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Lower Barakar flora of Raniganj Coalfield and insect/plant relationship

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The Lower Barakar flora of Raniganj Coalfield shows close affinity with the Karharbari flora. The venation pattern of different leaf genera and its evolutionary trends are discussed. Insect wings, insect affected leaf and stem specimens are recorded. On the available evidences, insect/plant relationship during the early phase of Glossopteris Flora is discussed.

Key-words—Megafossils, *Glossopteris*, Insect/plant relationship, Lower Barakar (India).

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सारांश

रानीगंज कोयला-क्षेत्र का अधरि बराकार वनस्पतिजात तथा कीट/पादप सम्बन्ध

अश्विनी कुमार श्रीवास्तव

रानीगंज कोयला-क्षेत्र का अधरि बराकार वनस्पतिजात करहरबारी वनस्पतिजात से घनिष्ठ सजातीयता व्यक्त करता है। कीटों के पंख, कीटों द्वारा नष्ट पत्ती एवं तने के प्रादर्श अभिलिखित किये गये हैं। उपलब्ध प्रमाणों के आधार पर ग्लॉसॉप्टेरिस वनस्पतिजात की प्रारम्भिक अवस्था में कीट/पादप सम्बन्धों की विवेचना की गई है।

BARAKAR Formation consisting of eight coal seams is well developed in the Raniganj Coalfield and covers an area of about 110 sq km. The present study deals with the plant fossil assemblages of the Lower Barakar coal seams I to IV, locally known as Pusai, Kalimati, Salanpur A, Salanpur B, Gourandih, Gopinathpur and Kasta seams. Plant fossils of the Barakar Formation of Raniganj Coalfield have earlier been investigated by Bandyopadhyay (1959), Chandra and Srivastava (1981), Srivastava and Rigby (1983), Maheshwari and Srivastava (1986) and Srivastava (1987). The specimens were collected from Sangramgarh, Dalmia, Palasthali, Gourandih, Raja, Nirsa, New Bagma, Gopinathpur, Lakhimata, Rajpura, Chapapur, Bajna and Khudia collieries.

Plant fossils are mostly preserved as impressions, however, thin carbonified crust is present on some of the specimens. On chemical treatment the crust gets fragmented and does not show cellular details. Therefore, the study is based entirely on the external morphological features. All the figured specimens are deposited with the Museum of Birbal Sahni Institute of Palaeobotany, Lucknow.

PLANT FOSSIL ASSEMBLAGES

Many genera and species of Equisetales, Filicales, Glossopteridales, Cordaitales and isolated

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seeds and sporangia have been identified. The records include the following:

Equisetales—Lelstotheca robusta (Feistmantel) Maheshwari, *L. striata* Maheshwari & Srivastava, *Trizygia speciosa* Royle, *Phyllotheca indica* Bunbury and a phyllothecan strobilus showing branched sporangiophore, attached near the node of axis (from Dalmia, Sangramgarh & Palasthali collieries).

Filicales—Neomariopteris polymorpha (Feistmantel) Maithy, *N. hughesii* (Zeiller) Maithy and a new sterile frond showing large size pinnules with auriculate base and pecopteroid types of vein (from Palasthali & Gourandih collieries).

Glossopteridales—This group is the dominant constituent of the assemblage and is frequently represented in almost all the collieries.

Rubidgea obovata Maithy, *Euryphyllum whittianum* Feistmantel, *Gangamopteris cyclopteroides* Feistmantel, *G. intermedia* Maithy, *G. major* Feistmantel, *Glossopteris indica* Schimper, *G. communis* Feistmantel, *G. stenoneura* Feistmantel, *G. nimishea* Chandra & Surange, *G. angustifolia* Brongniart, *G. fusa* Kulkarni, *G. browniana* Brongniart, *G. intermittens* Feistmantel, *G. emarginata* Maheshwari & Prakash, *G. barakarensis* Kulkarni, *G. stricta* Bunbury, *G. churiensis* Srivastava, *G. damudica* Feistmantel, *G. decipiens* Feistmantel, *G. longicaulis* Feistmantel, *G. angusta* Pant & Gupta, *G. giridihensis* Pant & Gupta, *Palaeovittaria kurzii* Feistmantel, *Gondwanophyllites dissectus* Srivastava, *Scutum* sp., *Lidgettonia* and a new type of leaf with persistent midrib and dichotomizing secondary veins.

Cordaitales—Noeggerathiopsis hislopii (Bunbury) Feistmantel, *N. minor* Chandra & Srivastava and *Cordaites* sp. (from Gopinathpur, Lakhimata, Rajpura, Raja, Chapapur & Bajna collieries).

Earlier it has been considered by many authors (Seward, 1917; Seward & Sahni, 1920; Meyen, 1969, 1972; Maheshwari & Meyen, 1975; Rigby, Maheshwari & Schopf, 1980) that Gondwana *Noeggerathiopsis* is similar to the northern genus *Cordaites* in external morphology. However, Pant and Verma (1964) and Maithy (1965) favoured retention of both the genera. Rigby (1984) placed all cuticular forms of *Noeggerathiopsis* under a new genus, *Pantophyllum* and has referred the non-cuticular forms to *Cordaites*. I have observed that in external morphological features also the leaves of *Cardaites* and *Noeggerathiopsis* are distinguishable and in the present assemblage both the forms are frequently represented, especially in Raja Colliery. The leaves of *Cordaites* are strap-shaped and show parallel running interstitial fibres in between thick veins, whereas such veins are entirely absent in the leaves of *Noeggerathiopsis*. The presence of *Cordaites*-like leaves in Glossopteris Flora is interesting.

Incertae Sedis—Isolated seeds, e.g., *Samaropsis* sp., *Cordaicarpus* sp., *Cornucarpus* sp. and *Arberiella* type of sporangia (from Raja, Rajpura & Lakhimata collieries).

FLORAL COMPARISON

In general the Lower Barakar assemblage is dominated by *Glossopteris* and *Noeggerathiopsis* complex. Genera, *Gangamopteris, Euryphyllum, Rubidgea* and *Palaeovittaria* are significantly represented. Most of the species of *Glossopteris*, e.g., *G. intermittens, G. churiensis, G. angusta, G. communis, G. fusa, G. giridihensis, G. nimishea* and *G. longicaulis* show parallel running strands in the median region of the leaf, instead of a solid midrib. *G. decipiens* shows an evanescent midrib.

The dominance of *Noeggerathiopsis* and Karharbari species of *Glossopteris* (Chandra & Surange, 1979) together with the presence of *Rubidgea, Euryphyllum* (exclusively reported from Karharbari Flora) and *Gangamopteris* suggests the floral affinity with the Karharbari flora. However, the presence of *Palaeovittaria* is significant because so far it is known only from the Raniganj Formation of the Raniganj Coalfield

EVOLUTIONARY SIGNIFICANCE

A critical analysis of the venation pattern of leaves suggests that there is a gradual transition from midrib-less form to midrib-form in two categories of leaves.

In non-reticulate type of leaves, the appearance of midrib has taken place from *Rubidgea* to new form of leaves with an intermediate form, *Palaeovittaria*, where the midrib is only up to 1/2 or 2/3 of the leaf lamina.

In reticulately veined leaves the midrib apeared at different levels, in different species. In *Gangamopteris cyclopteroides* the median region is occupied by inter-connecting parallel running veins. In some species of *Glossopteris*, the median region is occupied by only parallel running strands but without any inter-connection. Finally a consolidation of these strands results into the solid midrib of *Glossopteris*, e.g., in *G. stricta, G. angustifolia, G. browniana, G. indica*, etc.

INSECT/PLANT RELATIONSHIP

Definite and well-preserved complete and incomplete insect wings have been discovered in

