ON THE TERTIARY FLORA OF EASTERN INDIA*

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ABSTRACT

1. The available information on the Tertiary flora of eastern India is reviewed. The distribution of some genera between the middle Tertiary period and now shows a considerable difference, indicating a trend of migration towards south and east. But there are other genera which show little difference in their distribution.

2. A comparative study of the middle Tertiary flora of Europe, North America, the Indo-Malayan region and eastern India has been made and the general features in their vegetation are indicated.

3. No clue is yet available on the migration of some temperate genera to the hills of Indo-Malayan region.

INTRODUCTION

THE Tertiary flora of eastern India has not so far been studied in any detail, although the geological reports mention the occurrence of leaf impressions and fossil woods in many localities. Some of these materials may not be suitable for critical study due to their bad preservation, but there are likely to be others which will well repay the labour and the time spent on their investigation. The palaeobotanical specimens so far collected from this area consist of leaf and twig impressions, spores of plants and dicotyledonous woods. The first specimens were reported by Seward (1912) of some dicotyledonous leaves from the Coal Measures of Assam. In his opinion the leaves were undeterminable and he, therefore, placed them under the form genus *Phyllites*. Then Edwards (1923) identified two leaves from south-east Burma as *Ficophyllum burmense* and *Dipterocarpophyllum gregoryi*. Sahni (1928) also published a short note on the "Dicotyledonous Plant-remains from the Tertiary Beds of Assam" without giving any definite names to the material he had examined. These are all the records on leaf impressions.

From a recent note (SAHNI *et al.*, 1947) it appears that a study on the "Correlation of the Tertiary Succession in Assam by means of Microfossils" was in progress at Lucknow. When this work is completed, some interesting information is likely to be available. Now, as far as fossil woods are concerned, during the last 15 years, a few specimens from Assam have been reported by the author and his co-workers. Furthermore, some 27 fossil wood specimens from the extreme eastern part of Raniganj, Bihar, are being examined by the author and some of them have been definitely identified.

The classification and identification of these botanical remains, most of which are from the middle Tertiary period, give us some idea of the vegetation of that geological age. This information enables us not only to compare the vegetation of the middle Tertiary period with that of the present time in eastern India but also to review our present knowledge on the vegetation from the middle Tertiary to the present time in the area now known as South-east Asia. Finally, a knowledge of the vegetation of eastern India during the middle Tertiary provides us with an opportunity to compare it with that of Europe and North America from where considerable plant remains have already been reported.

It may be pointed out here that all discussion in this paper is based on identification of fossil specimens up to a genus. Our present knowledge in wood anatomy does not always permit us to identify isolated wood specimen to a species (CHOWDHURY, 1948).

THE GENERA SO FAR RECORDED FROM THE MIDDLE TERTIARY OF EASTERN INDIA WITH NOTES ON THEIR PRESENT DISTRIBUTION IN INDIAN ZONE[1]

(a) The first specimen of *Glutoxylon* was reported from the North Cachar Hills of

1 Indian zone includes here India, Pakistan, Burma and Ceylon.

* Eastern India includes here Assam, East Bengal and West Bengal, Bihar, Orissa and Burma

Assam and named *Glutoxylon assamicum* (CHOWDHURY, 1934, 1936). A couple of years later, some 20 wood specimens collected from the same Cachar Hills but from another locality were also found to be all *Glutoxylon* (CHOWDHURY, 1942). The two specimens of *Dipterocarpoxylon burmense* Holden (1916) from the "Irrawady System" of Burma have been recently re-examined. One of them, namely *Irrawadioxylon burmense* Gupta (1935), has been found to be a *Glutoxylon*. Furthermore, in the course of an investigation of some fossil wood specimens from the laterite of Raniganj coalfield, one specimen has been definitely identified as a *Glutoxylon*. This makes up the total number of four localities in India in which *Glutoxylon* has so far been recorded.

