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New Trends in Gondwana Palaeobotany

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Abstract

Discoveries of insect wings, insect activities in fossil flora and microbial association with plant fossils have helped to understand the interrelationship of plants and insects and role of mico-organisms in Gondwana flora.

Introduction

Taxonomy, systematics, origin, evolution and distribution of plants and their significance in stratigraphy, palaeoecology, palaeoclimatology and palaeogeography have traditionally been carried out by many workers in Gondwana sediments from different basins of India (Lakhanpal, *et al.* 1976; Chandra and Tewari, 1991). Recently, findings of insect wings, insect damaged plant fossils and evidences of fungal and bacterial assault in the flora have revealed the existence of well organized insect-plant relationship and mutualistic, parasitic and saprophytic role of microorganisms in Gondwana flora of India. The study provides a new trend in understanding the ecosystem dynamism, as evident in the extant flora.

Insect-Plant Association

Earliest evidence of insect-plant association in fossil flora is known from the Lower Devonian plant assemblages of Rhynie Chert (Smart and Hughes, 1973; Kevan *et al.,* 1975). It has been discussed that insects coevolved with the development of plant communities (Strong *et al.,* 1984) and systematic development of insect fauna and insect activities are evident in the subsequent flora of Carboniferous (Scott and Taylor, 1983; Scott *et al.,* 1992).

Feistmantel (1880) while describing the Lower Gondwana flora of Raniganj Coalfield doubted the presence of insect wing in the Gondwana sediments of India. Due to its uncertain nature he described the specimen as insect wing-like fragment of leaf (Feistmantel, 1880; Pl. 16, Figs.7, 7a).

Handlirsch (1906-1908) for the first time reported the well preserved and complete hind wing of cockroach, *Gondwanoblatta reticulata* from Gondwana equivalent sediments of extra-peninsular regions of Kashmir. Later Rao and Shah (1959), Bana (1964), Verma (1967) reported insect wings from different Gondwana localities. Recent investigations carried out by Dutt (1977), Srivastava (1988a, b, 1996), Pant and Srivastava (1995) have revealed the presence of insect wings in association with plant fossils. On the basis of venation pattern wings are classified with insects belonging to Blattoidea, Homoptera, Mecoptera and Coleoptera groups of insect.

Plant fossils showing insect activities in the form of eaten/chewed leaves, mining activity, gall impressions, egg pouches over the surface of leaves, burrowing behaviour in stems, seeds (Srivastava, 1988a, b, 1996, 1998; Pant and Srivastava, 1995) and trace fossils of faecal pelletes with plant material and horizontal/vertical burrows possibly representing the

locomotary behaviour of insect (De, 1990; Maheshwari and Bajpai, 1990; Chandra and Singh, 1996; Srivastava *et al.,* 1996) indicate the existence of mutualistic relationship of insect-plant in Gondwana flora of India. Insects used plants for feeding, shelter and reproductive purposes and in turn plants benefitted themselves in dispersal and propagation mechanisms.

The informations in hand suggest that there is enough scope to examine the insect-plant relationship in Gondwana flora of India. To study animal-plant interaction in flora there is a need to examine each and every fossil specimen. Lack of data in this discipline is probably due to identification of such features in fossils rather than their absence, for example leaves with severely chewed or eaten margin might well have been discarded because they were considered to have been badly preserved (Fig. 1).

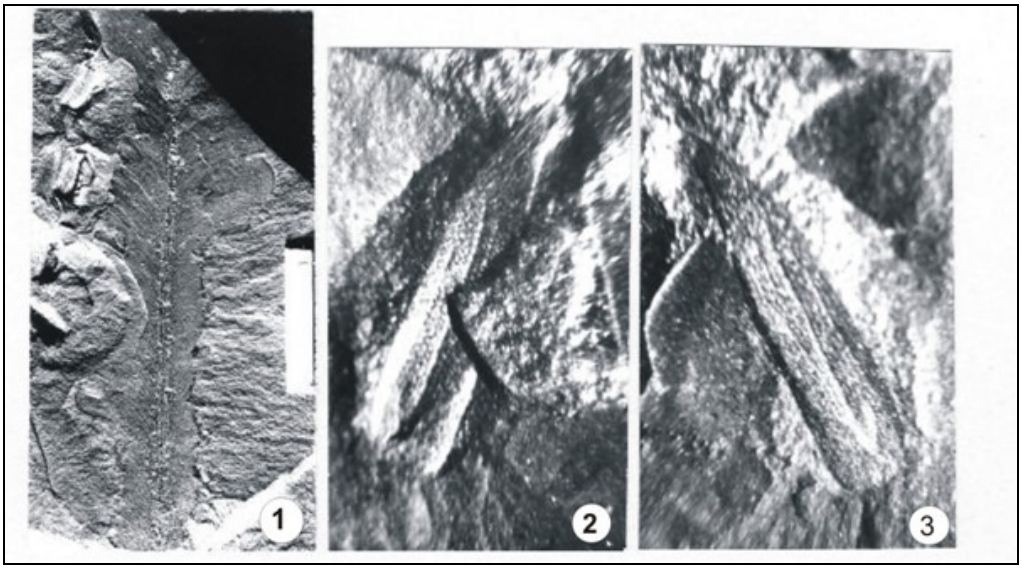

Fig. 1-3: 1. *Glossopteris* leaf showing insect chewed/eaten margin. BSIP No. 36229 x 1 (Srivastava, 1988b). 2&3. Part and counterpart of coleopteran insect wing comparable with *Kaltanicupes* sp. BSIP No. 37041 Ca 7 (Srivastava, 1996).

Fungal Association

Investigations of fungal association in fossil floras have increased the interest of palaeo-mycologists in understanding sedimentology, palaeoecology, palaeontology and evolutionary dimensions of plants and environment (Pirozynsky, 1981; Pirozynsky and Malloch, 1975; Malloch *et al.,* 1980; Stubblefield and Taylor 1988). Fungal diversity, interaction and role of fungi in plant fossils as heterotrophs, decomposers, saprophytes, parasites/pathogens and in palaeoecological interpretations are considerably examined in the flora of Europe and America (Boullard and Lemoigne, 1971; Lyons, 1991).

Gondwana plants from Permian and Triassic deposits of Antarctica show good deal of fungal interaction (Osborn and Taylor, 1989). In India fungal hyphae and fruiting bodies are mostly known from post-Gondwana sequence of Tertiary age (Jain, 1974; Rao and Ramanujam, 1976; Kar and Saxena, 1976; Saxena and Khare, 1992). Petrographic analysis of Gondwana coals has revealed the presence of fungal spores (Pareek, 1958). Biradar and Bonde (1976) have described *Rhizoctonia-a* deuteromycetaceous fungi in pith region of gymnospermous wood from Upper Permian beds of Maharashtra. The occurrence of fungi over the cuticular surface of *Glossopteris* and *Thinnfeldia* is known but apparently interference with the host plant is not known.

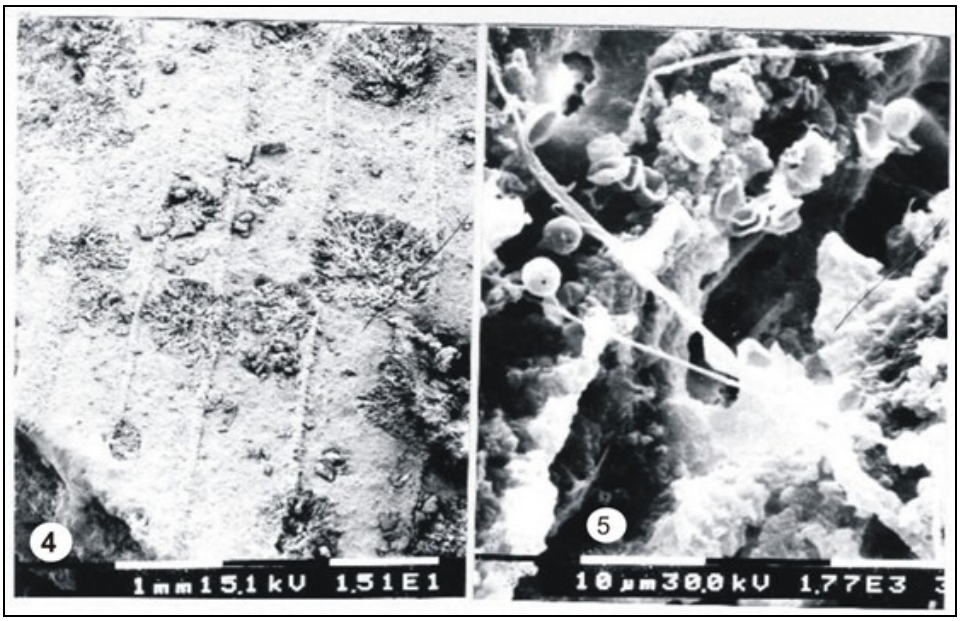

Fig. 4-5: 4. *Neoggerathiopsis* leaf under SEM to show irregular spots over the surface (Srivastava 1993) x 250. 5. SEM photograph of infected leaf showing fungal hyphae, spoes and degraded cellular tissues (Srivastava, 1993) x 2500.

Firm evidence of fungal interaction with host plant showing biological response has been observed in the leaf specimens of *Glossopteris* and *Noeggerathiopsis* (Fig. 4& 5). The leaves are preserved as coalfield compression and externally bear small irregular shaped spots over the surface. Scanning Electron Microscopic (SEM) study of infected portion of leaves show number of fungal hyphae and fruiting bodies in association with degraded and damaged cellular tissues of plant (Srivastava, 1993). The specimens signify the direct bearing of fungi with host plant and possibly suggest the parasitic or saprophytic nature of fungi. The example proposes to critically evaluate the Gondwana flora in terms of palaeomycology because plants ought to be affected by fungi for various types of biological and geological processes.

Bacterial Association

Bacteria play an active role in the formation and evolution of the bisophere and bacterial activity results into the genesis of different types of ores. Biodegradation process associated with bacteria help in decomposition of organic matter to release fixed carbon as a requisite step in the carbon cycle.

It is difficult to identify bacterial association with plants in fossils because of their small size and difficulty in identifying them from other smaller organisms like cynophytes and fungi. Sometimes artefacts formed during the preparation of sample also abduct their identification. However, bacterial colonies are known to exist in sediments ranging from Pre-Cambrian to Recent.

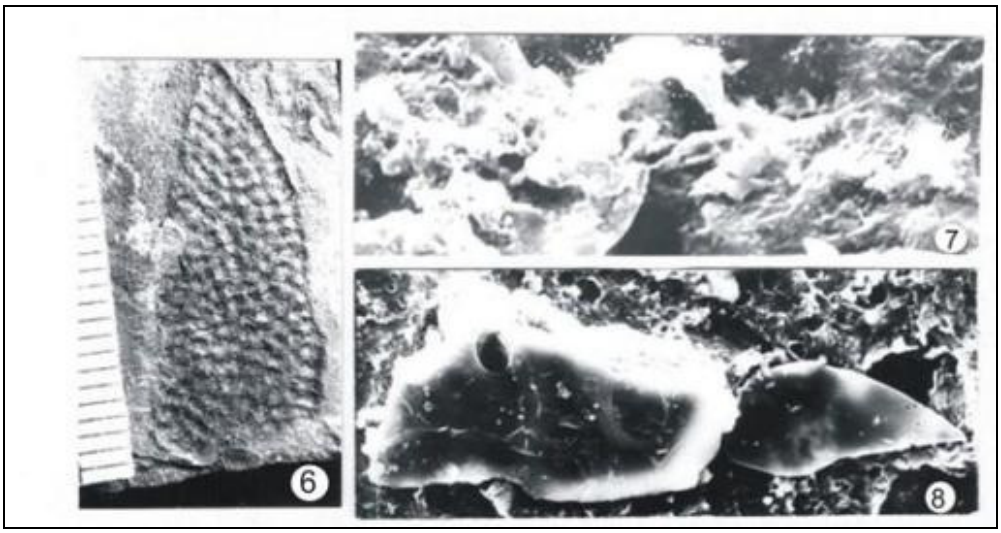

Fig. 6-8: 6. External morphological features of *Scutum* – type glossopterid fructification x 2 (Srivastava and Tewari, 1994). 7. SEM photograph of fructification cuticle showing damaged and degraded cellular tissues x 1500 (Srivastava and Tewari, 1994). 8. SEM photograph showing seed/ovule possessing plaque, pit-like structures with rod shaped bacterial colony x 1000 (Srivastava and Tewari,1994).

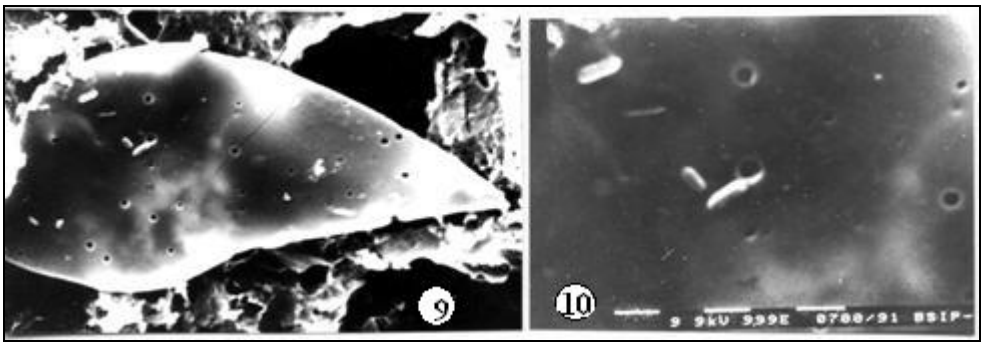

Fig. 9-10: 9. Enlargement of photo of fig. 8 to show the details of seed cuticle and bacteria x 12000. 10. Further enlargement to show the nature of rod shaped bacteria x 2500 (Srivastava and Tewari, 1994).

The decay of plant material by bacteria and fungi is well acclaimed in Indian Gondwana (Bobde, 1979) but study of bacteria or sign of bacterial degradational product has not been attempted positively in the Gondwana flora. Lower Gondwana plant fossils investigated from Jharia Coalfield, Bihar show their faithfulness towards an understanding of bacterial association with plants. Cuticular pieces recovered from *Scutum*- type glossopterid fructification, under SEM study indicates the presence of bacterial colony and degraded cellular tissues (Fig. 6&10). Quite often marred surface of seed cuticle with plaque/pit-like structures demonstrate association of rod shaped bacteria (Srivastava and Tewari, 1994). The specimen shows the testimony of bacterial association and bacterial degradation in Gondwana flora of India. The information derived from such specimens suggest that to examine bacterial association in

Gondwana plants the structural features especially the cuticles of leaf and fructifications be studied at higher resolutions preferably under Scanning Electron Microscope.

The knowledge of Indian Gondwana flora has greatly advanced with the established practice of morphology and taxonomy. Nevertheless, it is imperative to make sincere approach to examine the flora to find out the insect activities, trace fossils, association of micro-organisms and degradational phenomenon of the flora. The study will help in evaluating the interaction of plants with animals, microorganisms and in discussing the evolutionary and environmental stress during Gondwana in India.

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