1): 43-73.

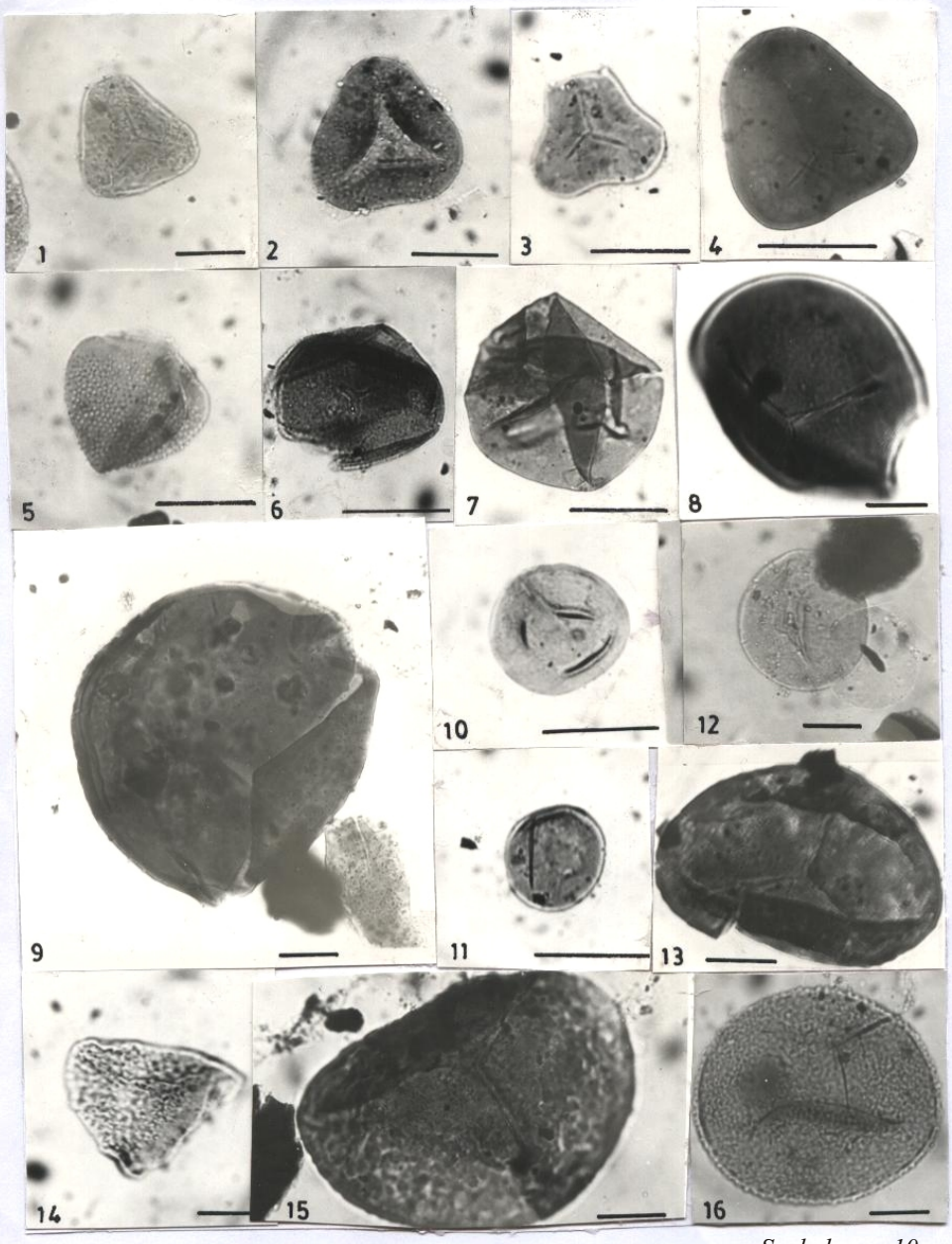
Shah, Ibrahim S.M. ed., (1977). Stratigraphy of Pakistan. *Mem. Geol. Surv. Pakistan,* **12**, 138 p.

Smith, A. H. V. and Butterworth, M. A. (1967). Miospores in the coal seams of the Carboniferous of Great Britain. *Special Papers in Palaeontology, No. 1. the Palaeontological Assoc.,* :1-324.

Virkki, C. (1937). On the occurrence of Winged spores in the Lower Gondwana rocks of India and Australia. *Proceedings of Natural Academy of Science,* India. **6**: 428-431.