In this connection, it may be pointed out that *Dipterocarpoxylon annamense* Colani (1919) is also a *Glutoxylon*. It will, therefore, be seen that the genus *Gluta* was growing in the Miocene period in an area starting from the east of Raniganj coalfield on the west, up to Indo-China, i.e. throughout the present provinces of West and East Bengal, Assam, Burma, Siam and Indo-China. The form-genus *Glutoxylon* is now being re-investigated by the author and full details will be published soon elsewhere.

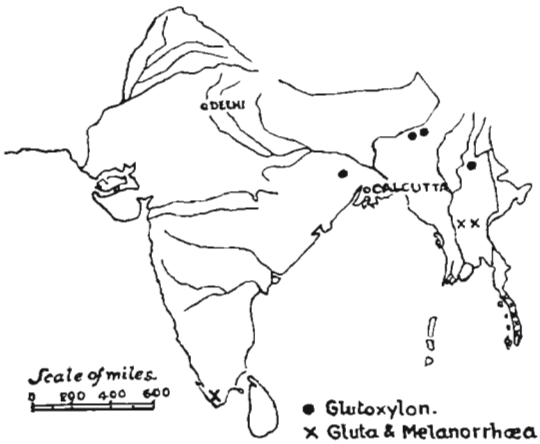
Now, *Glutoxylon* was started to include "all *Gluta* and those *Melanorrhoea* which have thin metatracheal bands of parenchyma, but excludes the *Melanorrhoea* with thick metatracheal bands" (CHOWDHURY, 1936). At the present time there are only three species of *Gluta* in the Indian zone. One, *G. travancorica*, is confined to the west coast of Travancore, and two, *G. tavoyana* and *G. elegans*, are in the coastal area of Tavoy in Burma (BRANDIS, 1906, PEARSON & BROWN, 1932). As far as *Melanorrhoea* is concerned, there are only two species, *M. usitata* and *M. glabra*, now growing in Burma but none in Peninsular India (BRANDIS, 1906).

(b) *Dipterocarpoxylon garoense* Chowdhury (1938) from the Upper Miocene of the Garo Hills, Assam, was the first Dipterocarpous fossil wood identified in the Indian zone. Although complete agreement of its anatomical structure with that of the living Anisopteras has been reported, yet, as a measure of caution, it has been placed under the group *Dipterocarpoxylon*. In this connection it is interesting to note here that one of the fossil wood specimens from the eastern laterite of Raniganj coalfield shows all anatomical structure similar to that of the living Anisopteras, i.e. it is similar to *Dipterocarpoxylon garoense*. The geological age of the latter specimen is not definitely known. It is said to be Miocene to Pleistocene (GEE, 1932).

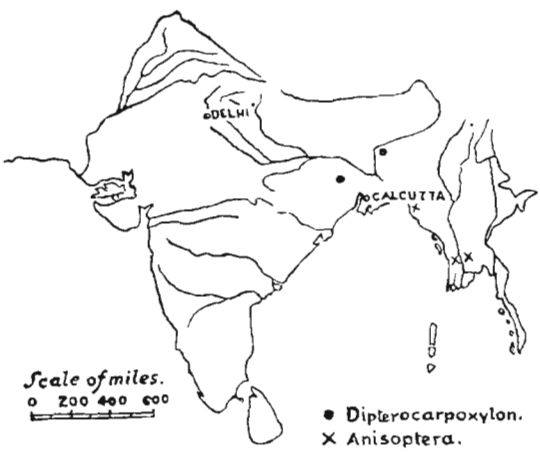
The distribution of *Anisoptera* in the Indian zone is at present limited to one species, *A. scaphula* in Chittagong (SYMINGTON, 1941) and two species, *A. scaphula* and *A. oblonga*, in Tenasserim and Taungoo districts of Burma (BRANDIS, 1906; PEARSON & BROWN, 1932).

