FLORA OF JOWAI

VOLUME ONE

N. P. BALAKRISHNAN

BOTANICAL SURVEY OF INDIA
SHILLONG-793003

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And

Vicinity

MEGHALAYA

A contribution towards a detailed knowledge of the Flora of the Northeastern region of India

[IN TWO VOLUMES]

N. P. Balakrishnan

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FOREWORD

The Botanical Survey of India has taken up the preparation of Flora of India. It is proposed to bring it out in several series.

The first, the national flora, has already been started and it deals with families and genera for the whole country. It is being brought out in the form of *Fascicles of Flora of India* as and when accounts of families, tribes and large genera are ready. Six fascicles have so far been published ; they deal with the families Coriariaceae, Paeoniaceae, Dilleniaceae, Simaroubaceae, Balanitaceae, Pittosporaceae and part of the families Poaceae and Orchidaceae. Several more fascicles are under printing, editing and preparation.

The second series will deal with census of plants of certain States, with notes on distribution and uses ; it will be called *State Flora Analysis.*

The third series called *District Floras* will have detailed accounts with keys and descriptions of plants of small areas such as one district or a few adjacent districts.

The present District Flora deals with a floristically very rich, but hitherto unexplored region in eastern India. The fact that the region has a unique flora, is substantiated by rich variety, endemism and interesting phytogeographical affinities.

In view of such speciality of the flora more details have been provided for the habitat, other ecological aspects and analysis of flora, and consequently this work has become little larger than the anticipated size of one District Flora. Some photographs of vegetation types have been given. Many species have been illustrated with line drawings. The flora is being presented in two volumes.

The author has preferred to present a new and rather unconventional key to the plant families of the area, based on his personal field and herbarium observations. This is a diversion from usual treatment, but it is hoped it will facilitate in the identification of plants.

This work is an adaptation from the doctoral thesis of the author and was carried out under the supervision of Dr. A. S. Rao, then Regional Botanist, Eastern Circle and now Joint Director, Botanical Survey of India, Howrah.

This Flora should help in the identification and study of the plants of many areas in north-eastern India.

S. K. JAIN
Director
Botanical Survey of India

Howrah
February, 1981

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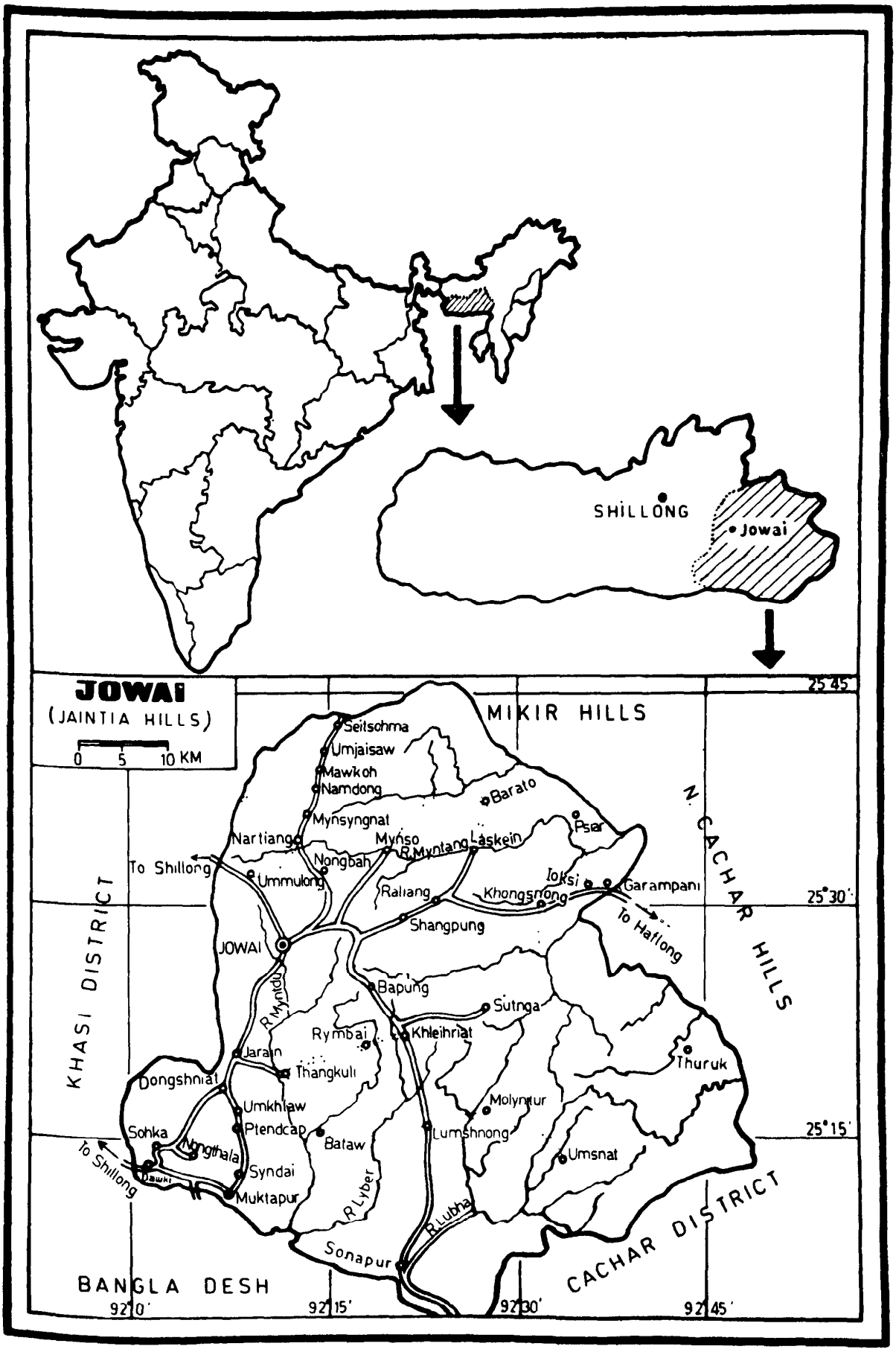

India, Meghalaya and Jowai district, the area of the flora

Nepenthes khasiana Hook. f.
The curious insectivorous Pitcher plant

INTRODUCTION

The North Eastern region of India, generally referred to as Assam,* is perhaps the richest and the most interesting floristic region in the country. It still remains floristically incompletely known, though practically all other regions have attained comparatively better floristic familiarity through regional floras of their own. These regional floras, for Bengal (Prain, 1903), Bombay (Cooke, 1903-08), Upper Gangetic Plains (Duthie, 1903-29), Madras (Gamble & Fischer, 1915-36), Bihar and Orissa (Haines, 1922-25), were all inspired (and in most cases used much of the same material) by The Flora of British India (Hooker, 1872-97). This monumental work of Hooker and many of his collaborators was carried out through a span of nearly sixty years and seen through in print during a quarter of a century, with an understanding and assured Government support through all this long span of time and based on innumerable earlier collections of countless enthusiasts —botanists and others—from all corners of the vast subcontinent during a century and half.

The obvious gap of the lack of a regional flora of Assam was a challenge that was taken up by U. N. Kanjilal, who following Gustav Mann, the first Conservator of Forests of Assam, organised extensive collection of plants from far corners of Assam through the many forest officials and drafted accounts of several families, based on careful field notes, and well-prepared herbarium specimens. The Flora of Assam (Kanjilal et al. 1934-40), however, was seen through print by his son P. C. Kanjilal and others. In view of the professional interest of the different authors, this work has a strong bias towards the woody flora, and includes very little of the herbaceous elements. Further, even otherwise, it remains incomplete, without any treatment of the monocots, except a volume on Gramineae (Poaceae) by Bor (Vol. 5). Notwithstanding this, it connotes a landmark in the history of Indian floristic works, in being the pioneer effort of Indian botanists.

One of the earliest account of Assam is that of Buchanan-Hamilton (1820), who published a detailed description of his pioneering expedition to Assam, including some botanical information. Robinson (1841) in his descriptive account of Assam, has provided a chapter on the flora. Roxburgh

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*Assam as referred to in earlier botanical literature, now consists of several political units. Only the Brahmaputra valley with the N. Cachar and Mikir Hills, forms the present Assam. The old Balipada Frontier and Sadiya Frontier Tracts, which were combined to one administrative unit : the North-Eastern Frontier Agency (NEFA), is now Arunachal Pradesh. The United Khasi & Jaintia Hills with Garo Hills have become Meghalaya. Mizo or Lushai Hills, is now Mizoram. Others are Nagaland, Manipur and Tripura. In view of the intermingled history of botanical exploration in the whole region, the introductory account refers to the entire North Eastern region.

(1820-24 & 1832) in his Flora Indica, described many plants (mostly novelties) from Assam, principally from the large Sylhet district (now in Bangladesh), from a study of live plants introduced into the East India Company's Garden at Calcutta (now the Indian Botanic Garden). While Wallich (1820 & 1820-32) presented illustrated detailed description of more Assam plants, Griffith (1848) listed a large number of plants collected in a good cross section of Assam stretching from Sylhet to the Mishmi Hills, traversing through the Khasi and Jaintia Hills and all along the Brahmaputra valley. However, the most interesting account of the flora is that of Hooker, who with Thomson spent more than half a year botanising in the Khasi and Jaintia Hills. Hooker (1854) has made several comparative observations on the flora of these hills with that of Sikkim, where he had earlier spent about 2 years collecting plants. However, his observations predominantly refer to areas in Khasi Hills and with scant consideration to the flora of Jaintia Hills (Jowai).

