PALYNOLOGY OF THE MESOZOIC SEDIMENTS OF KUTCH, W. INDIA. 7. REWORKED PERMIAN POLLEN FROM THE UPPER JURASSIC SEDIMENTS — A DISCUSSION

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ABSTRACT

Recycled Permian pollen are recognized in Katrol (Upper Jurassic) sediments along with typical Jurassic spores and pollen. Similar records in Jabalpur Series near Sehora (DEV, 1959) and Cannanore lignites (POTONIÉ & SAH, 1958) are also considered as significant in picturing the depositional history. It is inferred that Permian sediments extended as far as Kutch in the west and Cannanore in the south and have been since eroded away and redeposited in later times.

PALYNOLOGICAL fossils of older ages are commonly encountered amidst younger assemblages. A correct assessment and identification of these fossils help in palaeoecological interpretations and picturing the environment of deposition while failure to recognize them may result in erroneous dating of sediments. Reworked or recycled fossils are common in shales, limestones, siltstones and sandstones as these contain washed out material during deposition whereas peats and coals, to a great extent, represent *in situ* formations.

Reworked fossils are reported by various workers. The earliest report is of Bartlett (1928). He recovered reworked Carboniferous megaspores in coal pebbles from glacial deposits of Ann Arbor, U.S.A. Dijkstra (1949) recovered distinct Westphalian megaspores from the Cretaceous sediments of South Limburg. The same author (1950) recovered Carboniferous megaspores from the Quaternary sediments of southern England.

Cookson (1955) illustrated well-preserved typical Permian monosaccate pollen as well as striate bisaccate pollen from the

(1) Upper Cretaceous to Eocene sediments of Victoria;
(2) Palaeocene-Eocene sediments belonging to Moonlight Head-Princetown-Series of S.W. Victoria;
(3) Eocene basal clay of Castlecove section, Aire coast, Victoria;
(4) Eocene marine Carboniferous mudstone from near the base of the Dartmoor formation near Casterton, Victoria; and
(5) a marine carbonaceous deposits of probable Eocene age from Noarlunga, South Australia.

Potonié and Sah (1958) illustrated and named typical saccate pollen from the Cannanore lignites. *Cannanoropollis*, a new genus described by them, is a typical Permian fossil met with in the Permian continental deposits (VENKATACHALA & KAR, in press and others). In a subsequent publication this pollen has been named as *Virkkipollenites* from the Talchir beds by Lele (1964). *Lunatisporites* described by Potonié and Sah (*l.c.*) is also a Permian form.

Wilson (1964) mentioned occurrences of recycled Sylvan (Ordovician) fossils in Goddard (Mississippian) shales and also pointed out the confusion caused by the reworked pollen in the Anadarko basin, Oklahoma, U.S.A.

Wilson and Venkatachala (unpublished manuscript) identified a rich Carboniferous assemblage amidst typical Palaeocene spores, pollen, hystrichosphaerids and dinoflagellates of Wills Point shales in Saline County, Arkansas, U.S.A.

Groot (1963) recovered Palaeozoic, Mesozoic and Tertiary fossils from a core collected on the Biscay Abyssal plain in the Atlantic Ocean, and Muir (1967) recovered Carboniferous spores and pollen from Jurassic sediments in Great Britain.

The recycled fossils can be identified by differential biological stain reactions. The Carboniferous spores and pollen in Wills Point shales are dark brown to black in colour and not easily stained whereas the

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younger fossils absorb the stain readily. The stain safranin 'O' gives a differential stain reaction that may easily help to determine the reworked pollen (WILSON, 1964). Reworked fossils are also often not well preserved and thus can be recognized.

Using the stain technique Wilson (1965) differentiated Mississippian fossils in Pennsylvanian sediments from Ti Valley, Pittsburg County, Oklahoma. Van Gijzel (1967) suggests the use of fluorescence microscopy to detect reworked fossils in sediments.

Guennel (1963) reports a more interesting phenomenon of a reversal of this process, where Devonian fossils are recovered from a Middle Silurian core in southern Illinois. This represents fissure fillings — a stratigraphic leak.

