

OBSERVATIONS ON THE VEGETATION OF NOAMUNDI IRON ORE MINES, SINGHBHUM, BIHAR

S. C. NANDI* AND P. K. MUKHERJEE**

**Department of Botany, T. D. B. College, Raniganj, Burdwan (W. B.)*

***Department of Botany, Calcutta University, 35, Ballygunge Circular Road, Calcutta-19*

ABSTRACT

Noamundi iron ore mines form a part of the Iron Ore Series in the southern Singhbhum. The vegetational patterns in respect of different lithological substrates are discussed. The present forest is of a dry, mixed, deciduous type supplanted on higher plateaux by dry Sal formations and on sheltered positions along the water courses by a mixed, moist, deciduous type. The relict nature of the forest vegetation is also discussed.

INTRODUCTION

Noamundi is located in the south-western section of the Singhbhum district, Bihar, and the centre of the area is approximately 22°8' north and 85°30' east (Fig. 1). It is situated in the Chaibasa South Forest Division of Bihar State and the area (Noamundi Iron Ore Mines) is under lease by the Tata Iron and Steel Co. Ltd. for the presence of high grade Iron ore, which was discovered in 1917. The iron mine consists of two parallel ridges striking north to south, Katamati Buru in the east and Pachriburu in the west. The Katamati ridge extends for about 4.4 km north of Singhbhum-Keonjhar boundary and continues into the Keonjhar State (Orissa) into the south. The Pachriburu extends from Singhbhum-Keonjhar border for about 2.4 km in a northerly direction, and this has also extension into the south in the Keonjhar district, Orissa. At the north end of the Pachriburu are two small ridges. The elevation of the peaks vary from 160 to 280 m from the main plateau. The northernmost peak of Katamati range (Hill No. 1) is longer than the others and continues to the next peak (Hill No. 2) without much break. Hill No. 3 in the same range is a narrower one and has its strike in the east-west direction. Hill Nos. 4 and 5 with much flattened tops and south-north strikes are steeper hills. Between the two ridges are situated the Balijore and Kurta valleys.

Most of the areas in the western ridge and the Balijore are utilized for different establishments. Present mining operations are being carried out on the Hill Nos. 4, 5 and the southernmost part of the western ridge. Old and abandoned mines were located on the Hill-3 and parts of the western ridge while Hills 1 and 2 have been completely exhausted of iron ores.

The hill ridges are out-liers of the old plateau of the peninsula and the inselbergs rising over a peneplaned plateau country. The geology of the area has been studied by PERCIVAL (1931), JONES (1922) and DUNN (1937). Iron ores occur mainly in the banded haematite quartzite (bhq) and to a less extent in adjoining ferruginous shales. The ore bodies and the bhq are the hardest and most weather-resisting materials in the area, and, therefore, the iron ore usually occurs at or near the tops of the ridges. Other petrological types found within the area are shales, schists, quartzites and calcareous deposits. The tops and sides of the hills on which ore occurs are covered by laterite

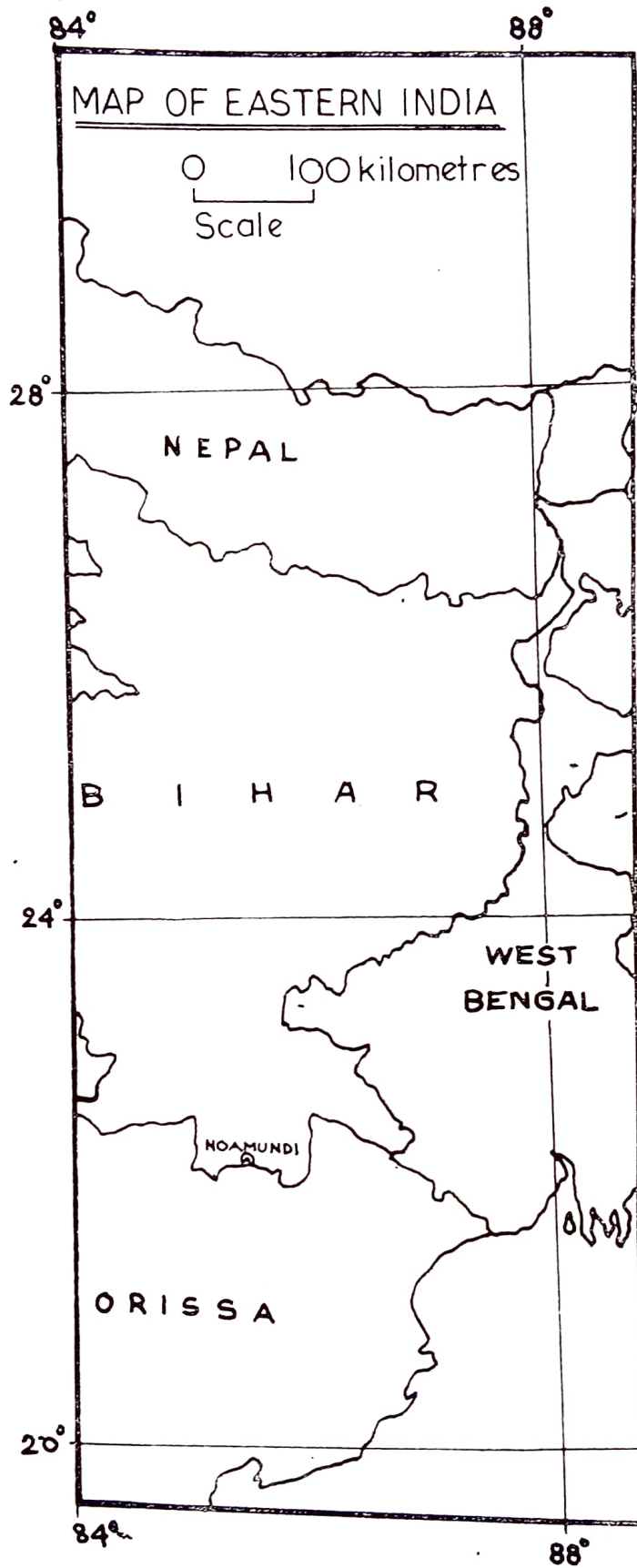


Fig. 1. The map of eastern India showing the geographical position of Noamundi.

and float or extremely hard conglomerate are formed by cementing of floats by laterite. Laterites occur on the northern end of the Hill 1, with conglomerates on the western ridge and along with alluvium in the valleys. Massive ore bodies of good quality are

being mined from Hill-4 and southern end of the western ridge. Bhq is exposed on Hill-1 and 2 after the removal of iron ores, and as out-crops in the southern tops of these hills as well as on the west of Hill-2 and 3 and southeastern corner of western ridge. Blue dusts occur in patches on Hill-3. Consolidated float ore forms cliff at the sides of stream courses and edges of the flattened areas and hill tops. Shales are observed on the southeastern and western sides of the western ridge. Calcareous materials occur occasionally in patches within the float ores (Fig. 2).

Except the lateritic covers on parts of the hill tops, most of the surfaces on the hills are bare of appreciable soil. The thin soil-cover on the mountainous tract is immature and no definite soil profile is yet formed on the slopes (MOONEY, 1937). Alluvium, mixed with laterites, occurs in the valleys. Soil is acidic but those parts derived from high silica and alumina tends to be alkaline.