(c) The form-genus *Cynometroxylon* (CHOWDHURY & GHOSH, 1946) was based on the study of a specimen from the Miocene strata of North Cachar Hills of Assam. At the present time, one species of *Cynometra*, i.e. *C. polyandra*, is growing near about the place from which the fossil specimen was obtained (KANJILAL *et al.*, 1938). Furthermore, throughout the rest of the Indian zone, some six species of this genus are now found. There are two species, *C. polyandra* and *C. ramiflora*, in Bengal (PRAIN, 1903); two, *C. ramiflora* and *C. cauliflora*, in Burma; three, *C. travancorica*, *C. beddomei* and *C. bourdillonii*, in Madras (GAMBLE, 1935); and one, *C. ramiflora*, in south Bombay (BRANDIS, 1906) and one, *C. ramiflora*, in Ceylon (LEWIS, 1934).

(d) *Kayeoxylon assamicum* (CHOWDHURY & TANDAN, 1949) has been found in the district of Sibsagar in Assam. The actual location of the place is about 50 miles from where the first specimen of *Glutoxylon* was collected. The genus *Kayea* is now represented in Assam by two species, namely *K. assamica* and *K. floribunda* (KANJILAL *et al.*, 1934). It is interesting to point out here that one of them, *K. assamica*, is confined to a small area at the foot of the Himalayas on the northern bank of the river Brahmaputra, while the other species grows within a hundred miles' distance from where the fossil wood has been collected. There are also some more species of *Kayea* growing within the Indian zone. There are two, namely *K. floribunda* and *K. nervosa*, in Burma; one, *K. manii*, in the Andamans (BRANDIS, 1906) and one, *K. stylosa*, in Ceylon (LEWIS, 1934).



TEXT-FIG. 1 — Map showing occurrence of *Gluta*, *Melanorrhoea* and *Glutoxylon*.



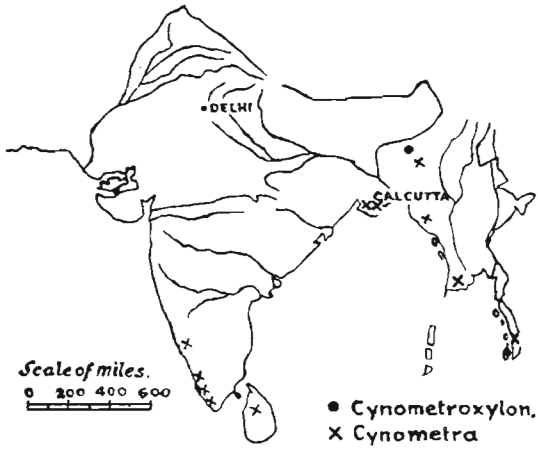
TEXT-FIG. 2 — Map showing occurrence of *Anisoptera* and *Dipterocarpoxylon*.

INDICATION OF PLANT MIGRATION

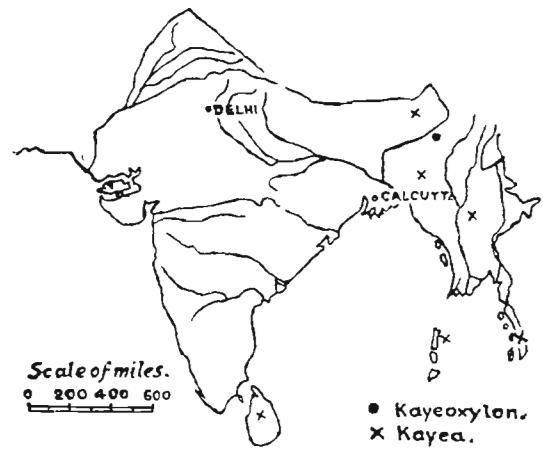
The distribution of the genera *Gluta* and *Melanorrhoea*, and *Anisoptera* during the Miocene period would appear to be at least a few hundred miles or so further north than they are found today. Again, when the present western limit of the *Anisoptera* is compared with that of the middle Tertiary period, it appears that the genus has migrated a few hundred miles towards the east. In the case of *Gluta* too there is a tendency for an eastern migration except for a single species now growing on the south-west coast of India (TEXT-FIGS. 1, 2). A much fuller knowledge of the middle Tertiary vegetation will be necessary before any reason for the migration of these plants can be put forward. The effect of the Ice Age on the vegetation of this part of India is said to be small. But what effect the change in configuration of the land had on the migration of plants, it is difficult to say at present. For our knowledge of the various changes that took place in the eastern India during the last 16 million years is not yet complete. Now, the distribution of the genera *Cynometra* and *Kayea*, between the middle Tertiary and the present period, suggests two possibilities (FIGS. 3, 4). These genera might have been growing in this area from the Miocene period to this day. This means that whatever changes took place during the last 16 million years, either in the configuration of the land or in the climate, these genera had been able to withstand them. The second alternative is that they might have migrated to distant lands and came back later on. At present there is no evidence to prove either of these possibilities.

