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Trilete Spores Isolated From Sonda Coal Field District Thatta Sindh, Pakistan

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Abstract: The present paper deals with the description and distribution of trilete spores of 25 species belongs to 13 families. Family Schizaceae and Osmundaceae were dominant *Todisporites punctata sp nov. (*Leghari *et al.,).* Are newly reported.

Keywords: Trilete Spores of Sonda Coal.

1. INTRODUCTION

The coal deposits present in tertiary rock of Sindh, presents with in a two stratigraphic horizon i.e Ranikot seris and laki series (Balanford 1979). With the change of nomiculture are recognized as bara formation and Laki formation respectively. The coal desposits of sonda discovered during early 1981 are assigned to Bara formation (Lower Eocene). The coal deposits contain innumerable fossil remain with in them. During the investigation provide valueable in formation about Paleocological/Paleolimnological condition previling in that area. (Sahito *et al.*, 1987, 1988, 1996a,b) reported some Trilete spore, winged pollen grains, Algal microfossils, Angiospermic I Monocotyledan and II Dicotyledon Pollengrains and fungal remains isolated from Sonda Coal. Leghari *et al.*, (2001) described some rare algal and fungal spores from sonda coal. Soomro *et al.*, (2010) described 35 species of fungal spores including two new species during her research work. This paper deals with the some more trilete spores isolated and described in detail from sonda coal district Thatta Sindh Pakistan.

2. MATERIAL AND METHODS

The core samples of the Paleocene coal and associated sediments were collected from the borehole DH. No. 18 in the Sonda coal area, the drilling proved the occurrence of a number of coal seams in the subsurface up to depth of 1200 ft. In total 40 samples were collected, out of which 16 samples were selected. The coal was grayish black in color; the samples were taken from the depth Sonda coal mines (Bore whole DH.18) is located at Sonda which is almost 60 km in the south of Kotri, 30–35 km north from Thatta city.

The coalfield samples were macerated by adopting Schultz's (1928) method of maceration. The microscopic slides were prepared following Kisser method (1935). The slides were studied on ORTHOLUX II (Leitz Whatzler) microscope using eyepiece x10 with 40×objectives.

Systamatic Pleonology:

1. *Calamospora* Sp.I Bhardwaj and Venkatachala (1957)

Spore light brown in color 66 x 93 µm in size, trilet leasurae Y mark sign distinct rays extending up to 1 / 2 of the spore radius, straight labra thin inter – ray area darkened but the darkening clearly delimited from rest of the Surface of the Spore. (Pl2. Fig 10)

Affinity: *Colamitaceae*

Remarks: The present specimen is larger in size than that described by Bhardwaj and Venkatachala (1957) reported from Permian syste, in Pfalz (W. Germany).

2. *Callumispora tenuis* (Bhardwaj and Srivastava, 1968)

Spore yellowish brown in color, spherical to sub – spherical in shape, amb roundly 63 × 64.5 µm in size. Trilete laesurae with distinct labra, laesurae reaching upto the ¾ of the spore radius, equal to each other in length and placed at equal angles, ray ends tapering Exine 4.5 µm thick, laevigate, intrapunctate, the puncta uniformly distributed. This specie occur at depth of 177.7 meter deep in dark brown clay. (PL.No 1 Fig. 1).

Affinity: Uncertain.

Remarks: the present specimen is smaller in size than that described by Bahardwaj and Srivastava (1968) reported from Gondwana India.

***3. Callialasporites dampieri* (Balme) Dev (1971).**

Pollen grain brown in color, amb circular to sub circular 33 × 36 µm in size. Prosaccus 7.5 – 8µm wide, possessing radial folds which give, it a frilled appearance. Alete a very faint undulating Y mark sign seen which extends from pole to equator. Exine two layered and finely granulose. Occur at the depth of 567 meter deep with in Brownish grey clay. (Pl. 3, Fig 21)

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Affinity: ***Podocarpaceae.***
Remarks: The present specimen reported is smaller in size then those species described by Bhardwaj and Kumar (1970), Maheshwari (1974).