While the earlier trend of initial accomplishment of large floras followed by treatment for smaller areas, was, perhaps appropriate in those times, it is now clear that for a satisfactory knowledge of our plant resources, it is fitting that small areas should be comprehensively studied first, and all resulting data pooled, reviewed and summarised for the entire country as in the case of Flora Europaea (Tutin, et al. 1964 & 1968). Some scattered attempts for such local floras have been made in the past, for the hill resort of Simla (Collett, 1902), for South Indian Hill-tops (Fyson, 1915) and the urban areas of Madras (Mayuranathan, 1929) and Delhi (Maheshwari, 1963). Another attempt, to elucidate a long standing personal experience with plants, is that of Santapau (1953) for Khandala, a hill resort in Maharashtra State. Other attempts are that of Vartak (1966) and Chavan & Oza (1966). A more recent work (in Meghalaya) is that of Joseph (1968), who made a detailed study of the flora of Nongpoh on the northern slopes of Khasi hills, midway between Shillong and Gauhati. Still other efforts in the last few years have resulted in publications of Floras covering different areas (*see* under Literature consulted).

The present work is a contribution, prepared after detailed intensive field studies and collections in the **Jaintia Hills** to assist in the ultimate assembling of all plant inventories and vegetable wealth in a **Flora of India**. The work is called the *Flora of Jowai,* after Jowai, the eastern District of Meghalaya State in N. E. India.

AREA AND PHYSIOGRAPHY

The Jaintia Hills subdivision or the general area of this Flora of Jowai comprises of a tract of about 2000 sq. km lying within 92°00′ and 92°45′ E. longitudes and 25°00′ and 25°45′ N. latitudes. It is bordered

in the west by Khasi Hills, in the north by Mikir Hills, in the east by Cachar Hills and in the south by the plains of Bangladesh.

The region with altitudes varying from 100 to 1800 m above sea level has a large central plateau—a continuation of the Shillong plateau of Khasi hills—extending from Mawryngkneng in the western border of the district to Raliang in the east and Nartiang-Mynso in the north to Jarain-Khleihriat in the south. Towards the east the plateau gradually descends and disappears into the N. Cachar Hills, but more gently descends in the north to finally merge with the Mikir Hills. In the south, however, the descent is rather abrupt into the plains of Bangladesh. This central plateau forming the main watershed of the region has striking landscapes with round-topped hillocks, rolling smooth grassy Downs running into dark green densely wooded valleys.

The main river in the area is the Myntdu springing in the central ridge near Jowai town and flowing southwards and becoming the Hari river of Bangladesh. The Wah Myntang river arising near Ummulong traverses the northern part of the central plateau through Nartiang and Mynso to finally join the Kopili river, a tributary of Brahmaputra. The Lubha and Kopili rivers in the east, both originate in the hills between Raliang and Sutnga. The former flows southwards through Sonapur to Bangladesh and joins the Surma river. The latter flows northwards through Garampani along the border of Jaintia and N. Cachar Hills and finally joins the Brahmaputra. The Umngot river commencing from near Ummulong flows southwards through a deep gorge on the border between Jaintia and Khasi hills and flows to Bangladesh, finally joining the Kalni river. Apart from these perennial rivers and rivulets, there are innumerable seasonal streams and streamless which swell with a surfeit of water during the rains, cascading and wildly tumbling in water falls and rapids in the rugged hill areas before quieting into sluggishly flowing streams in the plains area. These rivers and streams have rather sharp deep ravines in the southern parts, where the descent is rapid from 1500 to 100 m in about 20-30 km.

The road from Shillong to Silchar enters the Jaintia Hills between Mawryngkneng and Ummulong winding its way along the high ridge of Jowai, the principal town. The picturesque Thadlaskein lake lying beside this road between Ummulong and Jowai is a popular picnic-spot of this area. From Jowai the road to Silchar continues along the ridge eastwards and then turns southeast-wards through Khleihriat to Sonapur, the south-easternmost village of the region on the banks of Lubha river. From here after crossing a magnificient bridge, the road continues to Silchar. Another road branching off from Silchar road between Jowai and Shangpung, runs eastwards via Shangpung, Raliang, Khongsnong and Ioski to Garampani, the easternmost village on the banks of Kopili river and continues to

Haflong. The hotsprings at Garampani, which give the village its name, also attract many visitors. Two jeepable roads run northwards, one to Mynso and another through Nartiang to Umjaisaw on the northern border. In Nartiang there are some remarkable ancient, gigantic monoliths or stone slabs, all placed vertically in semicircular design. These are generally raised as memorials of great events and often as monuments to great people. Hooker (1854: p. 320) has sketched these monoliths as seen during his visit in 1851, but unfortunately with the passage of time many of these have fallen leaving a solitary giant which persists, erect amidst the other fallen giants. From Jowai a jeepable road extends southwards to Jarain and from there bifurcates to Dawki and Muktapur, the two villages on the border with Bangladesh. Another jeepable road connects Khleihriat with the village Sutnga, the home of ancient Jaintia Kings. On the northern side of this road are some of the most beautiful and picturesque Downs with gently sloping hillocks rolling down to pockets of primary forests in the valleys and isolated scattered pine groves on the slopes.

GEOLOGY AND SOIL

JAINTIA HILLS along with the entire Meghalaya region, is the oldest part of a chain of hills forming the southern boundary of Brahmaputra valley and was once continuous with peninsular India. The theory of continental drift formulated by Wegener (1915) and later elaborated by Du Toit (1937) envisages that in the early part of the Palaeozoic, the southern continents were all joined together in one huge land mass called the 'Gondwanaland' which subsequently drifted apart until Pleistocene, to reach the position they now occupy. A large part of Meghalaya, along with peninsular India, was also part of the Gondwanaland and this has a bearing on the phytogeography of this region. Hooker (1854: p. 325) remarks: 'The geological features of the Khasia are in many respects similar to those of the Vindhya, Kymore, Behar and Rajmahal mountains, that they have been considered by some observers as an eastern prolongation of the great chain, from which they are geologically separated by the delta of Ganges and Burampooter.'

Geomorphological history of the region, summarised by Murthy (1969), shows that during early part of Palaeozoic, the eastern and southeastern parts of Meghalaya became a basin of sedimentation in which are deposited the sandstones and shales of Jaintia series. During the Permo-Carboniferous period these were uplifted and coal-bearing sediments were deposited in south and southeastern parts, where peneplanation resulted in the formation of flat, levelled surfaces. By the end of Jurassic times ($\pm$150 million years ago), the southern plateau experienced plateau-volcanism resulting in east-west fissures, now called the 'Dawki tear fault', along which the southern portion sunk and the northern portion rose. The sinking of the southern

Stones at Nartiang : As Hooker saw it and sketched (1854 : p. 320)

Stone Monuments at Nartiang : The present condition with only a solitary giant persisting (see arrow)

[To face page 4]

part resulted in the advancement of the sea and deposition of Upper Cretaceous formations till about Eocene (±60 million years ago). During lower Miocene (±25 million years ago), the continuation of sedimentation resulted in the areas being uplifted, corrugated, sheared and twisted to an extraordinary extent. During this period the Himalayas also got uplifted. The next great event was the onset of the glacial age during Pleistocene, resulting in a shifting of the preglacial flora of the Himalayas to the south and subsequently during the retreat of the ice, the migration of Malaysian flora to the north.

The rise of the Himalayas from the mediterranean Tethys seabed was an epic event in the geological history of this region. It was spread through a long period from post-Eocene to the end of Tertiary. This phenomenon of uplift is still in progress in the E. Himalayas at a very slow rate and is marked by frequent earthquakes (Mithal, 1968). Being close to E. Himalayas, Meghalaya is a siesmic area and short tremors are common. However, widespread havoc was caused by the great earthquake of 12 June 1897, seriously damaging many buildings in most places in Assam. The last earthquake on 15 August 1950, though severe and keenly felt, did not do any great damage in Meghalaya.

The central portion of Meghalaya is a wedge-like obstrusive fragment trapped between Himalayan and Burmese elevatory movements and is made up largely of pre-Cambrian rocks, acutely folded and sharply dipping with an overturn fringe of Mesozoic and Tertiary sediments (Pascoe, 1950). The kernel of the plateau is an ancient mass of gneiss, much intruded by coarse granite. These are exposed in the northern slopes, but are hidden beneath Cretaceous and Tertiary deposits and the Mesozoic trap in the south (Singh, 1969).

The plateau region of Jaintia hills, extending to Mynso-Raliang-Khleihriat, is predominantly composed of metamorphic rocks of very great age and consist of thick series of quartzites and schists with intrusions of granites, dolerites and perodites and thin imbedded bands of argillites. This feature is taken by geologists are evidence to show that the core of Meghalaya is related to peninsular India and was once part of the ancient Gondwanaland, as distinct from the Himalayas and Burma. The southern and south-eastern region composed of 'Jaintia series', consists of pre-Tertiary and Tertiary rocks of limestones lying almost horizontally. Limestones and shales are more pronounced in the Kopili valley, where fossiliferous Cretaceous rocks are also common. On the northen part of the Jaintia Hills, the Cretaceous and overlying beds are nearly horizontal and form small scattered outcrops, but on the southern parts they are thicker and plunge steeply southwards below the tertiaries and into the alluvium of the Surma valley.