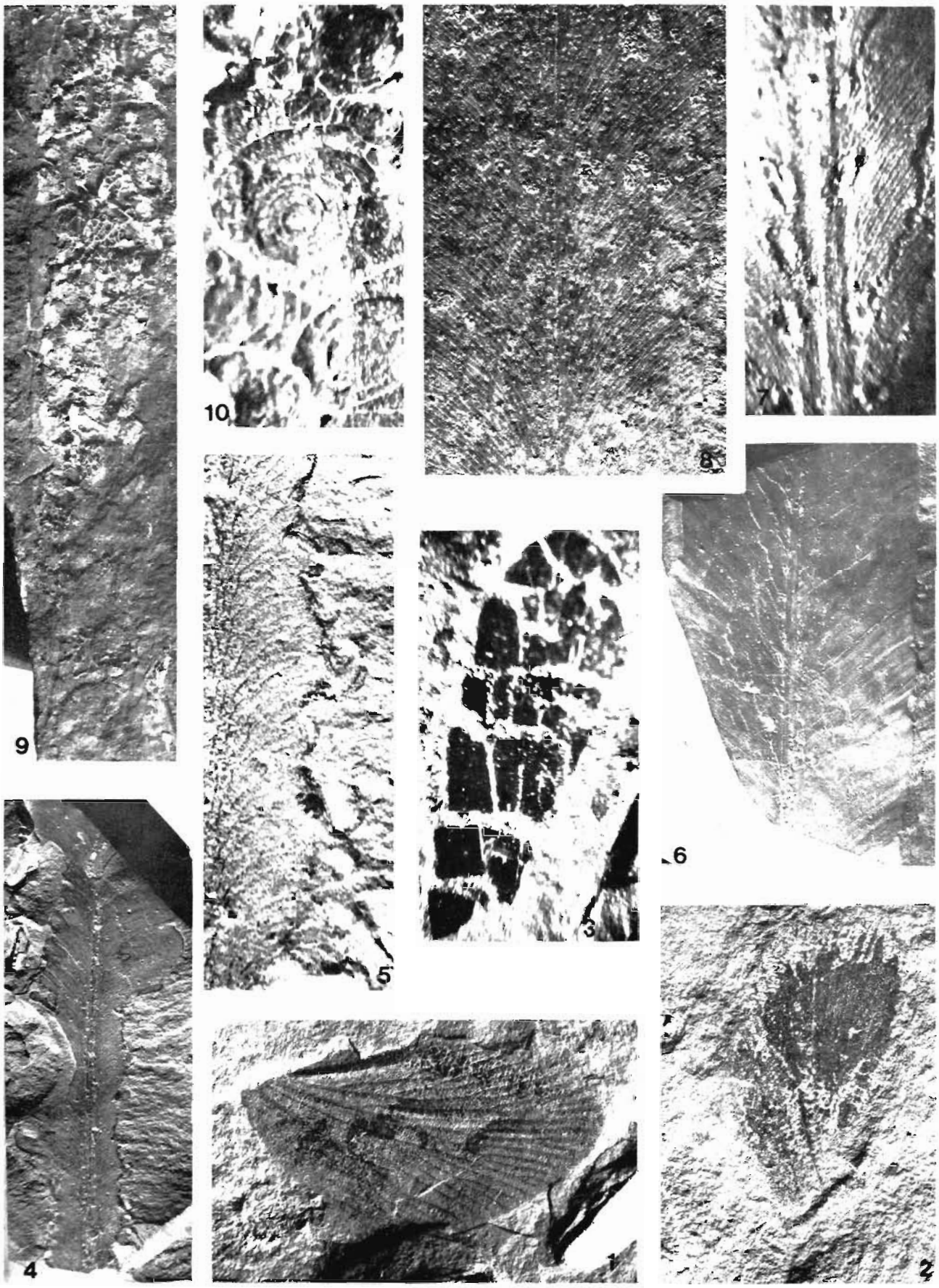

PLATE 1

association with plant fossils. The wings are comparable to the wings of ancient cockroaches belonging to Archimylacridae of Blattoidea Group of insects. Homopteraen insect wings have also been recovered from the assemblage (Pl. 1, figs 1-3).

It has also been observed that the leaf lamina of many specimens is characteristically damaged or distorted. Nibbling, rolling or distortion of leaf lamina have been regarded possibly due to insect activity (Plumstead, 1963; Van Amerom, 1966; Van Amerom & Boersma, 1971; Scott & Taylor, 1983; Scott & Paterson, 1984). Structures similar with the trailing and burrows habit of insect have also been studied (Pl. 1, figs 4, 5).

One of the leaves shows two rows of minute (0.1 to 0.5 mm), ovoid structure along the midrib. Similar structures have also been observed in groups or bunches scattered over the surface of leaf. The structural features and organizational pattern are comparable with the eggs of herbivorous insects like caterpillar, beetles, aphids, leaf hoppers, bugs and their allies (Metcalf & Flint, 1928; Ross, 1956) (Pl. 1, figs 6, 7).

Disfigurement of lamina with minute irregular-shaped (less than 0.1 mm) outgrowths has also been noticed. In modern forest, many insects, e.g., plant lice, moths, flies and mites injure the plants and such injury results into an abnormal growth of plant tissue and this insect activity causes similar structures known as the gall (Metcalf & Flint, 1928; Comstock, 1948; Ross, 1956; Mani, 1982) (*see* Pl. 1, fig. 8).

Some stem specimens show circular, helicoidal irregularly distributed, filamentous structures (2-10 mm in diameter). Chemical treatment of cellulose acetate pulls reveals nonseptate filaments without any structural details. Boring and tunneling activities of some modern insects, e.g., leaf hoppers, aphids and scale insect result in the formation of such features (Ross, 1956; Wigglesworth, 1964; Mani, 1982) (*see* Pl. 1, figs 9, 10).

The discovery of insect wings in association with plant megafossils demonstrates that the insects, more particularly arthropods, might have played an important role in pollination and dispersal of the glossopterid plants.

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PLATE 1

1-3. Insect wings showing the venation pattern. Fig. 1 shows the coastal, radial, median, cubital and anal veins. Specimen nos. BSIP 36147, 36227 and 36228. × 4.

4. *Glossopteris* leaf showing distorted and damaged part of lamina. specimen no. BSIP 36229. × 1.

5. Leaf lamina enlarged to show the pattern of distortion and nibbling. Specimen no. BSIP 36229. × 3.

6. *Glossopteris* leaf showing two rows of minute ovoid-shaped structures along the midrib. Specimen no. BSIP 36230. × 1.

7. Enlarged portion of leaf showing regular distribution of ovoid structures along the midrib. Specimen no. BSIP 36230. × 8.

8. Part of *Glossopteris* leaf showing disfigurement of lamina and irregular shaped outgrowth over the surface. Specimen no. BSIP 36231, × 2.

9. Probable insect damaged stem showing helicoidal-shaped structures, distributed all over the surface. Specimen no. BSIP 36232. × 1.5.

10. Stem surface enlarged to show the distribution and organizational pattern of helicoidal structures. Specimen no. BSIP 36232. × 8.

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