Wilson, L. R. and Kosanke, R. M. (1944). Seven new species of unassigned plant microfossils from the Des Moines Series of Iowa. *Iowa Acad. Sci. Proc.,* **51**: 329-333.

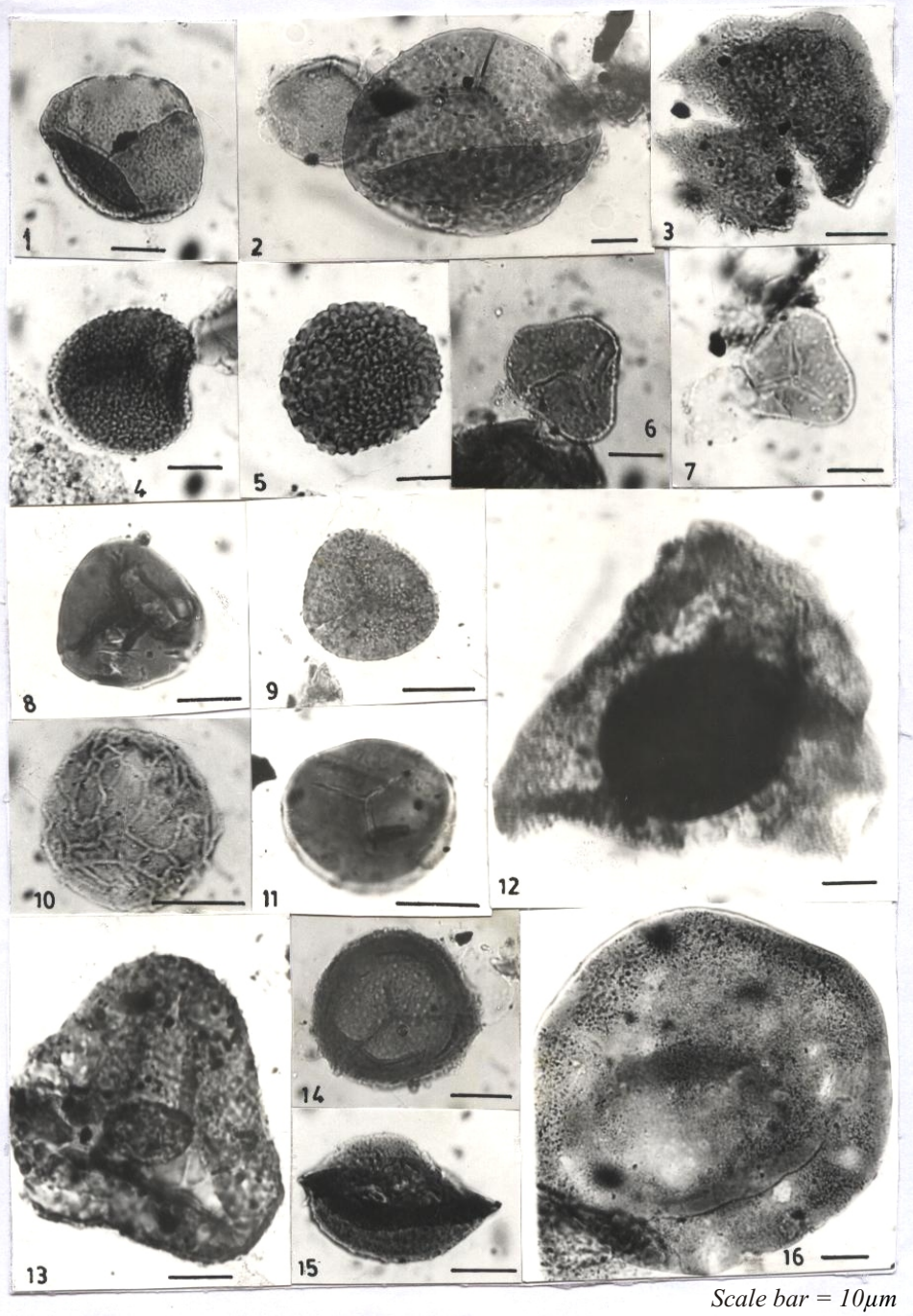
PLATE-1



Scale bar = 10μm

1. ***Leiotriletes adnatoides*** Potonie & Kremp
2. ***Leiotriletes notatus*** Hacquebard
3. ***Leiotriletes adnatus*** Kosanke
4. ***Leiotriletes parvus*** Gunnel
5. ***Leiotriletes directus*** Balme & Hennelly
6. ***Calamspora diversiformis*** Balme & Hennelly
7. ***Calamospora flexilis*** Kosanke, 1950
8&9. ***Punctatisporites gretensis*** Balme & Hennelly
10&11. ***Punctatisporites curviradiatus*** Staplin
12. ***Punctatisporites orbicularis*** Kosanke
13. ***Punctatisporites pseudolevatus*** Hoffmeister, Staplin & Malloy
14. ***Granulatisporites micronodusus*** Balme & Hennelly
15. ***Cyclogranisporites aureus*** (Loose) Pötonie & Kremp, 1955
16. ***Cyclogranisporites arenosus*** Madler, 1964