The erosional features produced by fluvial action are very important

in landscape-formation. During rainy season, the streams flow with high velocity producing heavy soil erosion in areas of sparse vegetation, the softer rocks wearing away, exposing the harder rocks Generally, all over Jaintia hills the amount of loose soil is very scanty, except in places where there is dense primary vegetation and in valleys with poor drainage. In the central plateau the soils are mainly lateritic with an assortment of red and brown soils on highlands and black and yellowish soils in the valleys. The soils of the southern region, where there is heavier rainfall, are mostly sandy. In the eastern region, the soils are mainly derived from limestone, often concealed below Bengal alluvium in the river valleys. The brown and red soils derived from the laterite occur in drier zones of the northern slopes. Where the vegetation is dense, as in most of the ravines and their slopes, there is always plenty of humus on the ground, the layer often up to 15-25 cm thick, with many saprophytic fungi and moss. Where the vegetation has been cleared for cultivation on steep slopes, the soil is easily washed away, often exposing bare rocks.

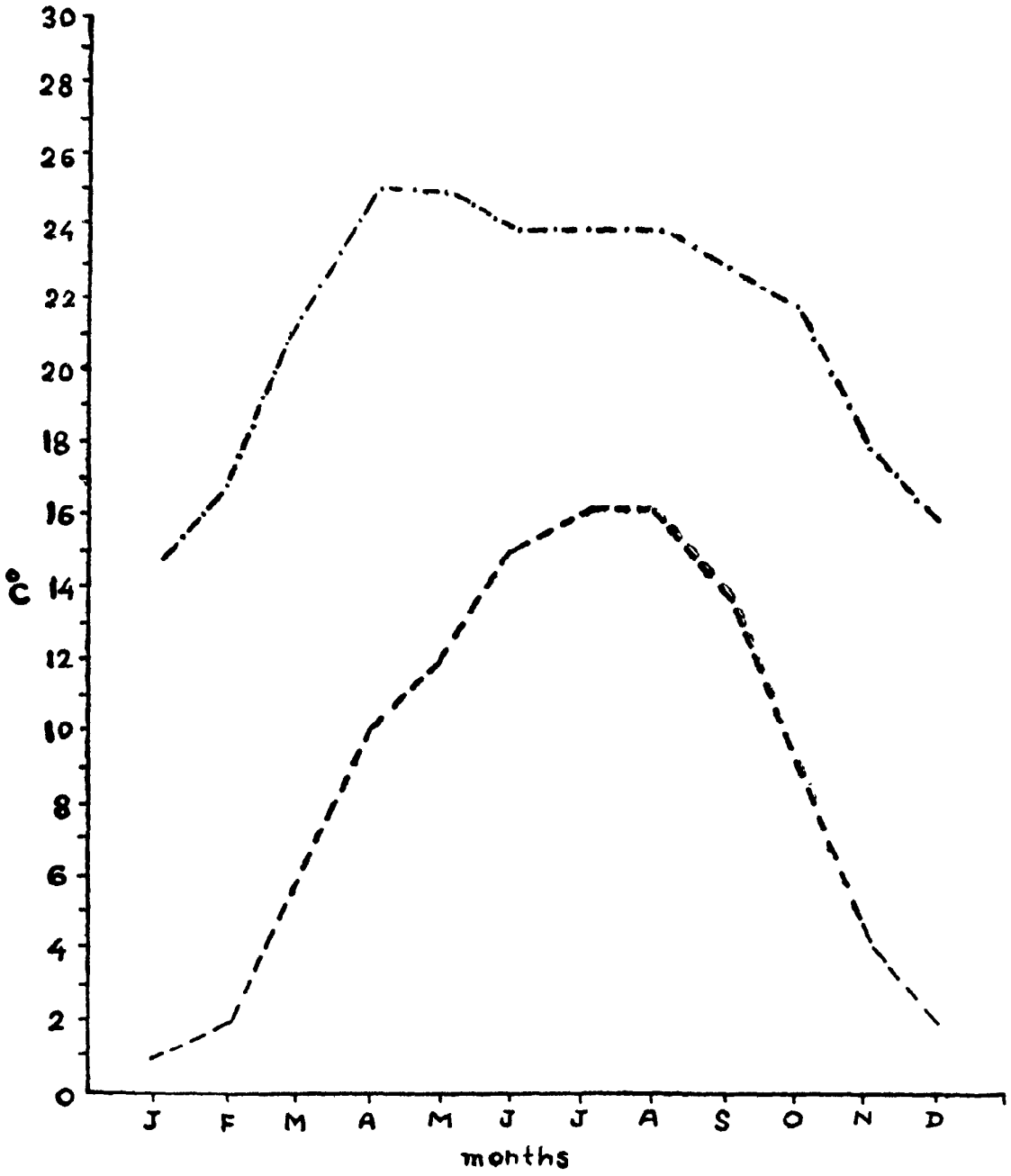
CLIMATE

The climate of the area is very mild, with neither too hot summer nor too cold winter, except in the foothills of southern slopes where it is somewhat hotter in summer months. Graph 1 shows average maximum and minimum monthly temperatures for a period of 5 years at Jowai town. During the deep winter in December-January, in the central plateau at altitudes above 1300 m, there is usually ground frost. At low altitudes on the southern slopes, the climate is humid and warm, showing only minor variations in temperature during the year.

Rainfall however, is the most pronounced climatic factor and is fairly distributed throughout all the months. An entirely dry month is rare, except in northern slopes, where February-March are usually dry. Graph 2 shows average monthly rainfall for a period of 5 years at 3 selected areas on the southern slopes (Jarain), the plateau region (Jowai) and the northern slopes (Nartiang).

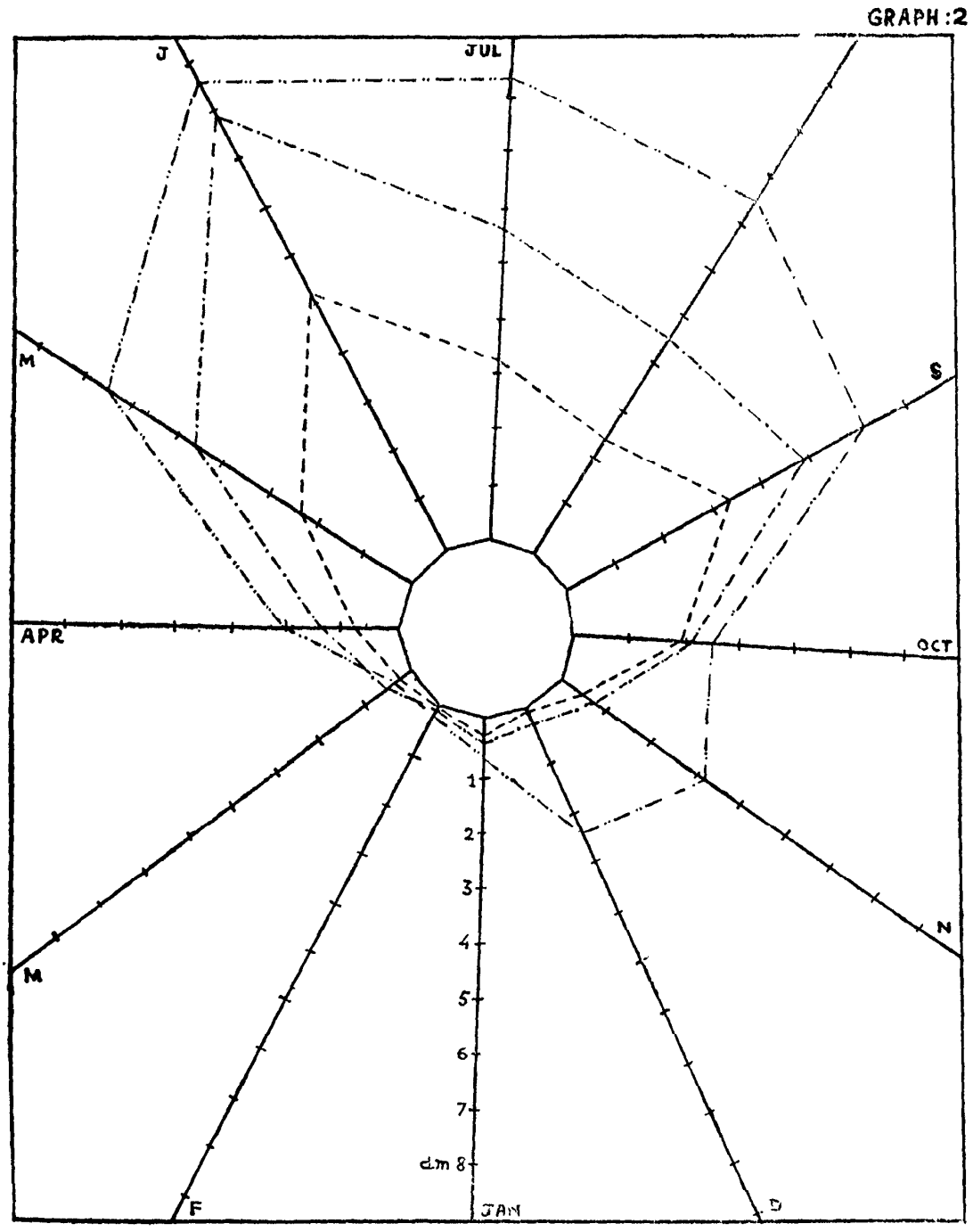
The summer monsoon or the south-west monsoon sets in during June-July and is usually accompanied by squally winds, and dense mists. Clouds brought in during this period get intercepted by the high central ridge, resulting in heavy precipitation on the southern face of the region. The monsoon, which lasts till September, contributes nearly 75% of annual rainfall in the area. July-August are typical monsoon months experiencing the heaviest downpour, when a rainfall of as much as 150 cm is not unusual. Depressions in the Bay of Bengal, moving northwards cause most of the

GRAPH : 1



Graph 1 : Maximum (above) and Minimum (below) temperatures at Jowai (monthly average for 1965-70)

rainfall. By the autumn, the southwest monsoon is replaced by north-east monsoon and this continues till January. Depressions at the eastern end of the Himalayas moving southwards and south-westwards cause most of the precipitation in winter. During February-March, a strong southerly wind blows across the tract. April, the intermonsoon period is the hottest and driest, with very little wind-velocity. Destructive storms and cyclones are unknown.