The recognition of fossil suits of older age, in younger sediments has a direct bearing on the reconstruction of past history of the concerned formations.

Dev (1959) illustrated and described striate saccate and other Permian pollen from sediments of Jabalpur Series exposed near Sehora on the Sher river in Narsinghpur district, Madhya Pradesh. The following taxa, described by him, are characteristic Permian fossils:

Sehorisporites indicus (PL. 3, FIG. 22) (= *Densipollenites* sp.).

cf. *Zonalasporites* (PL. 3, FIG. 23) (= *Virkkipollenites* sp.).

Circella splendidus (PL, 4, FIG. 24) (= *Virkkipollenites* sp.).

Striatites indicus (PL. 4, FIG. 32) (= *Lahirites* sp.).

Striatites sp. (PL. 4, FIG. 23) (= *Strotersporites* sp.).

Protosacculina sp. (PL. 5, FIG. 1) (= *Hamiapollenites* sp.).

Protosacculina sp. (PL. 5, FIG. 35) (= *Sulcatisporites* sp.).

Protosacculina sp. (PL. 5, FIG. 36).

Striatopodocarpites balmei (PL. 5, FIG. 37) (= *Striatopiceites* sp.).

Striatopodocarpites sp. (PL. 5, FIG. 38) (= *Striatopiceites* sp.).

Protoconiferus grandis (PL. 7, FIGS. 50, 51) (= *Sulcatisporites* sp.).

Pityosporites sp. (PL. 6, FIG. 46) (= *Vestigisporites* sp.).

These forms are associated with typical Mesozoic fossils, viz. *Cyathidites, Concavissimisporites, Todisporites, Lycopodiumsporites, Boseisporites, Callialasporites* (= *Applanopsis*); *Podocarpidites, Podosporites, Araucariacites*, etc.

Singh (1966) studied coals from the neighbourhood of Sehora and Hathnapur and described a typical Lower Cretaceous palynological assemblage characterized by the following spore-pollen genera: *Aequitriradites, Cooksonites, Matonisporites, Rouseisporites, Contignisporites, Densoisporites, Murospora, Araucariacites, Callialasporites* (= *Applanopsis*), *Classopollis* and others.

Singh (*l.c.*) was unable to recover any saccate Permian pollen from coals he studied and thus could not confirm the findings of Dev (*l.c.*) in regard to the occurrence of saccate Permian type of pollen. Since the two authors investigated entirely two different types of deposits, viz. coal and detrital sediments, it is not surprising to find this difference in palynological composition. Coals mostly contain endemic and wind-borne palynological fossils, *per contra* clastic rocks like sands, shales, siltstones contain water and wind-borne fossils and still others derived from the pre-existing rocks which themselves may contain fossils of earlier ages. Therefore, it is possible to explain fossils of older formations in younger ones. The Permian fossils in the Jabalpur assemblage described by Dev (*l.c.*) may be reworked fossils from the older formations.

The author recently investigated palynological fossils from the Katrol formation (Upper Jurassic) of Kutch (VENKATACHALA, KAR & RAZA, 1969) and recognized the following Permian assemblage (PLATE 1):

Virkkipollenites Lele (= *Cannanoropollis* Pot. & Sah)

Parasaccites Bharad. & Tiw.

Limitisporites Leschik

Densipollenites Bharad.

Strotersporites Wils.

Striatopiceites (Zor. & Sed.) Sed.

Striatites (Pant) Bharad.

Sulcatisporites (Leschik) Bharad.

The above fossils are not rare in the preparations and encountered frequently. The other spores and pollen in the assemblage characteristic of Upper Jurassic (Katrol) are: *Cyathidites, Concavissimisporites, Lycopodiumsporites, Foveotriletes, Impardecispora, Contignisporites, Araucariacites, Callialasporites, Podocarpidites, Trilobosporites, Laricoidites, Matonisporites, Katrolaites* and others.