The tract lies with the line of south-west monsoon. The monsoon extends from July-September, in winter from mid November to end of February and in the summer from March to June. The average minimum temperature in winter is 15°C which may come down to 11°C during days in January. The average maximum temperature is 43°C which may soar upto 48°C in days of May. The rainfall is 130 cm a year (based on averages of 5 years: 1975 to 1979). Precipitation also occurs in other months of the year, other than those of the rainy season and pre-monsoon in the months of May and June are not rare.

Insolation is great in almost all the hill tops which are having a N-S strike. So also are the slopes facing the valley. A lesser quantity is, however, possible on the north face of Hill-4 and the slopes along the Balijore nullah which is shattered in the south by the 'quartzite hill'.

OBSERVATION

Although botanical work of the State has been done by HAINES (1910, 1921-25), and part of the district by MOONEY (1937), SRIVASTAVA (1958, 59), MAZUMDAR AND BISWAS (1971) and GHOSH (1966), none of these relate to vegetation of Iron Ore Series. JONES (1934) noted that the hills were covered with heavy forest around 1920. PERCIVAL (1931) has remarked the accuracy of the forest maps of this area and occurrences of heavy forests on rich ore and jasper. The present study aims at recording the vegetational types with records of assemblages which are likely to be disturbed, if not completely wiped out, in consequence to mining exploitations. Observations of the flora on the newly exposed rock materials is also given in this study (Fig. 3).

Presumably the vegetation of the area is much disturbed due to the mining and ancillary activities. Most of the natural forests have been wiped out, specially in those hills where mining operations are going on and which are abandoned after completion of mining (Pl. 1, Figs. 1-9). However, the Hill-5 retains most of its forests which can be characterised as a dry peninsular Sal forest (CHAMPION, 1936; CHAMPION & SETH, 1968). Though the percentage of Sal is low, $\pm 30\%$, this forest merits recognition as a Sal forest instead of the non-Sal-miscellaneous type following MEHER-HOMJI (1971). According to MOONEY (1937) this type of vegetation, apparently being an edaphic-climax, should best be viewed as a sub-climax to the Hill Sal-type. It has been observed (MOONEY, 1937) that 'Sal' prefers acidic rocks and iron appears to be beneficial (NAIR, 1944). The common associates of Sal (*Shorea robusta*) are *Anogzissus latifolia*, *Terminalia alata*, *Boswellia serrata*, *Adina cordifolia*, *Schleichera oleosa*, *Pterocarpus marsupium*, *Bursera serrata*. The trees of second storey include *Gardenia latifolia*, *Nyctanthes arbor-tristis*, *Symplocos racemosa*, *Zizi-*

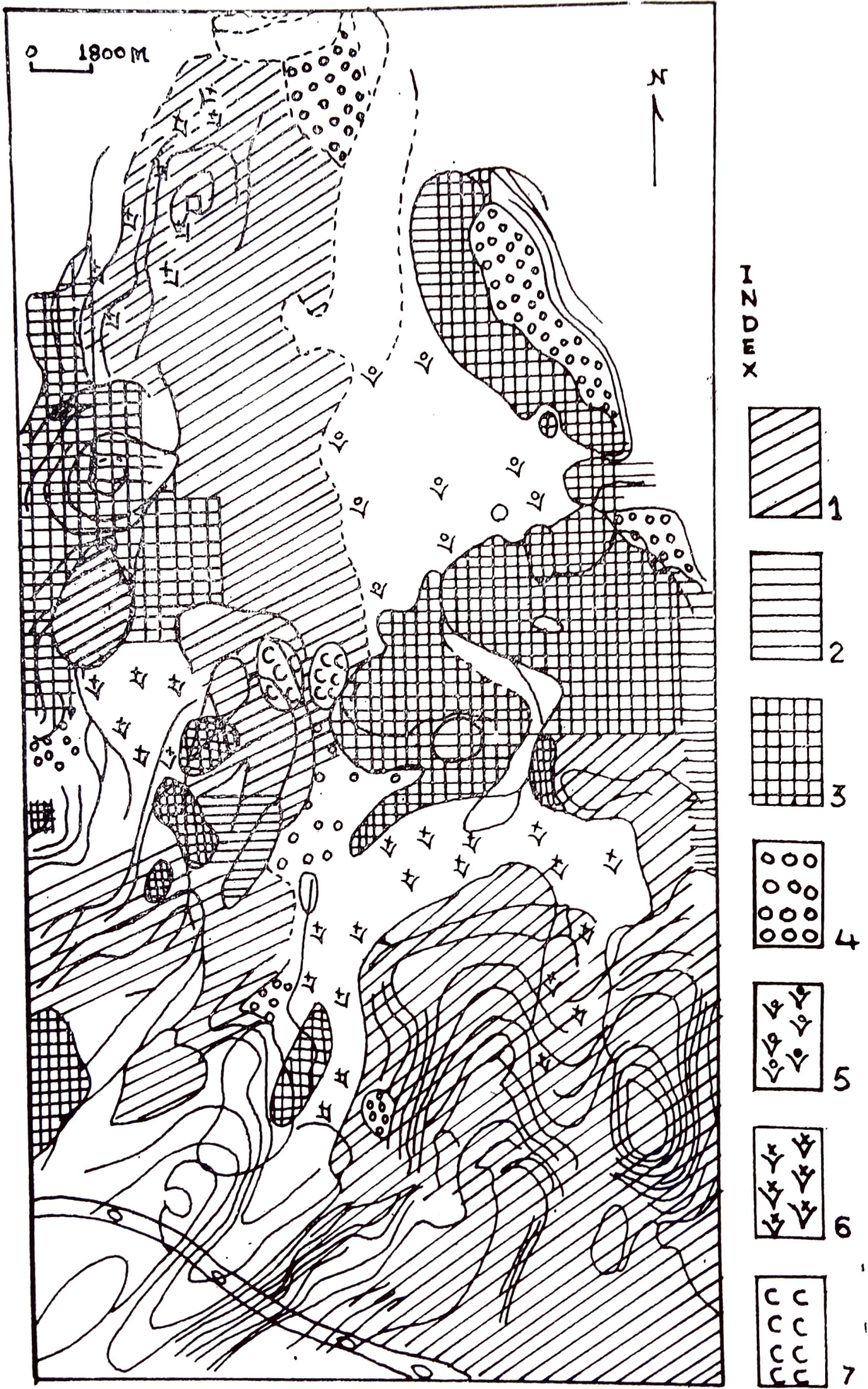


Fig. 2. Geological map of Noamundi Iron ore mines : 1—Iron Ore, 2—Shale, 3—B.H.Q., 4—Laterite, 5—Soil with float, 6—Soil with laterite, 7—Canga.