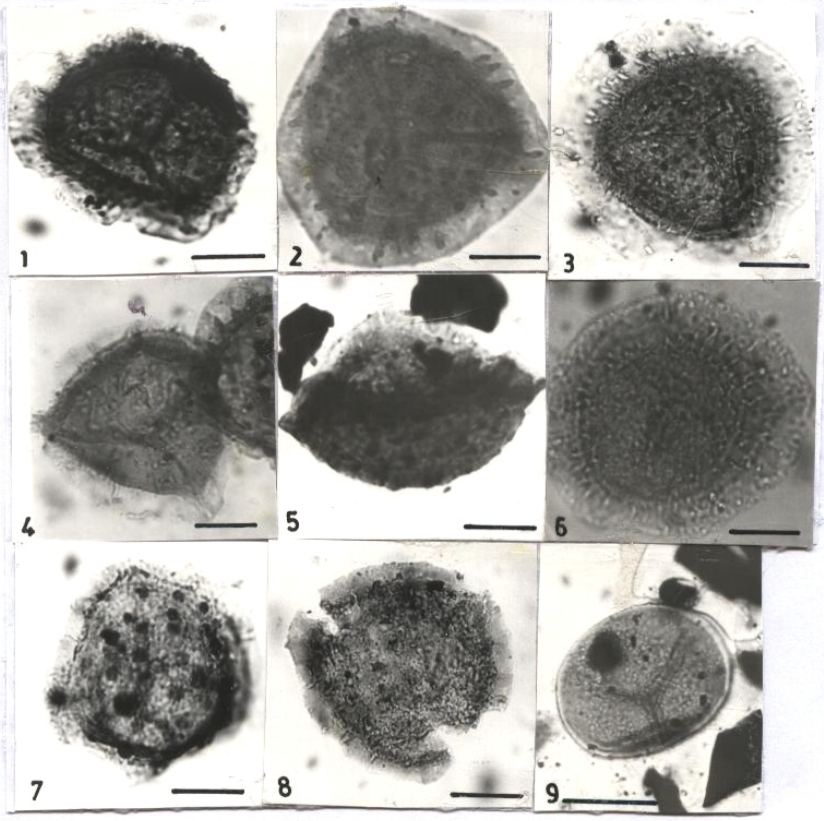
PLATE-2



Scale bar = 10µm

1. ***Cyclogranisporites arenosus*** Madler, 1964
2. ***Osmundacidites senectus*** Balme, 1970
3. ***Converrucosisporites subverrucosis*** Bharadwaj
4. ***Brevitriletes parmatus*** (Balme & Hennely) Backhouse
5. ***Leschikisporis cestus*** Segroves
6&7. ***Acanthotriletes tereteangulatus*** Balme & Hennelly, 1956
8. ***Altitriletes densus*** Venkatachala & Kar
9. ***Lophotriletes*** sp. cf. ***L. granoornatus*** Artüz
10. ***Dictyotriletes aules*** Rigby
11. ***Perotriletes*** sp.
12. ***Grandispora*** sp.
13. ***Camptotriletes warchianus*** Balme

PLATE-3



Scale bar = 10µm

1. ***Densoisporites complicates*** Balme
2. ***Densoisporites playfordi*** Balme
3&4. ***Lundbladispora obsoleta*** Balme
5. ***Kraeuselisporites rallus*** Balme
6. ***Kraeuselisporites cuspidus*** Balme
7&8. ***Jayantisporites variabilis*** (Anderson) Backhouse
9. ***Gondisporites imbricatus*** Segroves