Graph 2 : Diversity of Rainfall in Jaintia Hills (average for 1965-70). Outer polygon—Nartiang, middle—Jowai and the inner—Jarain

EARLY HISTORY AND COLLECTORS

The Jaintia Hill area has a long history of secluded and isolated development, with the people leading a contented life in the mountain fastness amidst forest lands. The people were ruled by a long dynasty of Kings (1500 A.D. onwards), whose reign came to an end in 1835 with the supremacy of the conquering British. The inhabitants are considered to

be of Mongolian origin, tracing their ancestry to a migrant race from China. The 'Jaintia' is progressively derived from T'sintaing or Tsin-tien or Zyn-tien or Synteng (Gait, 1926; Nath, 1948). In the early days the Kingdom stretched to the plains of Sylhet (now in Bangladesh) but later became confined only to the hill area, which, with the adjoining Khasi hills became the administrative unit of United Khasi and Jaintia Hills district of Assam, and quite recently with the adjacent western hill district, the Garo Hills, has become a new state of *Meghalaya* or 'clouds'-abode' in comparison with the relatively younger but mightier Himalayas or 'snow's-abode' in the north.

The Khasi and Jaintia hills have been the favourite plant-hunting grounds of a succession of botanists, horticulturists and hobbyists. Burkill (1965) has furnished full data of all these early plant collectors in the area. The earliest record is that of M. R. SMITH, who held a magisterial post in the Khasi Hills till 1819. He sent out collectors to various parts of southern Khasi and Jaintia hills exclusively for live plants, which were sent to Calcutta Botanic Garden, where Roxburgh cultivated and studied them. In 1826-30, DAVID SCOTT who was the Governor-General's Agent in N. E. India, did some plant collecting in the Khasi hills. SIR FRANCIS JENKINS, who was also a Governor-General's Agent in N. E. India, made some collections in the Khasi hills during 1834-35. In 1834, he sent a twig of a *Camellia* to Wallich at Calcutta Botanic Garden, who identified it as the true tea plant, *Camellia theifera* (now *C. sinensis*). This led to the formation of the Assam Delegation, comprising of N. Wallich, W. Griffith (both surgeons, but accomplished botanists) and J. McClelland, a soil chemist, to establish the occurrence of wild tea in Assam and to explore the feasibility of its cultivation. During this expedition in 1837, both GRIFFITH and WALLICH made vigorous collections in the Khasi and Jaintia Hills and then proceeded along the Brahmaputra valley to Upper Assam. Later in 1838, Griffith again visited these hills and made extensive collections. Most of these collections are kept at Kew and Calcutta Herbaria. Subsequently Griffith (1848) published notes on his collections in his 'Itinerary'.

In 1837 J. GIBSON collecting for the Duke of Devonshire, obtained several orchids for cultivation including a new *Dendrobium*, later named *D. gibsonii*. In 1848 T. LOBB visited these hills on behalf of the famous nursery firm of Veitch & Sons, and was travelling with a whole train of heavily loaded men and mules, described by Hooker as 'Lobb's Circus' (Burkill, 1965: p. 85). Among his collections mention may be made of *Agapetes lobbii* from Jaintia Hills.

The largest collection of plants from Khasi and Jaintia hills is that of J. D. HOOKER and T. THOMSON, who spent about 7 months from May

to November 1851, in various parts of these hills. They often sent out 16-18 men daily searching for plants in deep forests. At the end of their expedition they had about 200 men's load of dry and live plants brought to Calcutta. These are mainly deposited in Kew and Calcutta Herbaria, with duplicates distributed to various herbaria in Europe and America.

In 1861, the Kew Collector, R. OLDHAM made a short visit to Khasi hills. The geologist, T. OLDHAM, the zoologist, GODWIN-AUSTEN and the physician, J. FAYER also made stray collections in the area. The pharmacist, O. F. SIMONS made a fairly large collection and among the many novelties collected by him is *Strobilanthes simonsii.*

C. B. CLARKE, a brilliant mathematician by training, switched over to the studies of Indian botany, during his career as lecturer at the Presidency College, Calcutta and later as Inspector of Schools in Assam, made long collection trips to Khasi and Jaintia Hills in 1866, 1872 and 1877. He took all his specimens to Kew but later, duplicates were returned to the Calcutta Herbarium. Sir George King, Superintendent of Calcutta Botanic Garden in 1871-1898 (also first Director of Botanical Survey of India), sent out his plant collector, G. A. GALLATLY to these hills and his collections are mainly deposited in Calcutta and Kew herbaria, with duplicates in Berlin and Manchester.

While all these collections were either for introduction of exotics into English gardens or for a general knowledge of the flora, organised efforts to make collections for a detailed knowledge of the flora of Assam was that of GUSTAV MANN, who began collecting for Brandis, during the period 1863-81, while he was Conservator of Forests in Assam. He collected extensively throughout Assam and particularly in the Khasi and Jaintia hills and most of his specimens are deposited in the Forest Herbarium of Botanical Survey of India (ASSAM), with duplicates in Kew and Calcutta. Following the footsteps of Mann, U. N. KANJILAL, during his forest service in Assam (1906-1928) made extensive collections in the Khasi and Jaintia hills. His collections include plants from all corners of the then Assam province including Sylhet. He observed and kept detailed field notes which are an invaluable contribution to the knowledge of Assam plants. This careful professional effort was nurtured and encouraged by the enlightened administrative authority of Sir Archidale Earle, who had realised the dire need for a systematic plant inventory of this floristically rich region. While still working on the manuscript, Kanjilal died on 25 October 1928, before even the first volume of his Flora of Assam came out of the press. Subsequently, his son P. C. Kanjilal, also a forest officer, was invited to continue the work. He also made large collections from

various parts of Assam. He and his colleagues, A. Das, C. Purkayastha, and R. N. De edited and continued the publication of the Flora of Assam.

In 1936, N. L. Bor, during his tenure as Botanical Forest Officer of Assam, made extensive collections in the Khasi and Jaintia hills and as a political officer, also in Aka and Naga hills. His particular interest was in grasses, leading him to write up the Gramineae for the Flora of Assam (Vol. 5). From 1937 to 1948, R. N. De, M. M. Srinivasan and M. L. Saikia, all Sylviculturists, also made substantial collections for the Forest Herbarium. Among the other staff of the Assam Forest Herbarium particularly engaged in collection of plant specimens, special mention should be made of S. R. Sharma (1930-40) and the self-taught botanist G. K. Deka (1930-68), who made extensive collections and added, perhaps one of the largest collection of plants from Khasi and Jaintia hills to the Forest Herbarium.

In 1956, with the reorganisation of the Botanical Survey of India, the Eastern Circle station was set up at Shillong, to which the Assam Forest Herbarium was transferred on 8 August, 1956. Since then various officers of the new set up, R. S. Rao, G. Panigrahi, D. B. Deb, A. S. Rao and others have periodically visited areas of Jaintia hills (as also other parts of Assam) and collected considerable material enriching the Kanjilal Herbarium of Botanical Survey of India, Eastern Circle, Shillong (Assam).

VEGETATION TYPES

Assam's vegetation and ecology is rather broadly known through the accounts of Kanjilal (1934), Champion (1936), Rowntree (1954), Puri (1960), R. S. Rao and Panigrahi (1961), Rajkhowa (1961), Legris (1963) and A. S. Rao (1968 & 1974). However, references particularly to the vegetation of the Khasi and Jaintia hills are scanty. Hooker (1954) has given picturesque word-portraits of the vegetation in these hills, but these are scattered, and laborious effort is involved in piecing together the full spread of his vegetation picture. Recently A. S. Rao (1968) has sketched a summary account of the vegetation of the Khasi and Jaintia hills, but here again the slant is towards the Khasi hills area. The present study of the Jaintia hills flora has made it possible to obtain a more intimate glimpse of the vegetation and its various forms in the Jowai district.

The classification of vegetation types, especially with regard to the tropical areas is in an unsatisfactory state, mainly due to the floristic complexity and variations in botanical composition, even within a small area. Champion's classification of vegetation types (l.c.), as also those of Puri (l.c.), are more general than specific, pertaining to the entire Indian subcontinent. Its inadequacy is felt when a small area is taken up. Rao & Panigrahi (l.c.)

classified the vegetation types of the entire N. E. India including Bihar and Orissa, on the basis of altitude and latitude. However, the data available to them were only from certain selected areas in the vast N. E. India. Rajkhowa (l.c.) made a re-evaluation of the forest types of Assam with modifications of Champion's classification, the emphasis being mainly to the plains of Assam and very little of Meghalaya. The voluminous work of Legris (l.c.) dealing with Indian vegetation contains meagre data on Meghalaya.