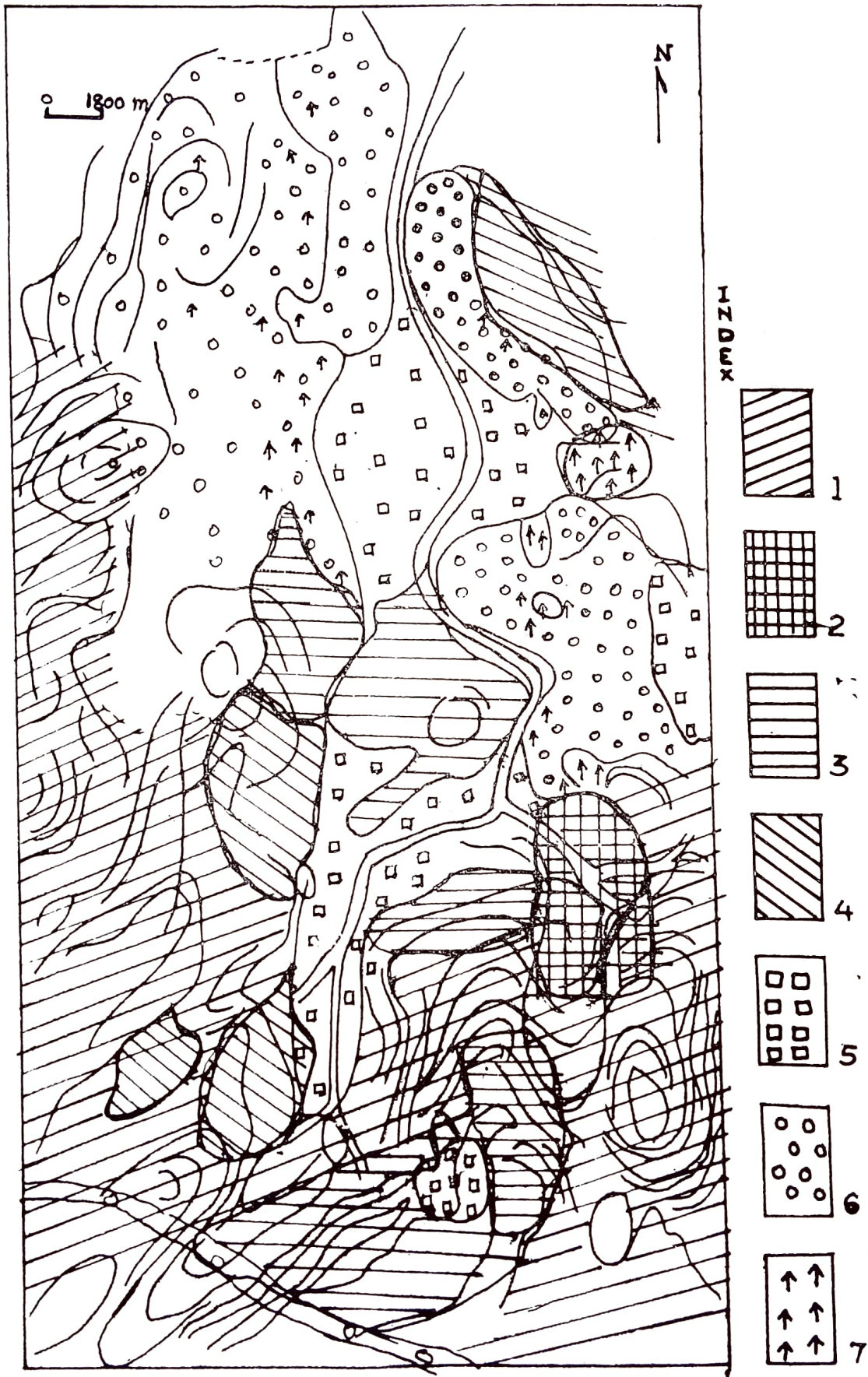


Fig. 3. Vegetation map of Noamundi iron ore mines area : 1—Dry 'Sal' forest (*Shorea—Anogeissus*), 2—Moist mixed tropical forest, 3—Dry Mixed forest with rare 'Sal', 4—Dry Mixed forest without 'Sal', 5—Grassy land, 6—Hyptis-Sereal community, 7—Shrub Sereal community.

phus xylopyrus, *Croton oblongifolius*, *Aegle marmelos*, *Embllica officinalis*. Climbers are not well-represented, except by *Combretum decandrum*, *Ventilago denticulata*, *Bauhinia vahlii*. In the south-western face of the hill, where conglomerates occur, the proportion of Sal is extremely low and even those occurring are dwarfed, and a more open, dry, mixed forest prevails. Here *Lannea coromandelica*, *Woodfordia fruticosa*, *Aegle marmelos*, *Ficus benghalensis*, *Brucea* sp., *Canthium dicoccum*, *Lagerstroemia parviflora* are found. Near the top, trees are sparse with many open grassy lands. The herbs and grasses, like—*Nelsonia canescens*, *Oldenlandia herbacea*, *Borreria pusilla*, *Pogostemon* sp., *Leucas cephhalotes*, *Eragrostis interrupta*, *E. uniloides*, *Paspalum scrobiculatum*, etc., are found. Undergrowth in the forest, after the monsoon, includes—*Knoxia sumatrensis*, *Bidens pilosa*, *Emilia sonchifolia*, *Elephantopus scaber*, *Andrographis paniculata*, *Phyllanthus variegatus*, *P. urinaria*, *Teramnus labialis*, *Desmodium pulchellum*, *Alysicarpus vaginalis* var. *heterophyllus*, *Zornia gibbosa*, *Sida cordifolia*, *Cyanotis pilosa*, *Rivea ornata*, *Physalis minima*, *Canscora diffusa*, *Curculigo orchioides*, *Fimbristylis ovata*, *Commelina paludosa*, *Adiantum lunulatum*, *Aeginetia indica*. Percentage of *Shorea robusta*, however, has been found to increase in places where the soil is found to have some moisture retaining capacity and this soil is formed on rock detritus.

A small patch of moist mixed forest occurs on the north-western side of LRP and in the gully between Hill 3 and 4 from where the Balijore nala emerges. Principal trees of this area include *Terminalia alata*, *Buchanania lanzan*, *Madhuca longifolia*, *Syzygium cumini*, *Schleichera oleosa*, *Mangifera indica*, *Anthocephalus indicus*, *Bridelia crenulata*, *Mallotus philippensis*, *Bombax ceiba*, *Bauhinia retusa*, *Sterculia urens*, *Symplocos racemosa*, *Eugenia densiflora*. Climbers, like *Bauhinia vahlii*, *Ampelocissus latifolia*, *Combretum decandrum*, *Helicteres isora*, occur on the eastern face of the Western ridge near Kurta valley. Where laterite and canga occur and the situation is very dry, *Shorea robusta* disappears altogether and *Bursera serrata*, *Anogeissus latifolia*, *Alangium salvifolium*, *Acacia farnesiana*, *Lannea coromandelica*, etc. predominate. Common herbs are *Hyptis suaveolens*, *Desmodium pulchellum*, *Cryptolepis buchmanii*, *Leonotis nepetifolia*, *Setaria glauca*, etc. The soil is acidic. In the eastern face of the western ridge near Balijore, trees, e. g. *Schleichera oleosa*, *Madhuca longifolia*, *Diospyros melanoxylon*, *Azadirachta indica*, *Bauhinia retusa*, *Lagerstroemia parviflora*, *Annona squamosa*, *Terminalia bellirica*, *Semecarpus anacardium*, *Buchanania lanzan*, *Embllica officinalis*, *Dalbergia lanceolaria*, *Cassia fistula*, etc. are found growing along with few *Shorea robusta*, chiefly on the bhq exposures. On the western face of the western ridge near Jojo, the forest is also a dry sal-and-miscellaneous forest with chief associates, like *Anogeissus latifolia*, *Boswellia serrata*, *Bursera serrata*, *Buchanania lanzan*, *Lagerstroemia parviflora*, etc. The climber *Acacia torta* is most noteworthy in this forest. The same plant has been found to grow on fissures of bare bhq rocks in abandoned mining faces.