The authenticity and identification of the Permian fossils in the Jurassic rocks

of Kutch cannot be doubted because true Permian (Lower Gondwana) palynological assemblages from India, Australia, Africa and other countries are well known. Balme and Hennelly in a series of papers (1956, 1956a, 1956b) illustrated and described the fossils occurring in various Australian Permian sediments. The Indian Permian sediments are studied extensively by Bharadwaj (1962), Bharadwaj and Tiwari (1964), Kar (1967, 1968, 1969), Lele (1964, 1965), Potonié and Lele (1961), Maheshwari (1966), Tiwari (1964, 1966), Venkatachala and Kar (1964a, 1964b, 1965, 1966a, 1966b, 1966c, 1967) and others.

Bose and Kar (1966, 1967a, 1967b), Bose and Maheshwari (1966) and Kar and Bose (1967) studied Lower Gondwana fossils from Belgian Congo, Leschik (1959) the fossils from the Karoo sandstones of South West Africa and Hart (1960, 1963, 1964, 1965) in considerable detail some African lower Gondwana sediments. Our knowledge of the Lower Gondwana fossils thus is extensive and, therefore, the chances of wrong assignment are practically negligible.

Very little is known of the Triassic spore-pollen assemblages from Gondwana continents. Balme (1963), De Jersey (1962) and others have described Triassic assemblages from Australia.

Indian Triassic assemblage that the author had the privilege of examining (SAH, VENKATACHALA & LAKHANPAL, in press) and those studied by Bharadwaj and Srivastava (personal communication) are distinctly different. Striate bisaccate pollen do occur in these sediments, they are: *Taeniasporites*, *Striatites*, *Strotersporites*, which are associated with other typical saccate Triassic fossils belonging to *Triadispora*, *Voltziaceaesporites*, *Falcisporites*, *Microcachryidites*, *Ovalipollis*, *Chordasporites*, besides trilete spores. Striate saccate pollen are known to extend only up to Triassic.

The restricted assemblage in question is thus undoubtedly of Permian aspect. *Virkkipollenites*, *Plicatipollenites*, *Parasaccites*, *Densipollenites* and *Lunatisporites* found in Katrol sediments are, as far as known to the author, restricted to Permian sediments.

The point of interest in this Permian suit occurring in younger rocks, i.e. Katrol, is far reaching. There are no Permian (Lower Gondwana) rocks occurring at the surface in the vicinity of Kutch which could have provided the reworked pollen assemblage. This leads to the inference that Permian sediments extended as far as Kutch and have been since eroded away and redeposited in the Jurassic times, or the Permian fossils are probably derived from the Rajasthan Permian outcrops. The occurrence of Permian pollen in the Cannanore lignites studied by Potonié and Sah (1958) also are of significance. There are no Lower Gondwana outcrops in this area or in the near vicinity. It is, therefore, suggested that the Permian sediments might have extended as far south as Cannanore and since then recycled and deposited in the younger sediments.

REFERENCES

BALME, B. E. (1963). Plant microfossils from the Lower Triassic of western Australia. *Palaeontology*. **6** (1): 12-40.

BALME, B. E. & HENNELLY, J. P. (1955). Bisaccate sporomorphs from Australian Permian coals. *Austrl. J. Bot.* **3**: 89-98.

Idem (1956a). Monolete, Monocolpate and Alete sporomorphs from Australian Permian sediments. *Ibid.* **4**: 54-67.

Idem (1956b). Trilete sporomorphs from Australian Permian sediments. *Ibid.* **5**: 240-260.

BARTLETT, H. H. (1928). Fossils of the Carboniferous coal pebbles of the glacial drift. *Pap. Mich. Acad. Sci. Arts & Letters.* **9**: 11-28.

BHARADWAJ, D. C. (1962). The Miospore genera in the coals of Raniganj stage (Upper Permian), India. *Palaeobotanist.* **9** (1&2), 68-106, 1960.