4. ***Cicatricosisporites australiensis potonie*** **(1956)**
Spores are golden brown yellowish in color and triangular 30 × 34.5 µm in size. Apices of the triangle are often rounded or notched, sides concave to slightly convex. Trilet laersurae Y mark sign distinc, rays slightly curved, reaching to the equatorial border commissure slightly raised, distal surface shows 3–4 series of narrow occasionally bifurcating muri, Exine 0.75 µm thick.. Spore Occur at the depth 77.7 meter deep in dark brown clay of Sonda Coal field. (PL. No1. Fig. 2)
Affinity: Schzaeaceae (Ricciceae)
Remarks: the present specimen smaller in size than that described by Ramanujam and Kalavati (1974) reported from Tamil Nadu India.

5.*Coniopteris hymenophylloides*. Brongt (1958)
Spore light brown in color and triangular, 33 × 36.6 µm in size, sides of Triangular are convex. Or planoconvex. Trilete leasure long reaching almost to the equator simple issues. Exine 1.5 µm thick and smooth. (Pl. 3, Fig 25)
Affinity: ***Dicksonaceae***
Remarks: In the present specimen is smaller in size then that described by Helal (1966) from Carbonaceous shales of middle Jurasic age Oasis from desert Egypt

6. ***Convolutispora*** **Sp.II Hoffmeister, Staplin and Malloy (1955).**
Spores are brown in color circular to sub – circular 53.4 x 63 µm in size Radial, Trilet surface ornamentation closely packed more or less reticualate ridges anastomosing in parts, Trilet mark, reaches upto the 2/3 of the spore radius, obscured by over lapping ridges, Exine 3 µm thick. (Pl2. Fig 11)
Affinity: ***Schizoaceaceae***
Remarks: The present specimen is slightly larger in size than that described by Sad (1965).

7. Cyathilites minor**: Couper (1953)**
Spore pale in color and rounded triangular 54 × 57 µm in size, side of the triangle straight to slightly concave, apical angle well rounded. Trilete laesurae clearly defined, short 7.5-9 µm thick. Occur at the depth of 587 meter deep with in brown clay and sandy partings. (PL. 3, Fig 22)
Affinity: ***Cyatheaceae***
Remarks: The present specimen is slightly larger in size then those species Ramanuyan and Kuluvati (1974), Reported from western Canadian Plains.

8. ***Dandotiaspora plicata*** **Sah and Kar (1971)**
Spore light brown in colour and round, Sub-triangular angles of the triangle are roundly broaded. Inter optical margin convex 46.5 x 51.7 µm in size. Trilete laesureae "Y" mark sign distinct moderate 15-18µm in length, thin, thickening appear at the ray angles. Exine 1.5 "Y" mark sign distinct moderate 15-18µm in length, thin, thickening appear at the ray angles. Exine 1.5 µm thick thicker at the apical region. This spore occur at the depth of 392 meter in the shale black in color with in abdent carbonaceous material. (PL. 1, Fig.5)
Affinity: ***SCHIZACEAE***
Remarks: the present spore is slightly smaller in size than that described by Kar and Jain (1978) reported from Akli lignite of Palaeocene- Eocene age Rajasthan India

9. Dandotiaspora telonata **Sah, Kar and Singh (1971)**
Spore brown in colour amb triangular to sub circular in polar view 69 x 72 µm in size. Trilete laesurae "Y"mark sign prominent and some what straight extending up to the ¾ of the spore radius, bifurcating at tips "Y" mark enclosed with in thick end and raised labrra. Exine 3.0µm thick, some times more thickened nearapices, laevigate. Some times intra punctata in prokimal view. Occur at the depth of 492 meter deep within liginite coal. (Pl.2, Fig.12).
Affinity: ***SCHIZAEACEAE***
Remarks: The present specimen shows close resemblances with that described by the Singh et al (1977) the genus *Dandotiaspora* was originally instated by Sah *et al.,* (1971) is a dominant in the Lower Eocene anemblage of India.