Vanda tesellata is the common epiphyte found growing on trees—like *Mangifera indica*, *Madhuca longifolia*. Common parasitic plants found in the forest are *Dendrophthoe falcata*, *Viscum nepalense*, *Loranthus gibbosus*, *Macrosolen capitellatus*.

The Hills-1 and 2 on which bhq rocks have been laid bare after mining and abandoned for about twenty years. No forest growth has since taken place. *Hyptis suaveolens* together with *Cassia occidentalis* and *Sida rhombifolia* covers the whole of western face of these areas. In the present study it has been found to cover large areas, specifically disturbed ones, in the Singhbhum district all the year round, and this forms a herbaceous climax in secondary succession in the xerosere. In the gully between Hill-1 and 2 where the rock facies is the same, the sereal community has progressed to some extent where dwarfed trees—like, *Brucea* sp., *Ficus benghalensis*, *Trema orientalis*, *Aegle marmelos*, *Ehretia acuminata*, *Gardenia latifolia*, etc. are found. There are several herbs also, viz. : *Chromo-*

laena odorata, *Elephantopus scaber*, *Andrographis paniculata*, *Phyllanthus virgatus*, *Sebastiania chamaelea*, *Desmodium pulchellum*, *Alysicarpus vaginalis* var. *heterophyllus*, *Zornia gibbosa*, *Sida cordifolia*, *S. acuta*, *Gomphrena celosioides*, *Triumfetta rhomboidea*, *Crotalaria prostrata*, *Cymbopogon pardus*, *Themeda quadrivalvis*, *Thysanolaena maxima*, *Dactyloctenium aegyptium*, *Cyanotis pilosa*, *Pteris longifolia*, *Adiantum lunulatum*, etc.

The eastern face of these hills, however, have a luxuriant growth of forest, probably they are not being exploited for mining because they are laterised and unworkable. This forest is also a mixed, dry, deciduous forest having—*Anogeissus latifolia*, *Pterocarpus marsupium*, *Adina cordifolia*, *Boswellia serrata*, *Bursera serrata*, *Lannea coromandelica*, *Schleichera oleosa*, *Madhuca longifolia*, *Casearia elliptica*, *Bauhinia malabarica*, etc. as the chief components. The eastern faces are less drier than the western faces as is evident from the composition of the forest.

On the top of Hill-3 where Blue dust occurs, *Hyptis suaveolens* is the major element of the flora. A few trees—like, *Madhuca longifolia*, *Terminalia bellirica*, *Schleichera oleosa* occur. Gregarious growth of *Mimosa rubicaulis* is also noteworthy. The rest of this top is grassy and is used for grazing.

Near the habitations, plants—like, *Azadirachta indica*, *Moringa oleifera*, *Annona squamosa*, *Carica papaya*, *Mangifera indica*, *Syzygium cumini*, *Tabernaemontana divaricata*, *Delonix regia*, *Cassia siamea*, *Nerium indicum*, etc. are found. Near marshy and drainage areas *Ipomoea carnea*, *Lantana camara*, *Croton bonplandianus* are chiefly found.

In the Kurta valley, where the soil is alluvial mixed with laterite, the place is grassy open land with occasional ditches harbouring rain water. The plants collected are : *Centella asiatica*, *Oenanthe javanica*, *Ludwigia hyssopifolia*, *Alternanthera sessilis*, *Aeschynomene indica*, *Rotala rotundifolia*, *Polygonum barbatum*, *Sida acuta*, *Cyanotis pilosa*, *Corchorus aestuans*, *Cyperus rotundus*, *Eleusine coracana*, *Paspalum scrobiculatum*, etc.

The absence of *Xylia xylocarpa* is noteworthy. MOONEY (1942) has stated that this species does not extend beyond the southern boundary of Singhbhum district. It is reported from adjoining areas, like Mayurbhanj, Saranda, which have a greater average rainfall than this area. *Shorea robusta* grows well on flat hill tops with laterite or in shallow soil derived from the haematite but it decreases in abundance on slopes particularly on southern and eastern sides. The presence of *Boswellia serrata* on dried aspects and on conglomerates is prominent and forms a subsidiary edaphic type of the dry tropical deciduous forest of this region. Composition of the forest types enumerated in the preceding paragraphs are shaped primarily by the lithological types on which they grow and also the microclimate i. e. shade, soil water retention capacity, diurnal variation of temperature, and to some extent altitude. Of course, mining activities have played a major role in shaping present alteration of the vegetation of the area. Hill-1 can be cited as an example to this where trees have been almost eliminated. *Hyptis suaveolens*, *Chrysopogon aciculatus*, *Acacia torta*, etc. form the major component of the vegetation. Natural regeneration is impeded by various biotic factors, pollutants emanating from mining operations and general dryness of the area. The presence of genera of typical moister atmosphere, like—*Bulbophyllum*, *Begonia*, *Aeginetia*, and ferns as monsoon ephemerals is noteworthy (HOOKER, 1904).

Geographically, the Noamundi hills form the southern-most extension of Chhotanagpur hills which are continued into the Keonjhar in Orissa. Phytogeographically, this region occupies a central position for the three decidedly distinct botanical provinces, viz. Himalaya, Peninsular India and Assam-Burma though the area was included under Deccan by HOOKER (1904) and HOOKER AND THOMSON (1855). As is expected, the

vegetation of Noamundi and adjoining hills comprises elements derived from these three provinces, in varying proportions, the peninsular one being prominent. Of the 265 plants collected, 61.6 per cent have a wide distribution in the Peninsular India, Himalaya, Gangetic plains and Assam. Only 15.3 per cent of these plants have a peninsular Indian affinity as compared to about 1.5 per cent of plants of northern affinity that do not cross further south. 13.4 per cent of species are common both to Himalaya and Peninsular India, but they are not found in Assam. According to HAINES (1921-25) these hills have served the purpose of stepping stones for the passage of peninsular plants to Himalaya, or in some cases in a reverse direction.

The present vegetation is probably composed basically of elements derived from a Tertiary lateritic flora and a post-Tertiary flora. The relict nature of the vegetation of Chhotanagpur has been remarked by BISWAS AND SAMPATKUMARAN (1949) and according to him the age is probably Tertiary. MOONEY (1942) has made some observations for the Bailadila vegetation, an area contemporaneous with the present area of study and the age of Bailadila flora has been supposed by HORA (1949) as of Pleistocene. The flora with a tropical facies developed in the lateritic soils during Tertiary times. Forms comparable to *Boswellia serrata*, *Terminalia alata*, *Schleichera oleosa*, *Lagerstroemia indica*, *Flacourtia indica*, *Bridelia crenulata*, *Mallotus philippensis* have been recorded from Paleogene flora of India (LAKHANPAL, 1970; PRAKASHI, 1973). With changing climatic conditions in subsequent times resulting in more desiccation, following rafting of Indian continent further north, closure of Tethys sea and the rise of the Himalaya, the dry deciduous types survived as a plateau relicts, associated with the advancing Neogene elements, like the species of *Shorea*, *Anogeissus*, *Lannea*, *Cassia*, *Acacia*, *Bauhinia*, *Ziziphus*, *Dalbergia*, *Madhuca*, *Ficus*, etc. and some northern elements which probably have arrived during post-Pleistocene period on the newer habitats caused by exposure or deposition of new soil materials.

The hills of the area under study form remnants of mid-Tertiary surfaces. Occurrences of Tertiary elements have been recorded for Hamersley Iron ore deposits in Australia by COLE (1965). The 'Canga' formed during the 'pluvial periods in the Pleistocene have a distinctive assemblage of *Acacia farnesiana*, *Lannea coromandelica*, *Alangium salvifolium*, etc. together with scattered *Bursera serrata* and *Anogeissus latifolia*. Probably these Tertiary relicts and present groups of plants for which iron content of soil exercises a fundamental control (COLE, 1965).

CONCLUSION

The area of study is the lease area of TISCO and is a part of Singhbhum district, Bihar, India. The main topographical features comprise of low hills which are rich in haematite ore bodies. The present vegetation is much disturbed owing to mining activities and the remaining ones are likely to be exhausted in consequence to mining exploitations. The vegetation is chiefly dry mixed deciduous one which is probably at a sub-climax stage with patches of moist mixed deciduous forests. Secondary succession of herbaceous climax on newly exposed rock surfaces (chiefly B. H. Q.) has been discussed phytogeographically. The area presents a junction of three distinct floral assemblages, namely Peninsular, Himalayan and an Eastern one. The vegetation is probably a relict one with trees represented in the Paleogene and Neogene flora of India, with latter incursions from other areas. The relationship of Tertiary flora and Iron ores is also presumed.

ACKNOWLEDGEMENTS

The authors wish to acknowledge with thanks the assistance rendered by the authorities of the Noamundi mines of the Tata Iron and Steel Company Limited during the explorations of the area and also in other ways. The work has been carried out of financial assistance (Research Fellowship to S. C. Nandi) rendered by the University of Burdwan.

List of plants collected from Noamundi (1978-1980).

Dicotyledons	Bihar	Assam	Himalaya	Peninsular India
Annonaceae				
<i>Annona squamosa</i> Linn.	+	+	—	+
<i>Unona longiflora</i> Roxb.	+	+	—	—
Papaveraceae				
<i>Argemone mexicana</i> Linn.	+	—	+	+
Capparaceae				
<i>Cleome chelidonii</i> Linn. f.	+	—	—	+
<i>Cleome viscosa</i> Linn.	+	+	+	+
Flacourtiaceae				
<i>Flacourtia cataphracta</i> Roxb.	+	+	+	+
<i>Flacourtia indica</i> (Burm.) Merr.*	+	+	+	+
Dipterocarpaceae				
<i>Shorea robusta</i> Gaertn. f.**	+	+	+	+
Malvaceae				
<i>Sida acuta</i> Burm.	+	+	+	+
<i>Sida cordifolia</i> Linn.	+	+	+	+
<i>Sida rhombifolia</i> Linn.	+	+	—	+
<i>Sida spinosa</i> Linn.	+	—	+	+
<i>Urena lobata</i> Linn.	+	+	+	+
Bombacaceae				
<i>Bombax ceiba</i> Linn.	+	+	—	+
Sterculiaceae				
<i>Helicteres isora</i> Linn.	+	—	+	+
<i>Sterculia urens</i> Roxb.	+	+	+	+
Tiliaceae				
<i>Corchorus aestuans</i> Linn.	+	+	—	+
<i>Triumfetta rhomboidea</i> Jacq.	+	+	—	+
Oxalidaceae				
<i>Oxalis corniculata</i> Linn.	+	+	+	+
<i>Oxalis richardiana</i> Babu	+	—	+	—

Dicotyledons	Bihar	Assam	Himalaya	Peninsular India
Rutaceae				
<i>Aegle marmelos</i> (Linn.) Corr.	+	+	+	+
Simaroubaceae				
<i>Brucea mollis</i> Wall. ex Kurz	+	+	+	+
Burseraceae				
<i>Boswellia serrata</i> Colebr*	+	—	+	+
<i>Bursera serrata</i> Colebr.	+	—	+	+
Meliaceae				
<i>Azadirachta indica</i> Juss.	+	+	+	+
<i>Trichilia connaroides</i> (Wight & Arn.) Bentvelzen	+	+	+	+
Olacaceae				
<i>Olex scandens</i> Roxb.	+	—	+	+
Celastraceae				
<i>Celastrus paniculatus</i> Willd.	+	+	+	+
Rhamnaceae				
<i>Ventilago denticulata</i> Willd.	+	+	+	+
<i>Ziziphus mauritiana</i> Lamk.**	+	+	+	+
<i>Ziziphus nummularia</i> (Burm.f.) W. & A.	+	—	—	+
<i>Ziziphus oenoplia</i> (Linn.) Mill.	+	+	+	+
<i>Ziziphus xylopyrus</i> (Retz.) Willd.	+	+	—	+
Vitaceae				
<i>Ampelocissus latifolia</i> (Roxb.) Planch.	+	+	+	+
<i>Vitis barbata</i> Wall.	+	+	—	—
Sapindaceae				
<i>Schleichera oleosa</i> (Lour.) Oken*	+	+	+	+
Anacardiaceae				
<i>Buchanania lanzan</i> Spreng.	+	—	+	+
<i>Lannea coromandelica</i> (Houtt.) Merrill**	+	+	+	+
<i>Mangifera indica</i> Linn.	+	+	+	+
<i>Semecarpus anacardium</i> Linn. f.	+	+	+	+
Moringaceae				
<i>Moringa oleifera</i> Lamk.	+	—	+	+
Fabaceae				
<i>Abrus precatorius</i> Linn.	+	+	+	+
<i>Aeschynomene indica</i> Linn.	+	+	+	+
<i>Alysicarpus vaginalis</i> var. <i>heterophyllus</i> Baker	+	—	+	+

Dicotyledons	Bihar	Assam	Himalaya	Peninsular India
<i>Alyosia scarabaeoides</i> (Linn.) Benth.	+	+	+	+
<i>Butea monosperma</i> (Lamk.) Taub.	+	+	+	+
<i>Butea parviflora</i> Roxb.	+	+	+	+
<i>Butea superba</i> Roxb.	+	+	+	+
<i>Crotalaria prostrata</i> Rottler ex Willd.	+	+	+	+
<i>Dalbergia lanceolaria</i> Linn. f.**	+	+	+	+
<i>Desmodium gangeticum</i> (Linn.) DC.	+	+	+	+
<i>Desmodium motorium</i> (Houtt.) Merrill	+	+	+	+
<i>Desmodium gyroides</i> DC.	+	+	+	+
<i>Desmodium pulchellum</i> (Linn.) Benth.	+	+	—	+
<i>Desmodium triflorum</i> (Linn.) DC.	+	+	+	+
<i>Vigna unguiculata</i> (Linn.) Walp. ssp. <i>unguiculata</i>	+	+	+	+
<i>Flemingia macrophylla</i> (Willd.) Prain ex Merrill	+	+	+	+
<i>Pterocarpus marsupium</i> Roxb.	+	+	—	+
<i>Rhynchosia rufescens</i> (Willd.) DC.	+	+	—	+
<i>Teramnus labialis</i> (Linn. f.) Spreng.	+	+	+	+
<i>Uraria neglecta</i> Prain	+	—	+	+
<i>Zornia gibbosa</i> Span.	+	+	+	+
Caesalpiniaaceae				
<i>Bauhinia malabarica</i> Roxb.**	+	+	+	+
<i>Bauhinia retusa</i> Ham.**	+	—	+	+
<i>Bauhinia vahlii</i> Wt. & Arn.	+	+	+	+
<i>Cassia absus</i> Linn.	+	+	+	+
<i>Cassia fistula</i> Linn.**	+	+	+	+
<i>Cassia mimosoides</i> Linn.	+	+	+	+
<i>Cassia occidentalis</i> Linn.	+	+	+	+
<i>Cassia siamea</i> Lam.**	+	—	—	+
<i>Cassia sophera</i> Linn.	+	+	+	+
<i>Cassia tora</i> Linn.	+	+	+	+
<i>Delonix regia</i> (Hk.) Raf.	+	+	—	+
<i>Peltophorum pterocarpum</i> (DC.) Bağer ex K. Heyne	+	+	+	+
<i>Tamarindus indica</i> Linn.	+	+	+	+

Dicotyledons	Bihar	Assam	Himalaya	Peninsular India
Mimosaceae				
<i>Acacia farnesiana</i> (Linn.) Willd.**	+	+	+	+
<i>Acacia torta</i> (Roxb.) Craib	+	—	—	+
<i>Mimosa rubicaulis</i> Lamk.	+	+	+	+
Crassulaceae				
<i>Kalanchoe grandiflora</i> W. & A.	+	—	—	+
Combretaceae				
<i>Anogeissus latifolia</i> (DC.) Bedd.**	+	+	+	+
<i>Combretum decandrum</i> Roxb.	+	+	—	+
<i>Combretum ovalifolium</i> Roxb.	+	—	—	+
<i>Quisqualis indica</i> Linn.	+	+	+	+
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wt. & Arn.	+	—	+	+
<i>Terminalia bellirica</i> (Gaertn.) Roxb.	+	+	+	+
<i>Terminalia alata</i> Heyne ex Roth.*	+	—	+	+
Myrtaceae				
<i>Eugenia densiflora</i> DC.	+	—	—	—
<i>Eugenia hemispherica</i> Wt.	+	—	—	+
<i>Syzygium cumini</i> (Linn.) Skeels	+	—	—	—
Melastomataceae				
<i>Osbeckia reticulata</i> Bedd.	+	—	—	+
Lythraceae				
<i>Lagerstroemia indica</i> Linn.*	+	+	+	+
<i>Lagerstroemia parviflora</i> Roxb.	+	—	+	+
<i>Rotala rotundifolia</i> (Don) Koehne	+	—	—	+
<i>Woodfordia fruticosa</i> (Linn.) Kurz	+	+	+	+
Onagraceae				
<i>Ludwigia hyssopifolia</i> (Don) Exell	+	—	—	+
<i>Ludwigia perennis</i> Linn.	+	—	—	+
Samydaceae				
<i>Casearia graveolens</i> Dalz.	+	—	+	+
<i>Casearia elliptica</i> Willd.	+	+	+	+
Passifloraceae				
<i>Passiflora foetida</i> Linn.	+	+	—	+
Caricaceae				
<i>Carica papaya</i> Linn.	+	+	—	+
Cucurbitaceae				
<i>Diplocyclos palmatus</i> (Linn.) Jeffrey	+	—	+	+

Dicotyledons	Bihar	Assam	Himalaya	Peninsular India
Begoniaceae	+	+	+	+
<i>Begonia picta</i> Sm.	+	+	+	+
Apiaceae				
<i>Centella asiatica</i> (Linn.) Urban.	+	+	+	+
<i>Oenanthe javanica</i> (El.) DC.	+	+	+	+
<i>Pimpinella heyneana</i> (DC.) Kurz	+	—	—	+
Araliaceae				
<i>Panax fruticosum</i> Linn.	+	+	—	+
Alangiaceae				
<i>Alangium salvifolium</i> (Linn. f.) Wang	+	+	+	+
Rubiaceae				
<i>Adina cordifolia</i> (Roxb.) Bran.	+	+	+	+
<i>Anthocephalus indicus</i> A. Rich.	+	+	+	+
<i>Borreria articularis</i> (Linn.f.) F.N. Will.	+	+	+	+
<i>Borreria pusilla</i> (Wall.) DC.	+	+	+	+
<i>Canthium dicoccum</i> (Gaertn.) Teys. & Binn. var. <i>umbellatum</i> (Wt.) Sant. & Merch.	+	+	+	+
<i>Gardenia latifolia</i> Aiton	+	+	+	+
<i>Spermadictyon suaveolens</i> Roxb.	+	—	+	+
<i>Hymenodictyon excelsum</i> (Roxb.) Wall.	+	+	+	+
<i>Knoxia sumatrensis</i> (Retz.) DC.	+	+	+	+
<i>Morinda citrifolia</i> Linn.	+	—	+	+
<i>Oldenlandia diffusa</i> Roxb.	+	+	+	+
<i>Oldenlandia herbacea</i> (Linn.) Roxb.	+	+	+	+
<i>Pavetta indica</i> Linn.	+	+	+	+
<i>Meyna laxiflora</i> Robyns	+	+	—	+
Asteraceae				
<i>Acanthospermum hispidum</i> DC.	+	—	—	+
<i>Ageratum conyzoides</i> Linn.	+	+	+	+
<i>Bidens pilosa</i> Linn.	+	—	+	+
<i>Blumea fistulosa</i> (Roxb.) Kurz	+	+	+	+
<i>Blumea mollis</i> (Don) Merrill	+	—	+	+
<i>Eclipta alba</i> (Linn.) Hassk.	+	+	+	+
<i>Elephantopus scaber</i> Linn.	+	+	+	+
<i>Emilia sonchifolia</i> (Linn.) DC.	+	+	+	+

Dicotyledons	Bihar	Assam	Himalaya	Peninsular India
<i>Chromolaena odorata</i> (Linn.) King & Robinson	+	+	+	+
<i>Guizotia abyssinica</i> (Linn.f.) Cass.	+	—	—	+
<i>Laggera flava</i> (DC.) Cl.	+	+	+	+
<i>Siegesbeckia orientalis</i> Linn.	+	+	+	+
<i>Synedrella nodiflora</i> (Linn.) Gaertn.	+	+	—	+
<i>Tridax procumbens</i> Linn.	+	+	+	+
<i>Vernonia cinerea</i> (Linn.) Less.	+	+	+	+
<i>Vicoa indica</i> (Linn.) DC.	+	—	+	+
Sapotaceae				
<i>Chrysophyllum cainito</i> Linn.	+	—	+	+
<i>Madhuca longifolia</i> (Koenig) Macbride**	+	—	+	+
Ebenaceae				
<i>Diospyros melanoxylon</i> Roxb.	+	+	—	+
Symplocaceae				
<i>Symplocos racemosa</i> Roxb.	+	+	+	+
Oleaceae				
<i>Jasminum arborescens</i> Roxb.	+	—	+	+
<i>Nyctanthes arbor-tristis</i> Linn.	+	+	—	+
Apocynaceae				
<i>Alstonia scholaris</i> (Linn.) R. Br.	+	+	+	+
<i>Holarrhena antidysenterica</i> (Roth) DC.	+	+	+	+
<i>Ichnocarpus frutescens</i> (Linn.) R. Br.	+	+	+	+
<i>Nerium indicum</i> Mill.	+	—	+	+
<i>Tabernaemontana divaricata</i> (Linn.) R. Br.	+	+	+	+
Asclepiadaceae				
<i>Calotropis gigantea</i> (Linn.) Dryand.	+	+	+	+
<i>Calotropis procera</i> (Ait.) Br.	+	+	+	+
<i>Cryptolepis buchananii</i> Roem. & Sch.	+	+	+	+
<i>Hemidesmus indicus</i> (Linn.) R. Br.	+	—	+	+
<i>Pergularia daemia</i> (Forsk.) Chiov.	+	—	+	+
Gentianaceae				
<i>Canscora decussata</i> Schult. & Schult.	+	+	+	+
<i>Canscora diffusa</i> (Vahl.) R. Br.	+	+	+	+
Boraginaceae				
<i>Ehretia acuminata</i> R. Br.	+	+	+	+