BHARADWAJ, D. C. & SRIVASTAVA, S. C. (1969). A Triassic mioflora from India. *Palaeontographica.* **122b.**

BHARADWAJ, D. C. & TIWARI, R. S. (1964). On two monosaccate genera from Barakar stage of India. *Palaeobotanist.* **12** (2): 139-146, 1963.

BOSE, M. N. & KAR, R. K. (1966). Palaeozoic sporae dispersae from Congo. I. Kindu-Kalima and Walikale regions. *Annls Mus. R. Congo cent. ser.* 8. **53**: 1-169.

Idem (1967a). Palaeozoic sporae dispersae from Congo. IV. On some new Miospore genera. *Ibid.* **54**: 87-99.

Idem (1967b). Palaeozoic sporae dispersae from Congo. V — Megaspores from Assise des Schistes Noirs de la Lukuga. *Ibid.* **54**: 105-111.

BOSE, M. N. & MAHESHWARI, H. K. (1966). Palaeozoic sporae dispersae from Congo. The Epulu River (Ituri). *Ibid.* **53**: 241-251.

COOKSON, I. C. (1955). The occurrence of Palaeozoic microspores in Australian Upper Cretaceous and Lower Tertiary sediments. *Aust. J. Sci.* **18** (2): 56-58.

DEV, SUKH (1959). The fossil flora of the Jabalpur Series. 3. Spores and pollen grains. *Palaeobotanist.* **8** (1&2): 43-56.

DIJKSTRA, S. J. (1949). Megaspores and some other fossils from the Aachenian (Senonian) in South Limburg, Netherlands. *Mededel. Geol. Sticht.*, n.s., No. 3, 19-32.

GIJZEL VAN, P. (1967). Palynology and Fluorescence microscopy. *Rev. Palaeobot. Palynol.* 2, 49-79.

GROOT, J. J. (1963). Palynological investigation of a core from the Biscay Abyssal plain. *Science.* **141** (3580): 522-523.

GUENNEL, G. K. (1963). Devonian spores in a Middle Silurian reef. *Grana palynol.* **4** (2): 245-261.

HART, G. F. (1960). Microfloral investigations of the lower coal measures (K2); Katewaka-Mchuchuma coalfield, Tanganyika. *Bull. geol. Surv. Tang.* **30**: 1-18.

Idem (1964). A review of the classification and distribution of the Permian Miospores: Disaccate striatiti. *C.r. 5. Cong. Strat. Geol. Carbon.* **83** (3): 363-369.

DE JERSEY, N. J. (1959). Jurassic spores and pollen grains from the Rosewood coalfield. *Qld. Govt. Min. Jour.* **60**: 346-366.

Idem (1962). Triassic spores and pollen grains from the Ipswich coalfield. *Publ. Geol. Surv. Qd.* No. **307**: 1-18.

Idem (1963). Jurassic spores and pollen grains from the Marburg sandstone. *Ibid.* No. **313**: 1-15.

KAR, R. K. (1968). Palynology of the Barren Measures sequence from Jharia coalfield, Bihar, India. 2. General Palynology. *Palaeobotanist.* **16**: 115-140, 1967.

KAR, R. K. & BOSE, M. N. (1967). Palaeozoic sporae dispersae from Congo. III. Assise des Schistes Noirs de la Lukuga. *Annls. Mus. R. Congo Belge.* 8. **54**: 3-61.

LELE, K. M. (1964). Studies in the Talchir Flora of India. 2. Resolution of the spore genus *Nuskoisporites* Pot. & Kl. *Palaeobotanist.* **12** (2): 147-168, 1963.

Idem (1965). Studies in the Talchir flora of India. 3. *Stellapollenites* — a new monosaccate pollen genus from the South Rewa Gondwana basin. *Ibid.* **13** (1): 109-113.

LESCHIK, GEORGE (1959). Sporen aus den " Karrusandsteinen " von Norronaub (Südwest Afrika). *Senck. Leth.* **40**: 51-95.