According to Gomez-Pompa (1967), the term *'Tropical Rain Forest'* first coined by Schimper (1903) and later used by many authors including Richards (1952), has no real meaning, as it is too broad, encompasing tropical evergreen, semievergreen as well as subtropical evergreen and semievergreen forests.

The classification presented here is mainly based on altitude and rainfall and includes four major vegetational zones, as given in table 1 below.

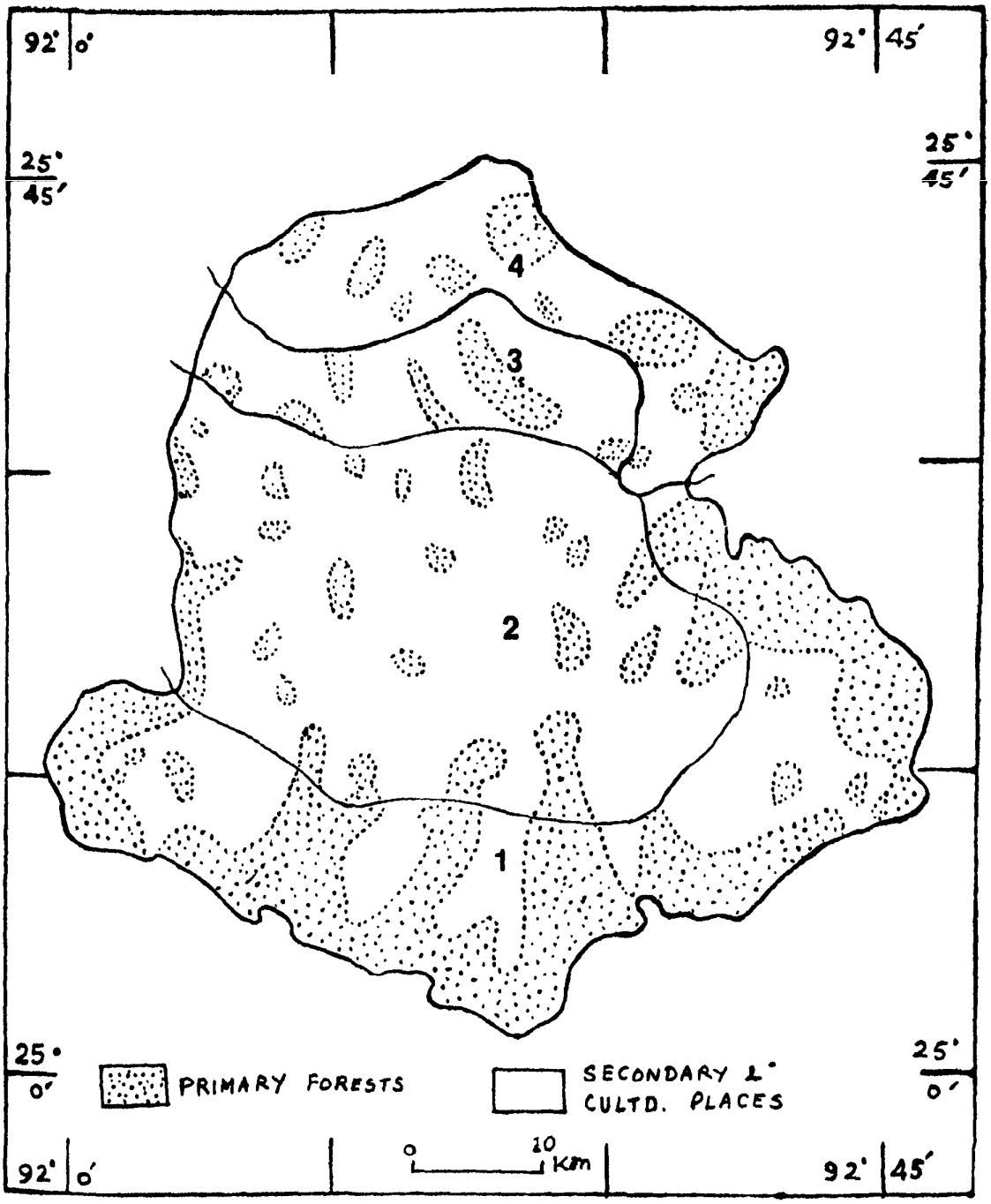
TABLE I : MAJOR VEGETATIONAL ZONES

Climatic Zone	Altitude in metres	Annual rainfall in cms	Vegetational Zones
Tropical	100-1200	300-500	Tropical Evergreen
		150-300	Tropical Semievergreen
Subtropical	1200-1800	300-500	Subtropical Evergreen
		150-300	Subtropical Semievergreen

A. Primary Vegetation

(1) *Tropical Evergreen Zone*: Tropical evergreen vegetation occurs in most of the southern and southeastern slopes of Jaintia hills, up to an altitude of 1200 m above sea level. This zone receives heavy rainfall of 300 to 500 cm per year and the relative humidity is usually above 80%. Winter is mild, followed by a comparatively dry season from February to April. The sloping area ensures quick drainage. Human interference is much less than in the northern zones, with people staying away from this unhealthy hot humid zone occupied by impenetrable forests infested with wild animals.

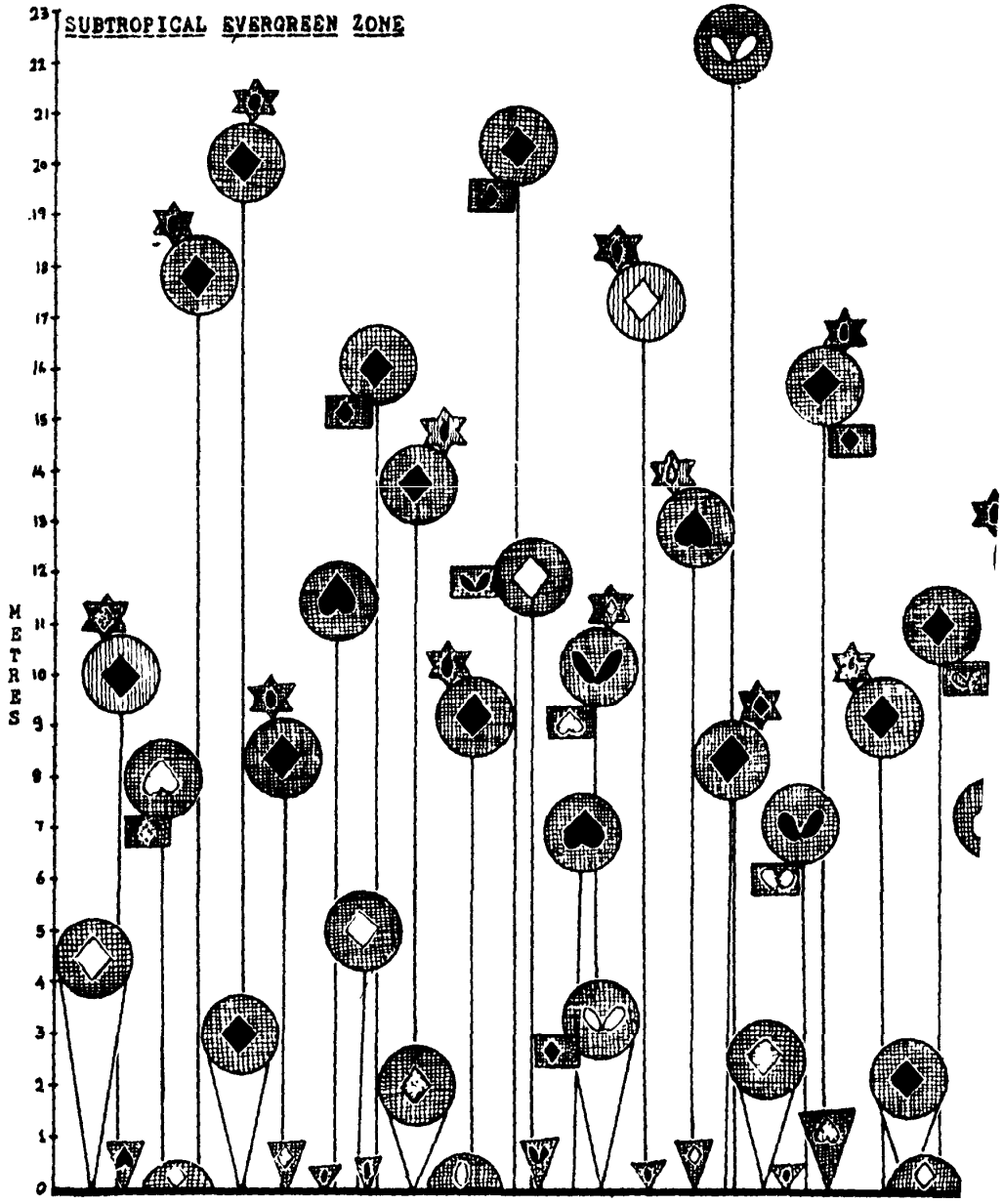
The vegetation in this area seems to be a climatic climax with a profusion of well-scattered species. Some of the component trees may shed their leaves individually each year, but no tree remains completely leafless for any part of the year. One striking feature of these tropical forests is



Vegetation map of Jaintia Hills
1. Tropical Evergreen. 2. Subtropical Evergreen. 3. Subtropical Semievergreen. 4. Tropical Semievergreen.