Dicotyledons	Bihar	Assam	Himalaya	Peninsular India
Convolvulaceae				
<i>Evolvulus alsinoides</i> (Linn.) Linn.	+	+	+	+
<i>Evolvulus nummularius</i> (Linn.) Linn.	+	—	—	—
<i>Ipomoea carnea</i> Jacq.	+	+	—	+
<i>Merremia umbellata</i> (Linn.) Hall.f.	+	+	+	+
<i>Rivea ornata</i> Choisy	+	+	+	+
Solanaceae				
<i>Lycopersicon lycopersicum</i> (L.) Karsten.	+	+	+	+
<i>Physalis minima</i> Linn.	+	+	+	+
<i>Solanum violaceum</i> Ortega	+	+	+	+
<i>Solanum nigrum</i> Linn.	+	+	+	+
<i>Solanum surattense</i> Burm.f.	+	+	+	+
Scrophulariaceae				
<i>Lindernia antipoda</i> (Linn.) Alston	+	—	—	+
<i>Linnophila indica</i> (Linn.) Druce	+	+	—	+
<i>Scoparia dulcis</i> Linn.	+	+	—	+
Orobanchaceae				
<i>Aeginetia indica</i> Linn	+	+	+	+
Bignoniaceae				
<i>Spathodea campanulata</i> Beauv.	+	—	—	+
Acanthaceae				
<i>Andrographis alata</i> (Vahl) Nees	+	—	—	+
<i>Andrographis echinoides</i> (Linn.) Nees	+	—	—	+
<i>Andrographis paniculata</i> (Burm.f.) Wall. ex Nees	+	+	+	+
<i>Barleria cristata</i> Linn.	+	+	+	+
<i>Dicliptera verticillata</i> (Forsk.) Christens.	+	—	—	+
<i>Hemigraphis latebrosa</i> (Roth) Nees	+	—	—	+
<i>Hygrophila quadrivalvis</i> Nees	+	—	—	+
<i>Justicia simplex</i> Don.	+	—	+	+
<i>Lepidagathis incurva</i> Don	+	+	+	+
<i>Nelsonia canescens</i> (Lamk.) Spreng.	+	+	+	+
Verbenaceae				
<i>Callicarpa tomentosa</i> (Linn.) Murray	+	—	—	+
<i>Clerodendrum viscosum</i> Vent.	+	+	—	+

Dicotyledons	Bihar	Assam	Himalaya	Peninsular India
<i>Clerodendrum serratum</i> (Linn.) Moon	+	+	+	+
<i>Duranta repens</i> Linn.	+	+	—	+
<i>Lantana camara</i> Linn.	+	+	—	+
<i>Premna integrifolia</i> Linn.	+	+	+	—
<i>Vitex negundo</i> Linn.	+	+	+	+
Lamiaceae				
<i>Hyptis suaveolens</i> (Linn.) Poit.	+	+	+	+
<i>Leonotis nepetifolia</i> (Linn.) R. Br.	+	—	+	+
<i>Leucas cephalotes</i> Spreng.	+	+	+	+
<i>Ocimum basilicum</i> Linn.	+	+	+	+
<i>Ocimum americanum</i> Linn.	+	+	+	+
<i>Plectranthus mollis</i> (Ait.) Spreng.	+	+	+	+
<i>Pogostemon benghalensis</i> (Burm.) Kuntze	+	—	+	+
Nyctaginaceae				
<i>Boerhavia diffusa</i> Linn.	+	+	+	+
<i>Bougainvillea glabra</i> Choisy	+	+	—	+
Amaranthaceae				
<i>Achyranthes aspera</i> Linn.	+	+	+	+
<i>Aerva lanata</i> (Linn.) Juss.	+	—	—	+
<i>Aerva monsoniae</i> (Linn.f.) Mart	+	—	—	+
<i>Alternanthera sessilis</i> (Linn.) R. Br.	+	—	+	+
<i>Amaranthus caturus</i> Heyne	+	—	—	+
<i>Gomphrena celosioides</i> Mart.	+	—	—	—
Polygonaceae				
<i>Polygonum barbatum</i> Linn.	+	+	+	+
Lauraceae				
<i>Litsea polyantha</i> Juss.	+	+	+	+
Loranthaceae				
<i>Dendrophthoe falcata</i> (Linn.f.) Etting.	+	+	+	+
<i>Loranthus gibbosus</i> Talbot	+	+	—	+
<i>Macrosolen copitellatus</i> (Wt. & Arn.) Danser	+	+	—	—
<i>Viscum nepalense</i> Spreng.	+	+	+	+
Santalaceae				
<i>Santalum album</i> Linn.	+	+	+	+

Dicotyledons	Bihar	Assam	Himalaya	Peninsular India
Euphorbiaceae				
<i>Antidesma diandrum</i> Roth	+	+	+	+
<i>Bridelia crenulata</i> Roxb.*	+	+	+	+
<i>Codiaeum variegatum</i> Blume	+	+	+	+
<i>Croton bonplandianus</i> Baill	+	—	—	+
<i>Croton oblongifolius</i> Roxb.	+	+	—	+
<i>Emblica officinalis</i> Gaertn.	+	+	+	+
<i>Euphorbia granulata</i> Forsk.	+	—	—	+
<i>Euphorbia hirta</i> Linn.	+	+	+	+
<i>Glochidion hohenackeri</i> Bedd.	+	+	+	+
<i>Jatropha gossypifolia</i> Linn.	+	+	—	+
<i>Mallotus philippensis</i> (Lamk.) Muell.	+	+	+	+
<i>Phyllanthus virgatus</i> Forst. f.	+	+	+	+
<i>Phyllanthus urinaria</i> Linn.	+	+	+	+
<i>Sebastiania chamaelea</i> (Linn.) Muell.	+	—	—	+
<i>Tragia involucrata</i> Linn.	+	+	+	+
Urticaceae				
<i>Trema orientalis</i> (Linn.) Blume	+	+	+	—
<i>Laportea interrupta</i> (Linn.) Chew	+	+	+	+
Moraceae				
<i>Ficus benghalensis</i> Linn.**	+	+	+	+
<i>Ficus cunia</i> Buch.—Ham. ex Roxb.	+	+	+	+
<i>Ficus racemosa</i> Linn.**	+	+	+	+
<i>Ficus rumphii</i> Blume	+	+	+	+
<i>Ficus tomentosus</i> Roxb.**	+	—	—	+
MONOCOTYLEDONS				
Orchidaceae				
<i>Bulbophyllum careyanum</i> Spr.	+	+	—	—
<i>Habenaria roxburghii</i> Nicolson	+	—	+	+
<i>Vanda tesellata</i> (Roxb.) Hock ex G. Don	+	—	—	+
Marantaceae				
<i>Maranta arundinacea</i> Linn.	+	—	+	+
Hypoxidaceae				
<i>Curculigo orchioides</i> Gaertn.	+	+	+	+

Monocotyledons	Bihar	Assam	Himalaya	Peninsular India
Agavaceae				
<i>Sansevieria roxburghina</i> J. & J. Schult.	+	—	+	+
Dioscoreaceae				
<i>Dioscorea pentaphylla</i> Linn.	+	—	+	+
Liliaceae				
<i>Smilax zeylanica</i> Linn.	+	+	+	+
Pontederiaceae				
<i>Monochoria hastaeifolia</i> Presl.	+	+	+	+
Commelinaceae				
<i>Commelina paludosa</i> Blume	+	+	+	+
<i>Cyanotis pilosa</i> Schult. f.	+	—	—	+
<i>Fiscopa scandens</i> Lour	+	—	+	+
Cyperaceae				
<i>Kyllinga nemoralis</i> (Forster)	+	—	+	+
Dandy ex Hutchinson				
<i>Cyperus rotundus</i> Linn.	+	+	+	+
<i>Fimbristylis ovata</i> (Burm.) Kern.	+	+	—	+
<i>Schoenoplectus juncooides</i> (Roxb.) Palla	+	+	+	+
Poaceae				
<i>Chrysopogon aciculatus</i> (Retz.) Trin.	+	+	+	+
<i>Cymbopogon nardus</i> (Linn.) Rendle	+	+	—	+
<i>Cynodon dactylon</i> Pers.	+	+	+	+
<i>Dactyloctenium aegyptium</i> (Linn.) Beauv.	+	+	+	+
<i>Eleusine coracana</i> (Linn.) Gaertn.	+	+	+	+
<i>Eragrostis interrupta</i> Beauv. var. <i>tenuissima</i> Stapf.	+	+	+	+
<i>Eragrostis uniloides</i> (Retz.) Steud.	+	+	+	+
<i>Paspalum scrobiculatum</i> Linn.	+	+	—	+
<i>Setaria glauca</i> (Linn.) P. Beauv.	+	+	+	+
<i>Triemeda quadrivalvis</i> (Linn.) O. Ktze.	+	—	+	+
<i>Thysanolaena maxima</i> (Roxb.) Kuntze	+	+	+	+
PTERIDOPHYTA				
Selaginellaceae				
<i>Selaginella proniflora</i> Bak.	+	—	—	—
Schizaeaceae				
<i>Lygodium flexuosum</i> (Linn.) Sw.	+	—	—	+

Pteridophyta	Bihar	Assam	Himalaya	Peninsular India
Adiantaceae				
<i>Adiantum lunulatum</i> Burm.	+	+	—	+
Polypodiaceae				
<i>Cheilanthes tenuifolia</i> Sw.	+	—	—	+
<i>Pteris longifolia</i> Linn.	+	—	+	—

*=Comparable forms recorded from Paleogene.

**=Comparable forms recorded from Neogene.

Distribution : '+' Presence, '—' Absence.

REFERENCES

- BISWAS, K. & SAMPATKUMARAN, M. A. (1949). Botanical notes on the Satpura theory. *Proc. nat. Inst. Sci. Ind.*, **15** (8) : 365-367.
- CHAMPION, H. G. (1936). A preliminary survey of the forest types of India and Burma. *Indian Forest Rec. (N.S.)*, **1** : 1-286.
- CHAMPION, H. G. & SETH, S. K. (1968). *A revised survey of the forest types of India*. Delhi.
- COLE, M. M. (1965). Use of vegetation in mineral exploration in Australia. *Commonwealth Mining Metal. Cong.*, 8th Melbourne, Australia, **6** : 1429-1458.
- DUNN, J. A. (1937). The mineral deposits of Eastern Singhbhum and surrounding areas. *Mem. geol. Surv. India*, **69** (1).
- GHOSH, T. K. (1966). Contribution to our knowledge of the flora of Singhbhum-II. *Proc. 53rd Indian Sci. Congr.*, Chandigarh, **3** : 265.
- HAINES, H. H. (1910). *A forest flora of Chotanagpur including Gangpur and the Santal Parganas*. Dehra Dun.
- HAINES, H. H. (1921-25). *The Botany of Bihar and Orissa (parts I-VI)*. London.
- HOOKE, J. D. (1904). *Sketch of the Flora of British India*. London.
- HOOKE, J. D. & THOMSON, T. (1855). *Flora Indica* : being a systematic account of the plants of British India, together with observations on the structure and affinities of the natural orders and genera. London.
- HORA, S. L. (1949). Geographical features of the Flora of the Bailadila Range in Bastar State, C. P. *Proc. nat. Inst. Sci. Ind.*, **15** (8) : 369-373.
- JONES, H. C. (1922). Iron Ores of Singhbhum and Orissa. *Rec. geol. Surv. India*, **54** : 203-214.
- JONES, H. C. (1934). The Iron Ore Deposits of Bihar and Orissa. *Mem. geol. Surv. India*, **63** (2).
- KRISHNAN, M. S. (1968). *Geology of India and Burma*. Madras.
- LAKHANPAL, R. N. (1970). Tertiary floras of India and their bearing on the historical geology of the Region. *Taxon*, **19** : 675-694.
- MAJUMDAR, N. C. & BISWAS, S. N. (1971). An account of the vegetation of Chaibasa, Singhbhum district in South Bihar. *Bull. bot. Soc. Beng.*, **25** (1 & 2) : 43-51.
- MEHER-HOMJI, V. M. (1971). A sketch of the vegetation of the Chotanagpur Plateau and its environs. *J. Indian bot. Soc.*, **50** : 162-174.
- MOONEY, H. F. (1937). A synecological study of the forests of Western Singhbhum with special reference to their geology. *Indian Forest Rec. (N. S.)*, **2** : 259-335.
- MOONEY, H. F. (1942). A sketch of the flora of the Bailadila range in Bastar State. *Indian Forest Rec.*, **3**(7) : 197-253.
- NAIR, K. N. P. (1944). A synecological study of the forests of Mayurbhanj. *Indian Forester*, **70**: 257.
- PERCIVAL, DR. F. G. (1931). The Iron Ore Deposits of Noamundi. *Trans. Min. Geol. Inst. India*, **26** (3).
- PRAKASH, U. (1973). Palaeoenvironmental analysis of Indian Tertiary floras. *Geophytology*, **2**(2) : 178-205.
- PURI, G. S. (1960). *Indian Forest Ecology*. **1** : 1-318. Oxford Book & Stn. Co., New Delhi & Calcutta.

SRIVASTAVA, J. G. (1958). *The vegetation of the Singhbhum District*. (Revised District Gazetteer of Bihar State), Singhbhum, Patna.

SRIVASTAVA, J. G. (1959). Recent trends in the flora of the Bihar State. *J. Indian bot. Soc.*, **38** : 186-194.

EXPLANATION OF PLATE 1

1. Sal trees and *Bauhinia vahlii*
2. Vegetation along Balijore nullah
3. Grassy hill top with dwarfed trees on conglomerates
4. Vegetation on 'Canga'
5. Dry deciduous mixed forest at the margin of mining bench on Hill-5

Note : Thin soil layer resting on ore bodies

6. A disturbed area for trees though the undergrowth is dense
7. Herbaceous climax of *Hyptis suaveolens* in the secondary succession of B.H.Q. in Hill-1
8. Secondary succession on the xerosere on Hill-1 facing south-east