The four genera recorded from the middle Tertiary of eastern India are new to science. It is, therefore, not possible to make a study on their distribution during this geological age throughout south-east Asia.

Lastly, it will be seen that all the genera that have been so far recorded from eastern India are exclusively tropical. The genus *Gluta* is now distributed throughout the Indo-Malayan region. Its eastern limit is Indo-China and the western border is the Travancore coast of India. It grows as far north as Tavoy in Burma and spreads to the south up to Java. *Melanorrhoea* shows its northern limit of distribution up to Katha and near about it in Burma, and its southern limit is up to New Guinea. Burma is also its western limit and New Guinea its eastern limit. The present distribution of *Anisoptera* is given by Symington (1941) "from Chittagong and Tenasserim to east of New Guinea". Its northern limit is Chittagong and the Philippine Islands and the southern limit is Java. The genus *Cynometra*, according to Pearson and Brown (1932), is "widely scattered through the tropics of both hemispheres, in the New World ranging into Mexico,



TEXT-FIG. 3 — Map showing the occurrence of *Cynometra* and *Cynometroxylon*.



TEXT-FIG. 4 — Map showing the occurrence of *Kayea* and *Kayeoxylon*.

Brazil and Columbia, in the Old World extending through Africa into Madagascar and eastward through Indo-Malayan region to the Philippines, Australia and Pacific islands". The genus *Kayea* is confined to Indo-Malayan region. Its northern limit is demarcated by an isolated species at the foot of the hill on the northern bank of the river Brahmaputra and its southern boundary is Sumatra. It spreads on the west up to Ceylon and in the east as far as the Philippine Islands. It will, therefore, be seen that from the Miocene period to this day the general character of the vegetation of this area has been tropical, although some signs of migration within the region of south-east Asia are not altogether absent.

COMPARISON OF THE MIDDLE TERTIARY FLORA OF EUROPE, NORTH AMERICA, INDO-MALAYAN REGION AND EASTERN INDIA

Researches on the fossil flora of the Tertiary period in different parts of the world have brought out some very interesting information on their past vegetation. It is now recognized that the Oligocene and early Miocene flora of the western Europe was "an admixture of elements now living in temperate Europe with others which are tropical or subtropical in range" (SEWARD, 1941). It is also known that the Miocene flora of North America was much richer than the present flora now in existence there (CHANEY, 1938). Moreover, a critical examination has shown that during the middle Tertiary period only temperate plants were growing in eastern north Asia and eastern North America. No tropical or subtropical plants have been so far recorded from the territory east of the Black Sea through Siberia, north Japan and east North America (KRYSHTOFOVICH, 1929). However, in the west North America there is an indication that some subtropical plants were in existence during the middle and upper Miocene period (CHANEY, 1938).

On the other hand, as has been mentioned earlier in this paper, the middle Tertiary flora of eastern India so far shows only a tropical range. The available information on the Tertiary flora of Malayan region may be classified under two categories; the fossil specimens which have been definitely identified and those that have been only described and recorded, but not identified. Both these groups, when critically examined, show a tropical flora. It will, therefore, be seen that there is still no clue to the migration of the few temperate genera that are at present found on the hills of south-east Asia. It is, however, hoped that more intensive research on the fossil plants of this area will in the near future enable us to reconstruct chronologically the past history of the vegetation now in existence in the territories included in the Indo-Malayan region.

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