10. ***Dictyophyllidites sp.*****I. Couper emend Dett mann (1963)**
Spore dark brown in color amb rounded triangular 69×78 µm in size. Inter–apical remain slightly cancave, often folded along one of trilete rays Haptotypic marks well developed. Trilete leasure distinct extending upto the equator. Associated with well developed, uniformly broad infra structured Kyrtome, Exine 3µm thick and infrastructured. (Pl. 2,Fig 13).
Affinity: ***Matoniaceae***
Remarks: The present specimens slightly smaller in size and has intra structured exine and Kyrtome than descriebd by Kar and Kumar (1986) from palaeocene Meghaliya India.

11. ***Dictyotriletes pseudoreticulatus*** **Couper and Pocock (1962)**
Spore dark brown in color, amd rounded triangular sides Convex to straight 33 × 49.5
µm in size. Trilete , larsurae almost reaching equator, commisures raised Distal surface shows strong fovea – reticulate ornamentation. Luminae about 6 – 12×9 – 15 µm wide. Seperated by muri about 1.5 µm thick . muri flat topped. Exine 1.5 µm thick.Occur at the depth of 567 meter deep in brownish gray clay of Sonda Coal. (Pl. 2, Fig 16-17)

Affinity: ***SCHIZACEAE***

Remarks: In present specimen the luminac are more wide than that described by Philips and Fleix (1971) Jurassic cretaceous boundary in the Western Canada

12. ***Dictyophyllidites cherrapunjensis*** **Kar and Kumar (1986)**

Spore golden brown in color, circular to sub circular, 43.5 × 45µm in size, mostly folded along haptotypic mark to provide various shapes. Surfaces punctuate. Trilete distinct extending upto ¾ radius of the spore associated with well developed, uniformly broad kyrtome Exine, 3 µm thick. Occur at the depth of 1528.07 mt deep in black lignitic coal. (Pl. 3, Fig 26)

Affinity: ***MATONIACEAE***

Remarks: The present specimen is slightly small in size with punctuate surface and exine described Kar and Kumar (1986) India.

13. ***Leiotriletes dorogensis*** **Kedves (1961)**

Spore dark brown in color, tri plano convex triangular, angles of the triangle are rounded obtuse, 78 x 84 µm in size. Trilete leisure "Y" mark sign extends through out the whole radius of the spore Exine 3 µm thick, laevigate. This species occur at the depth 392 meters within black color material.(Pl.1 Fig. 7)

Affinity: ***GLEICHENIACEAE.***

Remarks: The present specimen shows close resemblance with that described by Akyol (1971) reported from L. Oligocene sile Istanbul.

14. ***Laevigatis Sporites pseudomaximus*****: Thomson and Pflug (1953)**

Spore light brown in color, sub circular 52×69 µm Trilete Y marked leisure simple, reaching the 3/4th of the spore, radius. Exine 3 µm thick laevigate.

Affinity: ***SCHIZAEACEAE.***

Remarks: The present specimen is slightly smaller in size than that as described by Thomson and Pflug (1953) reported from Western Krefelds, Germany.

15. ***Leiotriletes dorogensis*** **Kedves (1961)**

Spore dark brown in color, triangular, triplanoconvex, angles of the triangle are rounded about 60×75 µm in size. Trilete, Y mark leisure extends through out the whole radius of the spore, Exine 3 µm thick leavigate.

Affinity: ***GLEICHENIACEAE***

Remarks: The present specimen shows close resemblance with that described by Erol Akyol (1971) from L. Obligocene of Sile – Istannbul.