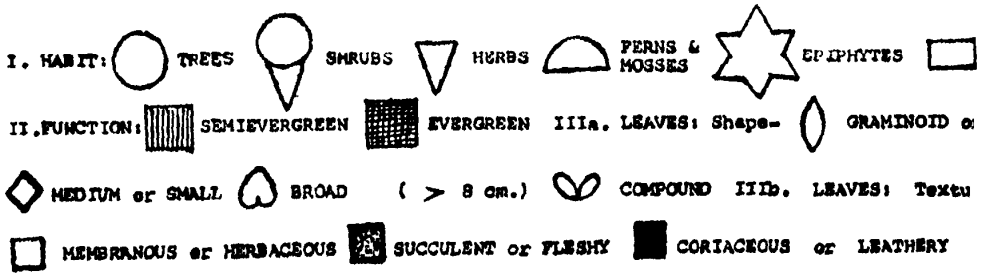
the extremely mixed dominance, so that no single tree species can be marked as dominant. The tree strata usually exhibit 2 to 3 storeys which are imperceptible to a casual look, owing to the fact that species of all gradations are commonly present. The roof of these forests formed by the upper canopy of tallest trees has usually an irregular profile and rarely forms a continuous layer. The dormant buds are usually small and un-

protected. Smooth bark, plank buttresses and large glossy thick le: are characteristics of the trees of this area.



PROFILE OF A SECTION OF FOREST BETWEEN JOWAI & JARAIN (ALT.145(
(DIAGRAMMATIC)

Explanation to graphic symbols (Symbols after Danserean, 1957)



The outstanding component species of the upper storey are: *Vitex pinnata, V. peduncularis, Terminalia bellirica, T. citrina, Gynocardia odorata, Talauma hodgsonii, Polyalthia cerasoides, Elaeocarpus rugosus, E. tectorius, Xerospermum glabratum, Castanopsis armata, Spondias pinnata* and *Chisocheton paniculatus.* The next lower storey usually forms a continuous layer and is composed of trees 10-20 m high. The usual species of this layer are *Syzygium grande, S. tetragonum, Garcinia paniculata, G. pedunculata, Ficus racemosa, Sapium baccatum, Heritiera macrophylla, Sterculia hamiltonii, Aporusa dioica* and *Pterospermum lancifolium.* The trees of the lowest storey are 5-10 m high and the main ones are: *Premna bengalensis, Canthium dicoccum, Carallia brachiata, Grewia disperma, Vernonia arborea, Trevesia palmata, Miliusa roxburghiana, Phoebe lanceolata, Syzygium formosum, Actephila excelsa, Hibiscus macrophyllus, Picrasma javanica* and *Pinanga gracilis.*

Below the third storey of trees is a layer of tall shrubs, 1-5 m high, which often merges with the smaller trees layer. Among the innumerable species of this layer, mention may be made of *Leea edgeworthii, Abroma augusta, Desmos chinensis, Boehmeria macrophylla, Lasianthus hookeri, Ficus hispida, Ixora roxburghii, Dracaena spicata, Ardisia paniculata, Hyptianthera stricta, Wallichia densiflora* and species of *Pandanus* and *Allophyllus.*

Although sunlight is directly on the upper-most canopy, this is soon filtered off by the successive tree canopies and a sort of gloom prevails inside the forests. Nevertheless, there is a dense herbaceous ground layer, with *Hedyotis auricularia, Ophiorrhiza nutans, Hygrophila salicifolia, Phrynium pubinerve, Alpinia allughas, Spiradiclis cylindrica, Begonia thomsonii* and *Caulokaempferia linearis.* There are also numerous species of ferns, Selaginellas and fungi. Along streams, water-falls and moist marshy places, *Impatiens tripetala, I. laevigata* and *Floscopa scandens* grow gregariously in large populations. On wet rocks and boulders in fairly sunny places, *Elatostema rupestre,* associated with *Peperomia pellucida,* grow profusely.

A few species of large lianas like *Ampelocissus latifolia, Cayratia pedata, Phanera khasiana* and *Entada phaseoloides* can be seen in these forests, usually climbing up to the topmost canopy of trees. The large-fruited *Hodgsonia macrocarpa* climb extensively in deep forests here and there. A few species of smaller lianas occur which are more or less scandent woody shrubs, spreading over smaller trees and bushes. Among them the common ones are *Combretum latifolium, Dalbergia stipulacea, Connarus paniculatus, Sphenodesme pentandra, Euonymus attenuatus, Millettia caudata, Capparis assamica, Fissistigma wallichii* and *Derris trifoliata* as also many species of prickly *Calamus.*

Among the less woody climbers which are often gregarious in forest

borders and in fairly sunny forest openings the outstanding species are *Thunbergia grandiflora, Ichnocarpus affinis, Gymnema tingens, Gouania tiliaefolia, Adenia trilobata* and *Dioscorea hispida. Piper thomsonii, Rhaphidophora grandis* and *Hoya griffithii* are also very common, climbing over trees, by their roots.

Tropical Evergreen Zone: *Impatiens laevigata* along streamsides, near Sohka

The epiphytic flora is not rich as compared to the subtropical zones. Most of them are ferns, Selaginellas and Lycopodiums. Among the flowering plants, which are by no means gregarious or abundant, mention may be made of *Aeschynanthes acuminatus* and *Peperomia pellucida.* Amongst the rather scarce epiphytic orchids are *Vanda teres, Dendrobium sulcatum, Agrostophyllum khasianum, Luisia teretifolia* and *Acampe ochreacea.* Lichens and mosses are also common, though not abundant.

(2) *Tropical Semievergreen Zone*: Tropical semievergreen forests occupy the north-eastern and the northern slopes of the tract, up to 1200 m above sea level. This zone receives lesser rainfall (150-300 cm per year) with a dry period of 2-3 months from February to April. Humidity may be high during monsoon but much less during the rest of the year. Winter is comparatively cooler. Being a sloping region, this tract has good drainage. Human interference is evident and consequently the area occupied by primary forests is much less than in the evergreen zone.

There are fewer number of species in these forests than in the evergreen zone. While most of the trees are evergreen, there are a few species like *Careya arborea, Dillenia pentagyna* and *Callicarpa arborea* which shed their leaves during dry season, giving a semievergreen appearance. The barks of the trees tend to be thick and plank buttresses are rare.

Trees of these forests are easily recognised to be 1 or 2 storeys. Those of the upper storey are 20-30 m high and the common ones among these are *Elaeocarpus floribundus, Dillenia pentagyna, D. indica, Hovenia acerba, Radermachera gigantea, Lithocarpus fenestrata, Alcimandra cathcartii* and *Albizia lebbek.* The second storey of trees are between 10-20 m high and seems to be richer in species. The common trees of this layer are: *Micromelum integerrimum, Garcinia lancifolia, Celastrus championii, Sapindus rarak, Meliosma wallichii, Symplocos paniculata, Rhus chinensis, Diospyros malabarica, Dalbergia assamica, Bridelia monoica, Litsea glutinosa, Ficus semi-cordata, F. hirta, Oroxylum indicum* and occasionally *Vernonia volkameriifolia.*

The undergrowth composed of shrubs and herbs are less dense and constitute two distinct layers. The upper layer consists of shrubs 1-3 m high and the most common ones are: *Randia griffithii, Boehmeria sidaefolia, Ardisia thomsonii, A. griffithii, Leea crispa, Clerodendrum serratum, Indigofera atropurpurea, Desmodium triangulare, Abelmoschus moschatus, Eriobotrya angustissima* and occasionally *Priotropis cytisoides.* Among the herbaceous plants of the lowermost layer, the common ones are *Costus speciosus, Pilea umbrosa, Zingiber capitatum, Curcuma domestica, Pogostemon auricularis, Leucas mollissima, Hedyotis ovatifolia, H. verticillata, Crotalaria mysorensis, Amorphophalus bulbifer* and *Hedychium* spp. Large populations of *Forrestia mollissima* are found sporadically in shaded wet sandy soil along streamsides.

The vegetation tends to be entangled with vines and woody scandent plants. Among these the lianas are scarce, with only *Mucuna macrocarpa* and *Entada phaseoloides* found at certain places. However, scandent shrubs and slender climbers are common. *Dalbergia mimosoides, D. confertiflora* and *Byttneria pilosa* are among the few stragglers which overgrow their supporting hosts and form dense impenetrable thickets. *Cissus repens, C. discolor, Willughbeia edulis, Cryptolepis sinensis, Solena heterophylla, Dioscorea trinervia, D. bulbifera, Smilax lancifolia, Argyreia hookeri, Diplocyclos palmatus* and frequently the large purple-flowered *Thunbergia grandiflora* are also commonly seen. Along the edges of forests, the introduced American plant, *Mikania micrantha* often virulently spreads in large patches over bushes.

Epiphytes are scarce, as is to be expected, because of the seasonally dry climate, but Loranthaceous hemiparasites like *Scurrula parasitica* and

S. gracilifolia are common. *Acampe ochreacea* and *Agapetes variegata* are seen occasionally.

(3) *Subtropical Evergreen Zone*: Subtropical evergreen forests cover the southern portion of the plateau bordered by Jowai-Jarain-Raliang-Sutnga with altitudes above 1200 m. This zone is characterised by very heavy rainfall of 300-500 cm per year and high humidity spread over most of the year. Being cloudy for most of the time, incident sunlight is less. There is noticeable difference between summer and winter, ground frosts being common in December-January. A transitional zone of mixed vegetation of both tropical and subtropical species is perceptible between altitudes of 1000-1400 m.