MAHESHWARI, H. K. (1966). Studies in the Glossopteris flora of India. 29. Miospore assemblage from the Lower Gondwana exposures along Bansloi river in Rajmahal Hills, Bihar. *Palaeobotanist.* **15** (3): 258-280.

MUIR, M. (1967). Reworking of spores in Jurassic assemblages. *Abstr. Int. Conf. Paly. Utrecht.* The Netherlands.

POTONIÉ, R. & SAH, S. C. D. (1958). Sporae dispersae of the lignites from Cannanore Beach on the Malabar coast of India. *Palaeobotanist.* **7** (2): 121-135.

POTONIÉ, R. & LELE, K. M. (1961). Studies in the Talchirs of India. I. Sporae dispersae from the Talchir beds of South Rewa Gondwana basin. *Palaeobotanist.* **8**: 22-37, 1959.

SINGH, H. P. (1966). Reappraisal of the Mioflora from the Jabalpur Series of India with remarks on the age of the beds. *Palaeobotanist.* **15** (1-2): 87-92.

SAH, S. C. D., VENKATACHALA, B. S. & LAKHANPAL, R. N. (1967). Palynological evidence on the age of Krols. *Abstr. Seminar on Krols. Pub. Centr. Adv. Study Geol.* No. **4**: 15-16.

TIWARI, R. S. (1964). New Miospore genera in the coals of Barakar stage (Lower Gondwana) of India. *Palaeobotanist.* **12** (3): 250-259, 1963.

Idem (1965). Miospore assemblage in some coals of Barakar stage (Lower Gondwana) of India. *Ibid.* **13** (2): 168-214.

VENKATACHALA, B. S. & KAR, R. K. (1964a). Nomenclatural notes on *Striatopodocarpites* Sedova, 1956. *Ibid.* **12** (3): 313-314, 1963.

Idem (1964b). *Schizopollis* Venkatachala & Kar, a new pollen genus from the Permian of North Karanpura coalfield, Bihar, India. *Grana palynol.* **5** (3): 413-424.

Idem (1965). Two new trilete spore genera from the Permian of India. *Palaeobotanist.* **13** (3): 337-340, 1964.

Idem (1966a). *Divarisaccus* gen. nov. a new saccate pollen genus from the Permian sediments of India. *Ibid.* **15**: 102-106.

Idem (1966b). *Corisaccites* Venkatachala & Kar, a new pollen genus from the Permian of Salt Range, W. Pakistan. *Ibid.* **15**: 107-109.

Idem (1966c). Palynology of the North Karanpura basin, Bihar, India. I. Barakar exposures near Badam, Hazaribagh distt. *Ibid.* **16**.

Idem (1967). Palynology of the Kathwai shales, Salt Range, West Pakistan. I. Shales 25 ft. above the Talchir boulder bed. *Ibid.* **16**.

VENKATACHALA, B. S., KAR, R. K. & RAZA, S. (1968). Palynology of the Mesozoic sediments of Kutch. 8. Spores and pollen from the Katrol sediments. *Ibid.* **17** (2): 184-207.

WILSON, L. R. (1964). Recycling, stratigraphic leakage and faulty techniques in Palynology. *Grana palynol.* **5** (3): 425-436.

Idem (1965). Palynological age determination of a rock section in Ti Valley, Pittsburg County, Oklahoma. *Okl. Geol. Notes.* **25** (I): 11-18.

WILSON, L. R. & VENKATACHALA, B. S. (MS). Palynology of the Wills Point formation, Arkansas, U.S.A.

EXPLANATION OF PLATE

Photographs magnified × 500; *slides are preserved at the Birbal Sahni Institute of Palaeobotany, Lucknow.*

1. *Virkkipollenites* Lele, 1964, Section C (Katrol), Reg. No. B.S.I.P.-900.

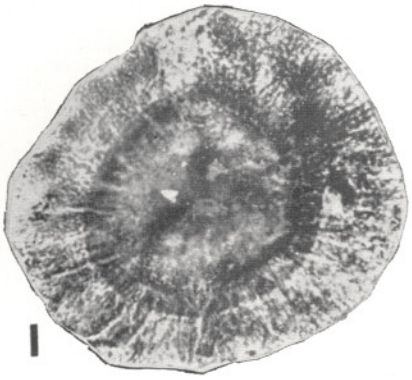
2. *Limitisporites* Leschik, 1956, Section C (Katrol), Reg. No. B.S.I.P.-900.

3. *Striatites* (Pant) Bharadwaj, 1962, Section C (Katrol), Reg. No. B.S.I.P.-900.

4. *Plicatipollenites* Lele, 1964, Section G (Katrol), Reg. No. B.S.I.P.-897.

5. *Striatopiceites* (Zoricheva & Sedova) Sedova, 1958, Section H (Katrol), Reg. No. B.S.I.P.-896.

6. *Sulcatisporites* (Leschik) Bharadwaj, 1962, Section G (Katrol), Reg. No. B.S.I.P.-897.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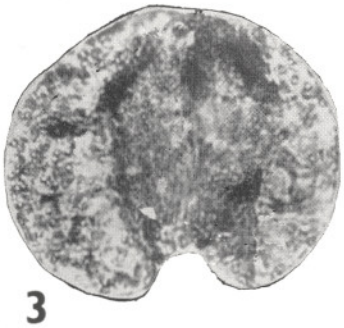
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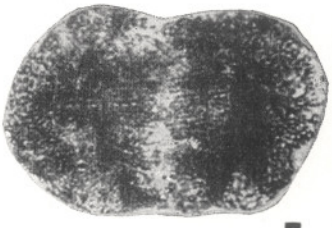
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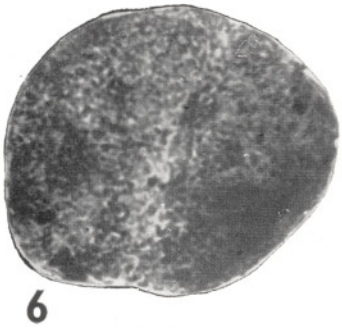
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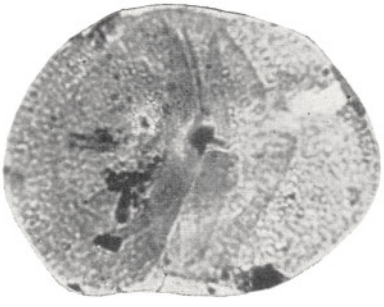
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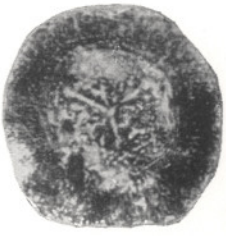
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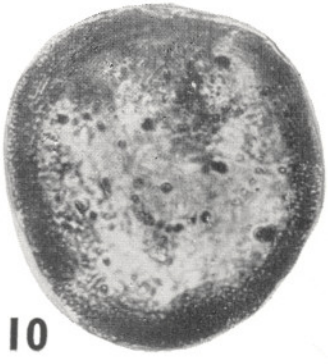
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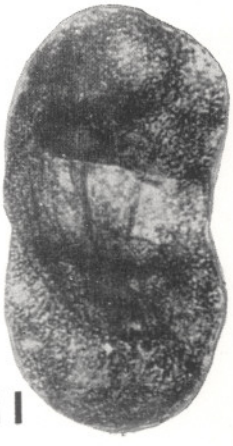
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7. *Lunatisporites* (Leschik) Bharadwaj, 1962, Section G (Katrol), Reg. No. B.S.I.P.-897.
8. *Virkkipollenites* Lele, 1964, Section H (Katrol), Reg. No. B.S.I.P.-896.
9. *Densipollenites* Bharadwaj, 1962, Section C (Katrol), Reg. No. B.S.I.P.-900.
10. *Parasaccites* Bharadwaj & Tiwari, 1964, Section C (Katrol), Reg. No. B.S.I.P.-900.
11. *Stroterspories* Wilson, 1962, Section G (Katrol), Reg. No. B.S.I.P.-897.