16. ***Laevigatisporites neddeni Sub Sp. torus*** **Thomson and Pflug (1953)**

Spores are light yellowish in color, triangular Concavo - Convex with broaded and rounded angles, 48 × 54 µm in size. Trilete laesurae "Y" mark sign reaching upto 2 / 3 radius of the spore. Exine 1.5 µm thick laevigate. Occur at the depth of 392 meter with shale black in color and also at the depth of 567 meter deep in brownish gray clay**. (Pl. 1 6 and Pl. 2, 18).**

Trilet spores of Pteridophyta Isolated from Sonda Coal area DH- 18 Bara Formation of Palaocene, District Thatta. Sindh.

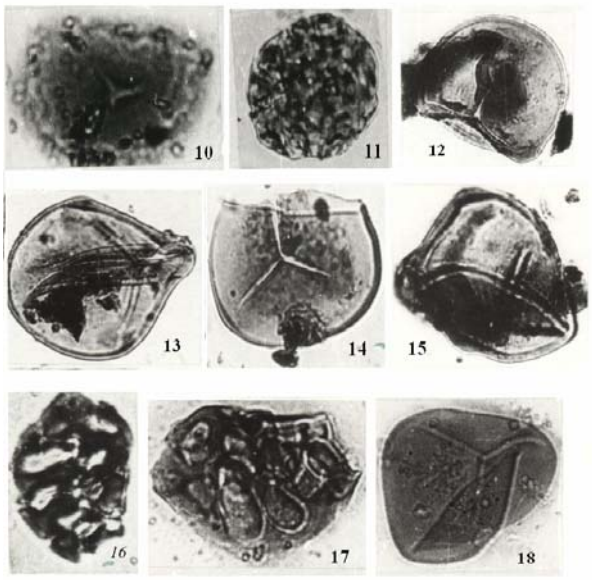

PLATE NO. 2 *Figs.10 - 18* *(10 ×40)*

10. Calamospora sp.1. Bhardwaj and Venkatachela
11. Convolutispora sp. Hoffmeister, Staplin and Malley.
12. Dandotiaspora telonata Sah, Kar and Singh.
13. Dictyophyllidites sp.1. Couper emend Dettman.
14. Laevigatisporites psendomaximus Pflug and Thompson
15. Leiotriletes dorogensis Kedves.
16. Dictyoriletes pseudoreticulatus Pocock
17. Dictyoriletes pseudoreticulatus Pocock
18. Laevigatisporites neddeni sub-sp. torus R.Pot

Trilet spores of Pteridophyta Isolated from Sonda Coal area DH- 18 Bara Formation of Palaocene, District Thatta. Sindh.

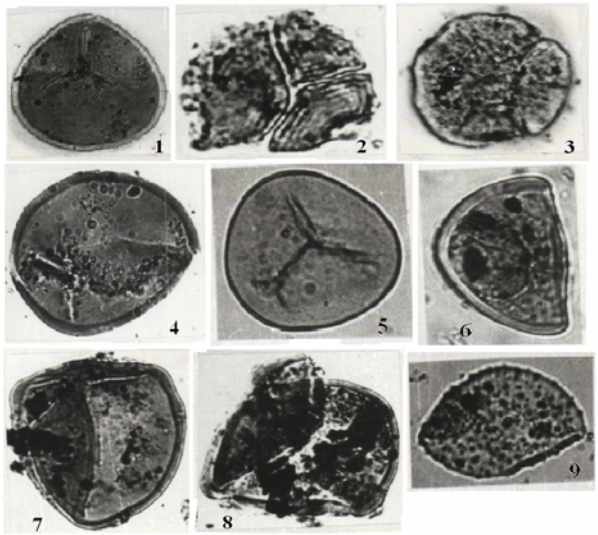

Plate No. 1. Fig: 1-9 *(10 × 40)*

1.Callumispora tenuis
2.Cicatricosisporites australiensis Potonie
3.Nevesisporites fossulatus Balme
4.Todisporites punctata sp. nov
5.Dandotiaspora plicata Sah, Kar and Singh
6.Leavigatisporites neddeni Sub sp torus Pf
7.Leiotriletes dorogensis Kedves
8.Murospora punctata Venkatachala
9.Osmundacidites senectus Balme

Affinity: ***Cyatheaceae***
Remarks: The present spore slightly larger in size than that descriebd by Thomson and Pflug (1953), from Tertiary Sediments North– Western Krefeild Germany.
17. ***Lygodium sporites padappak karensis*****. Rao and Ramanujam (1976).**
Spores are light brown in color, Amb rounded triangular 47 µm in size. Trilete laesurae "Y" mark sign clear, rays short, reaching only upto 1 / 2 half of the spore radius ends of the Y mark laesurae pointed.
Affinity: ***Schizaeaceae***
Remarks: The present spore shows close resemblance with that descriebd by (Rao Rananujam (1976), Venkatachala and Rawat (1971), South India
18. ***Lycopodium sporites palaeocenicus*** **Dutta and Sah (1970)**
Spore light brown in color and rounded triangular, 46.5×51 µm in size, apical side slightly convex. Trilete distinct, straight leasure short extending upto 1 / 2 of the spore radius exine 1.5 µm thick, reticulate, muri thin , usually projecting out the equator due to lateral pressing lumina, irregular to polygonal in shape ±1.5 µ macros. Occur at the depth of 923 meter deep in dirty brown loose sand stone medium grained.
Affinity: ***Lycopodiaceae***
Remarks: In the present specimen the trilete lacsurae is short but in size, It is a slightly larger than that described by Singh (1974), reported from turaformation – Tertiary succession of Garo Hills.
19. ***Murospora punctata*** **venkatachala (1968)**
Spore golden brown in color roundly triangular 60 × 75 µm in size. Cingulate, trilate laesure Y mark sign distinct, rays reaching upto cingulum. Cingulum 6.5 µm broad. Uniform. Exine of the centeral body punctuate, Puncta evenly distributed Exine 3.75 µm thick. Occur at the depth of 392 meter within Black colour of coaly material. (Pl. 1, Fig 8)
Affinity: Uncertain.
Remarks: the present specimen is slightly larger in size then that described by Venkatachela (1968) from Mesozoic Sediments of Kutch, Bhuj, India.
20. ***Nevesisporites fossulatus Balme*** **(1970)**
Spore amb circular to strongly rounded or triangular 45 × 48 µm in size. Trilet Lacsurae distinct, extending to inner margin of the Equatorial thickening ends of the laesurae bifurcate. Commissure bordered by narrow sinuous raised libra. Exine thin and translucent, bearing scattered and sparse genera. (PL. No. 1, Fig. 3)
21. ***Novitasporites triassicus Tiwari and Rana*** **(1978)**
Spore light brown in color out line some what quadrant 36 × 54 µm in size. Y mark trilete leasure prominent leasure extending upto ¾ of spore radius bifurcate at the end. Exine 3 µm thick. Infrapunctate covered tightly with hyaline sculptureless unsaturated perisporial covering perispore UN enely wide about 3 µm thick. Occur at the depth of 700 meter deep brownish sandy micaceous sand stone with miaceous partings. (Pl. 3, Fig 23)
Affinity: Uncertain
Remarks: Tiwari (1978) reported and described a new genus *Novitasporites* along with two new species *N. triassicus* and *N. triangularis* from lower middle Triassic sediments Damondear Basin India.
Result: The present specimen reported from Sonda Coalfield is smaller in *N. triassicus* Tiwari (1978).
22. ***Osmundacidites senectus*** **Blame (1970)**
Spore golden brown in color, amb distributed by compressional foldings elliptical oval 33 × 57 µm in size. Trilete laesurae extending upto ¾ of the spore radius Exine 0.75 µm thick. Sculptured by very fine elements, muri 0.6 µm high and about 1.5 µm apart from each other and about 0.9 µm broad at the base. Occur at the depth of 392 meter deep within black color of coaly material. (Pl1, Fig 9)
Affinity: ***Osmundaceae***
Remarks: The present speciment is slightly smaller in size then that described by Balme (1970) from permion and Triassic strata in the salt range and Surghar Range Pakistan.
23. ***Todisporites Punctata Sp. Nov*** **Leghari** ***et al.,***
Mio spore golden brown in color, Sub circular, 57 × 69 µm in size. Trilete Y mark, rays extending upto the 3/4 spore radius long open. Exine 3 µm thick intrra punctuate, puncta distinct, larger and more in number in the inter ray area. This species occur at the depth of 177 meter deep in dark brown clay. This sample are very rich with microfossils. (Pl. No.1 Fig. 4)
Affinity: ***Osmundaceae***
Remarks: The present mio spore is larger in size than that described by Maheshwari (1974) reported from lower creataceous Bansa Formation, South Gondwana Basin, India.
24. ***Todisporites minor*** **Couper (1958)**
Spore light brown in color, roundly triangular, 69× 73.5µm in size. Trilete laesure simple, extending upto the ¾ of the spore radius, Exine laevigate, thin frequently folded. This specie accur at the depth of 567 meter in brownish gray clay in Sonda coaly field.
Affinity: ***Osmundaceae***
Remarks: The present species is larger in size than all the previously described species by (Pocock, 1962; Thomas and Groot, 1966; Ramanujan and Kalavati, 1974; Rao and Singh, 1986; Saxena and Misra, 19890), reported from upper Jurrasic and lower cretaceous Boundary in the western Canadian plains, Marine upper cretaceous and lower cretaceous carbonaceous shales, Tamil Nadu India.
25. ***Veryucosisporites naumovae*** **Hart.**
Spore light brown in color and rounded triangular, sides convex. 93 × 108 µm in size, Trilete Y marks

leasure straight and extends upto the equator slightly sinuous. Commissure 0.75 µm wide and bordered by prominent elevated lebra which tend to lufurcate at their ends and then anastomore labra slightly punctutate Exine 1.5 µm thick, provided by densely spaced rounded flat topped verruaea or sub – baccula that are circular in out line. Occur at the depth of 1732 meter deep blacksandy clay with abdent carbon particles. (Pl. 3, Fig 27)

Affinity: *Osmundaceae*

Remarks: The present specimen larger in size that that descriebd by segroves (1970) from Permian perth Basin western Australia.

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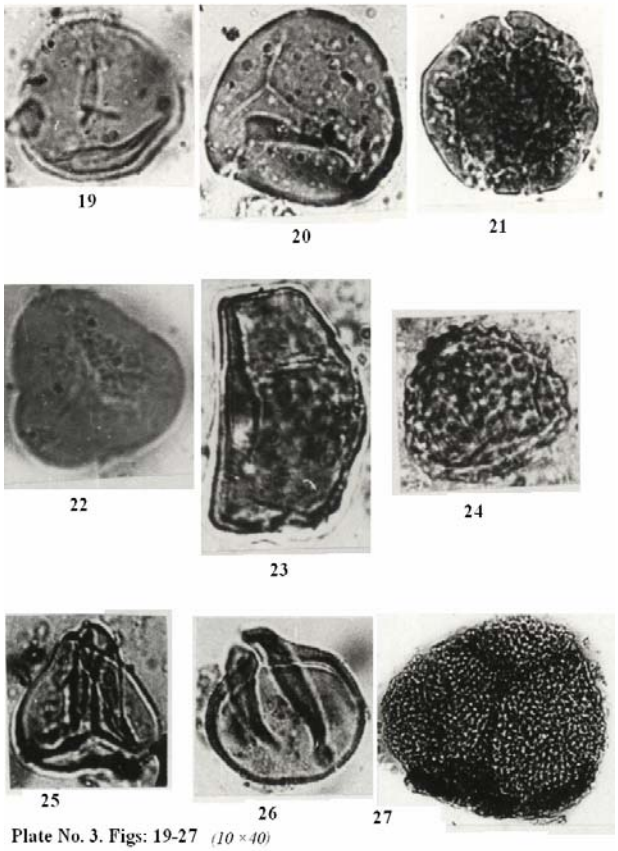

Plate No. 3. Figs: 19-27 *(10 × 40)*

19. Lygodiumsporites padappakkarensis Rao and Ramanujam.
20. Todisporites minor Couper.
21. Callialasporites dampieri Dev.
22. Cyathidites minor Couper
23. Novitasporites triassicus Tiwari and Rana
24. Lycopodiumsporites palaeocenicus Dutta and Sah.
25. Coniopteris hymenophylloides Brongt.
26. Dictyophyllidites cherrapunjensis Kar and Kumar.
27. Verrucosisporites naumovae Hart.

3. DISCUSSION

The Pteridophytic spores were found in the sediments in between coal seams and associated carbonaceious layers of Bara formation examined and have been described the distribution of palynomorphs. The palynomorphs include *Cyathidites minor, Polypodiisporties mawakimaensis, Novitasporites triassicus, Todisporites minor Dandotiaspora plicata, Laevigatisporites neddeni, sub sp. torus, Lycopodiumsporites, palaeoemicus, Dictyophylloidites cherrapunjensis* recorded from sediments in between the coal seams. Sahito *et al.,* (1987) repoted and described 14 species of trilate spores belong to 11 genera d 7 families of peteriodophyta from Sonda coal.

Similarly the fossil pteridophytic spores recorded in the present study recovered from carbonaceous layer below the coal sem in Sonda subsurface sequence have already been reported by many workers from various places and different Geological periods, *Dandotiaspora plicata* (Akli lignite of Palaeocene age Rajasthan India, Eocene Sediments Kerala coast South India.

Laevigatisporites neddeni sub. sp. torus and *Laevigatisporites pseudomaximus* have been reported from Tertiary sediments of North Western Krefeld, Germany Thompson and Pflug (1953), and *Laevigatisporites anomalus* from upper cretaceous and Lower Tertiary Montana, U.S.A. by Norton and Hall.

Among the fossil flora of pteridophyta the Genus *Dandotiaspora* is most significant as a stratigraphic marker as it exhibits marked dominance in different stratigraphic intervals of the Lower Eocene sediments of Assam, Gujrat, Rajasthan and Central Asia. This type of spore characterizes the palaeocene - lower Eocene sediments in India. Vimal, (1952) for the first time reported it from Dandot lignites (Lower Eocone), Salt rang, Punjab, Pakistan.

Todisporites minor has a wide range of occurrence. It is widely distributed in the Mesozoic and Tertiary sediments of both hemispheres. However Pocock (1962) earlier described it from upper Jurassic and Lower cretaceous boundary of the Western Canadian plain.

Lycopodiumsporites palaeocenicus was originally described as sp. Nov Dutta and Sah (1970), with short trileate laesurae from Tertiary rocks of Asam. Later on Singh (1974 and 1989) described the same species with long distinct trilate laesurae from Tura formation Tertiary Succession of Garo Hills and from Langrin coalfield; Khasi Hills, Meghalaya India respectively. Morphologically our specimen is slightly smaller in size relative to the earlier reported specimens but the trilete “Y” mark Laesurae character is short in the present specimen reported from Sonda Coal basin Sediments of District Thatta Sindh Pakistan.

4. CONCLUSION

In the observation Palaeo Ecological condition the Sond coal basan is the primary base of coal forming material. These trilate spores shows their distribution in tropical and sub tropical region. Prevalence of tropical to sub tropical climatic condition in this region, during middle palaeocene period.

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