These woodlands of climatic climax forests are seen scattered in deep sheltered valleys, banks of rivers and streams and occasionally in plain areas. These are surrounded by grasslands or pine forests and the demarcation between them is always precise. The trees are generally of a bushy appearance and shorter than in the tropical zone. The leaves are usually simple, smaller in size and often toothed, but at the same time firmer and more leathery. Plank buttresses are rare. The tree layers are less distinguishable into strata. This reduction in tree strata, coupled with lowering of canopy are associated with the increase in altitude. The shrubby and herbaceous layers are well-marked. These moist-loving forests are characterised by the rarity of lianas and the predominance of epiphytes. Mosses and liverworts are abundant. Undergrowth is so dense as to make it necessary to clear the way at every step, when traversing these forests. The forest floor is soft and dark with humus detritus, giving it a cushion-like texture, where many mosses, fungi, *Balanophora* and orchids grow. The floristic composition exhibits exceptional richness in species which are different from those of the tropical evergreen, although some of its components may be generically and even specifically identical with lowland species. In its great multiplicity of trees, these forests agree with the tropical forests, but a single species or a group of species showing dominance is much more common.

The usual trees of the uppermost storey are *Castanopsis tribuloides, Lithocarpus elegans, Engelhardia spicata, Ficus elastica, Mangleitia insignis, Prunus nepaulensis, Euodia trichotoma, Exbucklandia populnea* and *Betula alnoides*. Occasionally *Schima wallichii* can also be seen, however, this species prefers association with pines. This storey of tall trees is discontinuous and scattered. It is also noticeable that in many places these trees are smaller in stature and merge with those of the second storey, composed of *Viburnum foetidum, V. simonsii, Quercus glauca, Helicia nilagirica, Michelia punduana, Syzygium macrocarpum, Vernonia volkameriaefolia, Ternstroemia gymnanthera, Daphne involucrata, Lindera melastomacea,*

Styrax serrulatum, Symplocos racemosa, Debregeasia wallichiana, Schefflera alata, Acer oblongum and *Ligustrum robustum.* Occasionally *Corylopsis himalayana* could be seen in fairly sunny places in these forests. Tree ferns are very common in these forests.

In deep valleys, as well as in sheltered slopes of hills, where wind velocity is less, the trees grow taller and in these forests large lianas like *Tetrastigma obovatum, T. leucostaphylum, T. rumicispermum, Cayratia pedata* and *Entada phaseoloides* climb over the trees to the upper most layer. There are also many large scandent shrubs which do not reach such height, like *Aspidopterys indica, Hiptage benghalensis, Elaeagnus pyriformis, Rourea minor, Rosa moschata, Berchemia floribunda, Kadsura heteroclita* and various species of *Calamus.*

Perhaps the strata richest in number of species are the shrubby and herbaceous layers. The common shrubby species are *Goniothalamus sesquipedalis, Sarcococca saligna, Sarcandra glabra, Baliospermum micranthum, Neillia thyrsiflora, Ixora subsessilis, Mycetia longifolia, Clerodendrum* spp.; *Eurya japonica, Psychotria* spp., *Ardisia* spp., *Camellia caudata, Saurauia* spp., *Oxyspora paniculata,* and various species of Acanthaceae and Araliaceae. Along the edges of these forests and in fairly open places, *Lobelia nicotianifolia, Solanum nigrum, S. indicum* and *Polygala arillata* can be seen.

The forest floor is densely covered with fungi, moss, Selaginellas, Lycopodiums and various herbaceous angiosperms, represented by *Begonia palmata, Senecio griffithii, Houttuynia cordata, Sonerilla* spp., *Impatiens* spp., *Chlorophytum khasianum, Disporum* spp., *Adenostemma lavena* and various species of Zingiberaceae, Araceae and Commelianaceae, *Didymocarpus punduana, Chirita oblongifolia, Teucrium quadrifarium* and *Gomphostemma velultinum.* On rocks and boulders near streams and moss-covered cliffs, *Sarcopyramis napalensis, Elatostema rupestre, Begonia rubrovenia* and *Impatiens* spp., usually grow profusely. Many terrestrial orchids such as *Anoectochilus, Hateria, Phaius,* etc. are common in rich humus soil in shaded places. Root parasites like *Balanophora dioica* are also common.

There are many species of climbers spreading over bushes and shrubs and the usual ones are species of *Clematis, Smilax, Dioscorea, Melodinus,* Menispermaceae, Cucurbitaceae and occasionally *Holboellia latifolia* and at certain places near Jarain *Nepenthes khasiana.* Along the borders of forests spreading over bushes, thick masses of *Paederia foetida, Rubia cordifolia, Porana racemosa, Trichosanthes* spp.; and *Passiflora napalensis* are prominent.

The branches of trees bear innumerable species of orchids, mosses and ferns. The epiphytic orchid flora in these forests are the richest in the area, with almost every other tree forming a veritable hanging garden

of orchids and ferns. Species of *Agapetes, Hoya, Aeschynanthes, Piper* and *Medinella* are also very common. There are also many Loranthaceous hemiparasites. like *Helixanthera* spp.; *Taxillus vestitum, Viscum articulatum* and *Dendrophthoe falcata.* Along streams and rocky places with dripping water, *Utricularia bifida, U. striatula, Gonatanthus pumilus, Remusativa vivipara* and *Lindernia* spp. grow in isolated populations.

(4) *Subtropical Semievergreen Zone*: The vegetation of the area on the northern and north-eastern slopes of Jaintia hills, between altitudes of 1200-1800 m, experiencing lesser rainfall (150-300 cm per year) with a fairly dry season of 2-3 months from January to April, is broadly classified as subtropical semievergreen forests. Humidity may be high during rainy season, but comparatively less during the rest of the year. High winds are scarce. Winter and summer temperatures are noticeably different. Ground frost is common in January. A transitional zone of mixed vegetation with both tropical and subtropical types of species may be distinguishable at certain places between altitudes of 1000-1400 m.

There are lesser number of species in these forests than in the subtropical evergreen forests of southern portion. Most of the trees are ever green, but a few deciduous species can also be seen and thus giving it the semievergreen appearance during the dry months of February-April. Sometimes it is possible to notice certain species of trees occurring frequently and appearing to be dominant. While many of the component species in these forests are identical with those of the subtropical evergreen zone, there are also a good number of species exclusive to this region. Prickly and thorny species are more common.

Among the largest trees, the common ones are *Engelhardia roxburghiana, Castanopsis indica, Sapindus rarak, Paramichelia baillonii, Elaeocarpus floribunda, Albizia chinensis, Meliosma wallichii, Alcimandra cathcartii, Diospyros lancifolia, D. undulata, Ficus altissima* and *Vitex glabrata.* The second storey in these forests consists of trees which are of lesser height and the common ones are *Vitex vestita, Quercus semicarpifolia, Pyrularia edulis, Brucea mollis, Casearia vareca, Micromelum integerrimum, Photinia arguta, Loropetalum chinensis, Glyptopetalum quadrangulare, Docynia indica, Symplocos cochinchinensis* and *Xylosma controversum.*

Lianas are scarce, however, *Mucuna macrocarpa, Tetrastigma obovatum* and *Celastrus campionii* and *Gnetum scandens* are to be seen at certain places. There are also a few stragglers like *Fissistigma verrucosum, Dalbergia confertiflora, D. mimosoides, Erycibe schmidtii, Dendrotrophe umbellata, Calamus* spp. and *Dioscorea pentaphylla.*

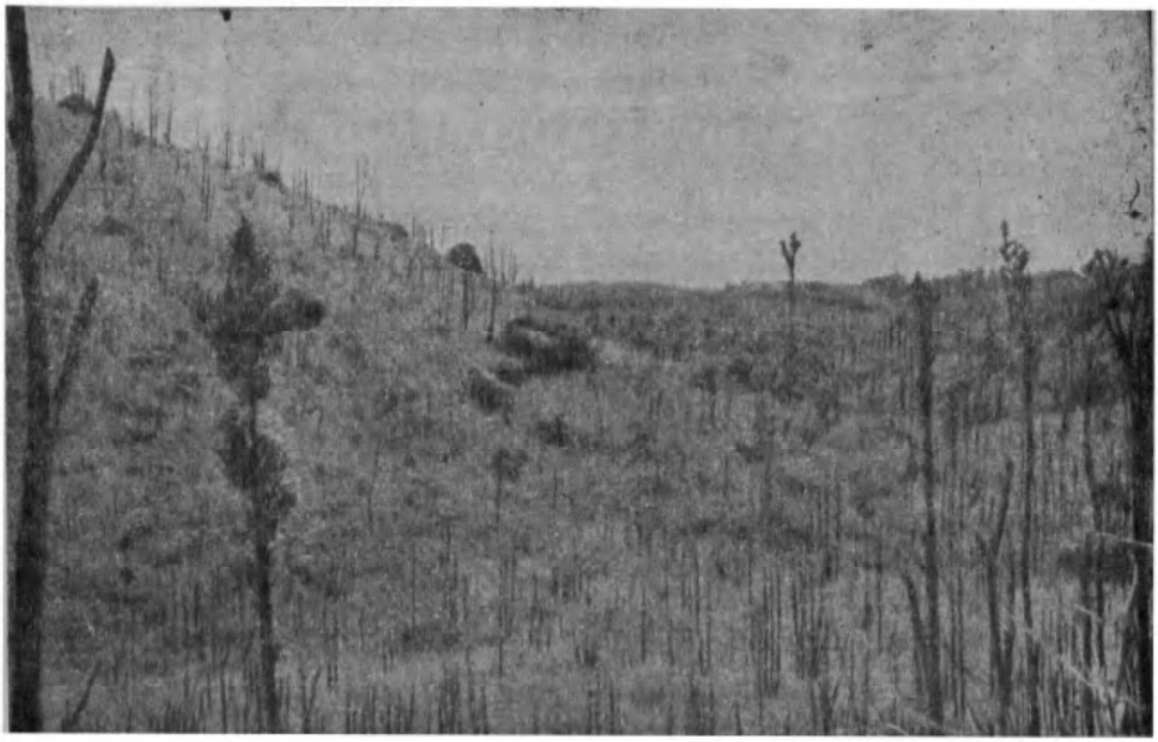
The shrubby layer consists of fewer species and the common ones are *Crotalaria assamica, Boehmeria platyphylla, Capparis acutifolia, Lyonia ovalifolia, Randia griffithii, Mussaenda glabra, Desmodium* spp., *Sida*

rhombifolia, Sambucuc javanica, Maesa tetrandra, Clerodendrum spp. and *Sarcococca saligna.*

The herbaceous layer in these forests are very poorly developed, mosses, ferns and Selaginellas are scarce except near very wet streamsides in sheltered valleys. Among the usual flowering plants are *Pilea umbrosa, Galinsoga parviflora, Anisadenia khasiana, Curcuma* spp., *Polygala* spp., *Lysimachia laxa, Acanthus leucostachys, Pouzolzia hirta, Globba clarkei, Hedychium* spp., *Costus speciosus* and many species of Asteraceae. Along streams and marshy shaded places in forests, more moist-loving plants like *Lindernia* spp., *Limnophila chinensis, Centella asiatica, Dactylicapnos torulosa, Polygala* spp., *Aneilema* spp. and *Salomonia* sp. can be seen.

B. Biotic Factors on Vegetation

In extensive areas of the region, the primary vegetation has been much disturbed and modified and in some places, destroyed. This has happened due to seismic activities, frequent landslides and soil erosion. While these natural causes have contributed to some extent in the change in vegetation types, it is man and his domestic animals that share the major part, in a rather rapid and often irrevocable transformation in the landscape. Even the most remote region of these hills have been ravaged by anthropomorphic influences.



Biotic influence on Flora : A recently jhummed (cleared and burned) area

By far the most important cause of destruction has been the system of shifting cultivation (called *Jhuming* locally), practiced by the local people. It is an ancient custom of the people of this region to clear a given area by chopping down the primary forest and burn it over to dispose off the debris from clearings. In this process the fire usually spreads and destroys the whole hill, much more than what is needed for cultivation. In a freshly cleared area, the soil is extremely fertile with rich humus content and hence the first few crops of upland paddy or millett (which they plant in such cleared areas) yield substantial harvests. However, slowly the soil shows signs of exhaustion and denudation mainly due to erosion. In the absence of any sort of terrace cultivation, (which is practically unknown in this area and now being introduced), the soil layer is gradually lost reducing its fertility and ultimately the area is abandoned and another area is cleared of primary vegetation. The deserted one reverts to barren rocky places, grasslands, scrubs or secondary forests, providing an easy path for migration of exotic plants. All gradations could be seen from grasslands studded with a few crooked charred shrubs or malformed trees to thickets or closed secondary forests. At higher elevations such abandoned places develop into grasslands or pine forests and at lower elevations to grasslands or secondary forests.

Another cause is the method of cultivation of potato and sweet potato, adding much to the erosion and depletion of the fertility of the soil. To prevent water-logging of the soil and consequent rotting of tubers, potato-beds are set up on steep hill-slopes with the ridges of plots steeply tilted downwards. The heavy rains wash away all soil between the beds and in a shortwhile such slopes become useless for cultivation.

Vegetation studies reveal the speed at which our vegetable wealth is being destroyed. For example, in 1851 J. D. Hooker on his expedition to Jaintia hills, collected 7 headloads of live *Vanda coerulea* plants for cultivation in England. Now after 100 years, during various field trips stretching from 1965 to 1970, the present author could hardly spot a dozen plants even in remote forest areas of Nartiang, where Hooker made his collections. This is an indicator of the rate at which primary forests and the wealth it carries are being irrevocably destroyed.

During the sixty years period from 1901 to 1961, the human population of the district has increased three-fold (Pakyntein, 1965). This increase in population coupled with the increased demand on natural forest areas for cultivation of cereals for food and for fuel, forest areas are being destroyed at a greater pace, year after year. Similarly increased communication even with remote villages by new road connections, etc. facilitates more movement of people from outside and consequently more interference with the vegetation. To quote Blair (1964): 'Man has enormously and

often recklessly modified ecosystems through interruption of ecological succession and substitution of simple (agricultural) plant communities for natural diversity through disruption of energy balance of communities by assisting (through artificial feeding) his herbivorous domesticates to escape the checks and balances that normally exist between primary producers and their consumers. All of this promotes erosion of soils that have evolved through countless centuries and thus degrades the ecosystem'. Such degraded ecosystems develop into several types of secondary vegetations as detailed below.

C. Secondary Vegetation

There is a succession of several edaphic formations, in many disturbed spots within the primary forests. These can be observed in various stages of development, depending on the extent of disturbance and the span of time during which the succession of secondary vegetation is taking place. These may be scattered herbaceous growth of several weed species or homogeneous grasslands or woody vegetation of shrubs, short trees or even quite tall trees, either belonging to several species or sometimes to a single species like in the case of pine. This secondary vegetation developing consequent on the disturbance of primary vegetation can also be partially and parallely classified into (1) Tropical Evergreen Zone, (2) Tropical Semi-evergreen Zone, (3) Subtropical Evergreen Zone, and (4) Subtropical Semi-evergreen Zone.

(1) *Tropical Evergreen Zone*: The herbaceous type forms the first succession stage and among the pioneers, mention may be made of ***Cassia tora, C. occidentalis, Scoparia dulcis, Mimosa pudica, Euphorbia hirta*** and various grasses like *Garnotia stricta, Cyrtococcum oxyphyllum, Paspalum conjugatum* and *Oplismenus compositus*. In due course certain shrubby species make their way and invade such herbaceous regrowth. Among them the usual ones are *Lantana camara, Calotropis gigantea, Phyllanthus* spp., *Tithonia diversifolia, Flemingia strobilifera, Eranthemum suffruticosum* and grasses like *Thysanolaena maxima*. Subsequently such places may either remain purely shrubby or, if destroyed by frequent fires, may develop into grasslands or in places where the soil layer is thick and where frequent fires do not occur, may develop into secondary forests.

In grasslands the common species of grasses are *Imperata cylindrica, Chrysopogon gryllus, Digitaria adscendens, Brachiaria distachya, Panicum brevifolium, Centotheca lappacea* and *Microstegium vagans*. These grasses are usually associated with herbaceous geophytes like *Hedychium* spp., *Asparagus* spp., etc. Very rarely such places may develop into bamboo forests, with the most common species like *Bambusa tulda, Dendrocalamus strictus* and *Pseudostachyum polymorphum*.

If the vegetation develops into secondary forests, trees like *Trema orientalis, Alstonia scholaris, Glochidion oblatum, Oroxylum indicum* and *Zanthoxylum ovalifolium* are common. Some of these trees are still surviving clumps of relict trees of primary forests, while others are new intruders. *Mikania micrantha,* an exotic straggling shrub with white flowers usually occupy such places early and establishes very well, spreading over bushes and scrubs forming gregarious carpets.

Aquatic vegetation is very poorly developed in this region, the landscape being a continuous slope. However, there are a few ponds and ditches in wastelands, near villages, where *Monochoria hastata, Tenagocharis latifolia* and various aquatic sedges are commonly seen. Along the edges of these ditches and ponds, marsh-loving plants like *Rotala indica, Murdannia blumei, Hydrocotyle javanica, Sacciolepis indica, Paspalum orbiculare* and species of *Polygonum* usually grow in large populations.

(2) *Tropical Semievergreen Zone*: Vast areas of this zone are occupied by grasslands and the common grass species are *Saccharum arundinaceum, Sorghum nitidum, Phragmites karka, Digitaria ternata, D. setigera, Eulalia* spp., etc. and those are usually associated with herbaceous plants like *Crotalaria occulta, Commelina bengalensis, Cyathula prostrata, Synedrella nodiflora, Cyanotis vaga, Hedychium* spp., *Cyperus digitatus, Mosla dianthera, Scleria levis* and *Plectranthus* sp.

In scrubby vegetation, the common plants are *Lantana camara, Barleria cristata, Desmodium* spp., *Indigofera* spp., *Cassia occidentalis, Ageratum conyzoides, Cynoglossum glochidiatum, etc.* In secondary forests the dominant tree species are *Trichelia connaroides, Glochidion acuminatum, Phyllanthus emblica, Symplocos paniculata, Rhus chinensis* and *Ziziphus mauritiana.* The undergrowth in these forests are usually plants such as *Abutilon indicum, Sida spinosa, S. rhombifolia, Leea indica, Crotalaria occulta, Desmodium racemosum, Indigofera dosua, Ageratum conyzoides, Blumea sessiliflora, Plectranthus ternifolius, Chenopodium ambrosoides, Cyathula prostrata, Jatropha curcas* and *Atylosia scarabaeoides.* The common climbers are *Mukia maderaspatana, Gymnopetalum cochinchinense, Argyreia splendens, Smilax lancifolia* and *Thunbergia grandiflora.*

In open places, pondsides and streamsides, plants like *Cyperus cyperoides, