

MESOZOIC FLORAS OF INDIA: THE KOTA-MALERI STAGE*

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ABSTRACT

The paper gives an account of some recent investigations on the Flora of Kota and Maleri, two villages lying on the Maharashtra-Andhra Pradesh border and a little further. These two areas have been variously treated by different geologists and botanists as belonging to the Upper or Lower Gondwana System. As a matter of fact, they belong to what are called the "Transitional beds". Evidence from plants and animals found in them indicates that there was a distinct dry interlude between the Lower and Upper Gondwanas which is now well recognised as the Middle Gondwanas. It corresponds to the Triassic of Europe. On the basis of the flora at least, it seems, that these two areas represent two distinct stages and not one. The Maleri stage corresponds to the Middle Gondwanas on par with the Rhaetic of Europe and Kota on par with the Upper Gondwanas or the Liassic.

THE Gondwana system of India consists of sedimentary rocks of considerable interest ever since they were discovered more than hundred years ago. They range from the Upper Carboniferous to Lower Cretaceous period, much of their development being through the Mesozoic era. They are generally divided into Lower and Upper Gondwanas by different authors. The Lower Gondwanas comprise Talchir, Damuda and Panchet Series followed by Upper Gondwanas, having Mahadev and Umia-Jabalpore Series. In between these two, *Transitional beds* are well exposed in the Rewa Basin and in Peninsular India: and it was felt by a number of geologists and palaeobotanists that they constitute the Middle Gondwanas. It is these beds which have provoked the greatest controversy over the classification of the Gondwana system, whether to be divided into two or three-fold division. They are generally considered as belonging to Triassic. They are not continuous but rather spread out in a number of pockets such as Dubrajpur, Golapilli, Chikiala, Parsora, Kota, Maleri, Tikki, Shreerperametur, in Cutch, etc. The

present paper deals only with those occurring at Kota and Maleri.

The total time over which the whole Gondwana System is spread has been estimated to be 150 million years, the intermediate beds occupying approximately 50 millions from Upper-Triassic to Lower Oolite. The climatic conditions prevailing at that time were rather different than those that prevailed earlier or afterwards. The climate was warm and dry in the Middle Gondwanas as it was in many parts of the Triassic world. The early climate of the Lower Gondwanas after glaciation became cold and dry. It could not have supported the same kind of vegetation or species as it did earlier in the arid atmosphere of the Middle Gondwanas. This is conceivable as the Gondwana flora is largely a flora of the valleys in which the main sediments were laid in fresh water in river valleys or under extensive lacustrine conditions. These lakes were fed and drained by river systems. In all probabilities they were separated from each other by intervening mountain ranges or land masses. Thus we find that the valley of the Damodar and Son rivers, where they occur, is separated from the valley of Mahanadi, or that of the Wardha and Godavari rivers separated from the valley of Narmada by Satpura Ranges. It is unlikely that the sediments so formed isolated by mountain ranges, developed floras contemporaneously. Probably each developed independently of the other due to isolating agents with a slightly varying sequence of time.

Flora of the early Gondwana System, the Lower Gondwanas, is more or less uniform consisting of *Glossopteris*, *Vertebraria*, *Phyllothea*, etc. The flora of the Upper Gondwanas is developed mainly on Bengal and Bihar border under more or less warm humid climate as opposed to the earlier cold and dry climate of the Lower Gondwanas. Naturally the pteridophytes and pteridosperms, a few conifers and such

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other plants which preponderate in them were different than those in the Jurassic flora of the Rajmahals in which *Cycads*, *Bennettitales*, *Thinnfeldia*, *Gleichenia*, *Mara-ttiopsis*, *Osmundites*, with a sprinkling of *Ginkgo*, and other conifers were dominant members of the vegetation. In all these *Ptilophyllum* was the most conspicuous member in the Rajmahal flora and, therefore, this flora is often referred to as the *Ptilophyllum* flora. The *Glossopteris* flora of the Lower Gondwanas is supposed to have been succeeded by the *Thinnfeldia*-*Ptilophyllum* flora in the Upper Gondwanas.

These facts are too well-known to be discussed. The real difficulty, however, is presented by the *Transitional beds* which are recognized as an intermediate division of the Gondwanas. Fortunately these *Transitional beds*, the Middle Gondwanas, are now receiving better attention at the hands of paleobotanists than before and are being studied by various authors. The age of the much debated Parsora beds has now been settled by the work of Lele (1953-55) who has clearly shown the affinities of Parsora beds with the Middle Gondwanas, probably Triassic or Rhaetic. Their flora is comparable with the flora of that period in Australia, South Africa and New Zealand. Finding of *Thinnfeldia* elements by Saksena (1962) or *Pterophyllum*, *Taeniopteris* and *Neocalamites* by Lele (1955), and by me in the Bazargaon and other localities near Nagpur, is also of considerable significance in this connection, as *Neocalamites* is a typical Triassic genus. It is necessary that the *Transitional beds* at other places also be intensively studied similarly and their age determined. The present paper discusses the question of the *Transitional beds* known as Kota-Maleri stage in the Gondwana System of Peninsular India.

Kota and Maleri are two villages known to geologists and botanists since long time like the villages of Parsora, Autune or Rhynie. They lie in the valley of Wardha Godavari rivers in which a special development of the Gondwana rocks has taken place. Kota lies on Long. 80°-02' and Lat. 18°-55' and Maleri on Long. 79°-38' and Lat. 10°-14'. Maleri lies 32 miles N.W. of Sironcha at the confluence of the Godavari and Pranhita rivers (FIG. 3). Kota is on the East bank of Pranhita river. It is about five miles North of Sironcha. Here

the two stages are not conformable: nor have they been investigated much by botanists, being in inaccessible region in thick forests on the border of Maharashtra and Andhra Pradesh. For a long time both of them were considered to represent a single stage, but Feistmantel (1879-1886) and King (1881) had separated them. Their relative positions were also shifted from time to time by different authors as can be seen from the Table 1. A field examination thereof was therefore thought necessary. It showed that the Maleri beds lie on Kamathi beds. They consist of ferruginous clays and sandstones and are not conformable. They contain a number of animal fossils.

In our trips to this area, in an open field at Maleri a number of animal fossils, especially fish scales, labyrinthodonts and reptiles were found with plant remains, generally in the form of pieces of petrified trunks. The strata in which they occurred consist of red clay and compressed limestone on both the sides of the fossiliferous layer (FIG. 6). On examination these pieces of fossil trunks turned out to be the woods of conifers resembling *Araucarioxylon* and *Mesembrioxylon*. A species of *Neocalamites* was also found somewhat similar to that in Parsora and Bazargaon. *Schizoneura* was sometimes found but not abundantly. *Cladophlebis indica* was common. On the other hand, *Glossopteris indica* was also present. *Pagiophyllum* sp., *Elatocladus conferta*, *Thinnfeldia hughesi*, *Araucarites cutchensis* occurred here and there. The red clays also contained plenty of coprolites, and three species of fish, *Ceratodus*. Others have reported two reptiles *Hypero-depidon* and *Parasuchus* from here. These are similar to the Upper Triassic fishes and reptiles of the European continent. But it is difficult to generalize on their basis, as the Maleri red clays and sandstones are sometimes overlain by bands of lime stone. At a place not very far from Maleri, called Nawgaon, one finds *Araucarites cutchensis* and *Elatocladus jubbulporensis*. At other places like Andeli and Borigaon close by, one notices the junction of Maleri with Kota, and the same is true of Gangapur (Long. 79°-30', Lat. 19°-16') (FIG. 5). There is a layer of sandstone here separating the red clays of Maleri from the white limestone of Kota. The Maleri beds thus seem to be quite distinct by themselves and are

probably of the Triassic age on the basis of plant and animal remains noted above.

At Kota one gets a series of layers overlying the colourful hardened clay, soft clay, reddish sandstone, grits, overlain by white limestone, again overlain by soft sandstone covered by recent alluvium. They contain a few shales and a number of tree trunks (FIGS. 1-4). Impressions are not many, but *Elatocladus* was noteworthy. The fishes belonging to genera *Lepidotus* such as *L. decanensis*, *L. breviceps*, *L. longiceps* are reported to have been associated with Kota beds. As a matter of fact, limestone, sandstone and red clays all intermingle at Kota; it is only in a few sections that one notices the Kamthi base thereof, or the Upper Jurassic sandstone on the top, e.g. at Jangaon. Here again the rocks are much disturbed and they have yielded a flora consisting of *Elatocladus conferta*, *E. jubbulporensis*, *Cheirolepis munsteri*, *Taeniopteris spathulata*, *Retinosporites indica*, *Araucarites cutchensis*, *Ptilophyllum acutifolium*, etc. There thus seems to be a regular transition from Kamthi to Maleri, Maleri to Kota, Kota to Rajmahal as well as to Jabbalpore Series. But at Maleri there is a discrepancy, as one notices a Liassic fish *Lepidotus* mixed with the Triassic crocodile *Parasuchus* which of course is not correct; possibly the drifted contents of various strata have been redeposited. But one thing that seems to be clear from this is that the affinities of the Kota stage are more with the Rajmahal series rather than with the lower strata of Maleri and Damudas. According to Sahni (1921) *Ptilophyllum* and *Taeniopteris* are characteristic plants of the Rajmahal flora; and hence combining the Kota stage with Maleri, as they do sometimes, does not seem to be correct. There is a break between them which can be seen at Andeli where the two series lie unconformably. The age of Kota stage, therefore, could not be later than Rajmahals and earlier than Jabbalpore, and that of Maleri with

its distinct flora and fauna, like the distinct flora of Parsora beds, Triassic.

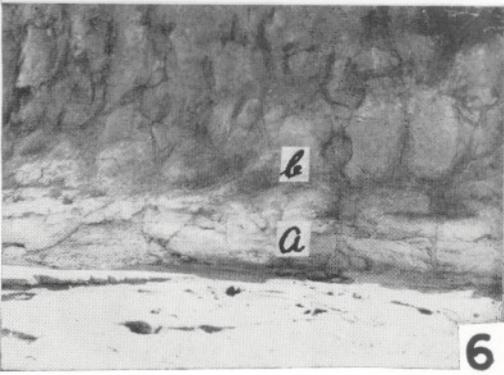
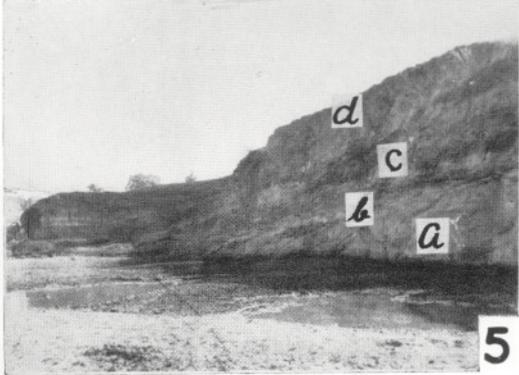
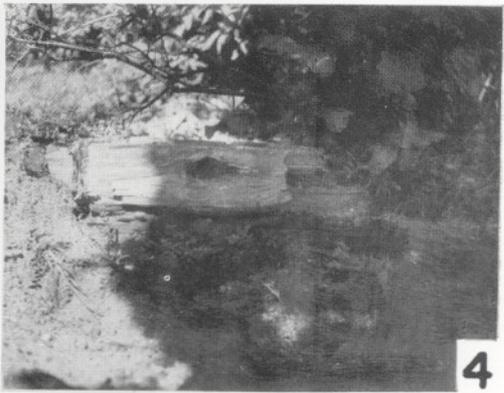
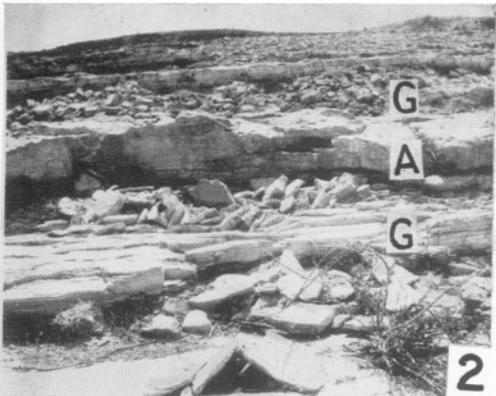
As one works in the field the whole area looks so disturbed, that every little horizon in this area probably represents a separate successive stage in the development of the flora from the Lower to the Upper Gondwanas. And, therefore, no useful purpose will be served by combining the two. At the same time there is a great need for intensive search for fossils both animal and plant in this area and mapping it in detail. Till then it will be difficult to settle this controversy. However, there does exist a distinct arid zone here consisting of gypsum, red sandstone or red clay, similar to those in the Triassic elsewhere. In our search for fossils at Kota, tree trunks were seen to be many. They were lying scattered all over the fields or embedded in the strata at Kota or near about (FIGS. 3 & 4). They contained *Mesembrioxylon*, *Araucarioxylon*, *Taxoxylon*, *Podocarpoxyton*. Unfortunately the shales available yielded no microfossils, and impressions were very few. That made the task of correlation difficult, as on the basis of the spore contents we can now separate different stages of the Lower Gondwanas. But taking into account everything known at present, one cannot escape the conclusion that these two stages are different. The Kota flora showing more affinity with the Flora of Andigama and Tabbowa in North Ceylon described by Sitholey (1944) and with that of Rajmahals. The Maleri flora is probably transitional and represents the flora of an arid period, the Middle Gondwanas or the Triassic, at least on botanical grounds.

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EXPLANATION OF PLATE 1

1. Kota locality. General view of the strata showing A-fossiliferous sandstone in which petrified woods are found. 2. Kota locality. The fossiliferous layer A of sandstone getting mixed up with gypsiferous rocks G. 3. A part of fossiliferous layer A shown in Fig. 1 above on the bank of the Pranhita River showing a tree trunk lying horizontally partially exposed. 4. The same showing

another large fossilized log of wood. 5. A general view of Kota and Maleri layers exposed near Borigaon 8 miles North West of Maleri showing lower white calcareous lime stone-a, upper red clay-b, sandstone of Kota stage-c, overlain by alluvium-d. 6. Strata exposing Maleri stage 4 furlongs to the South of Maleri village showing white calcareous limestone-a and red clay-b.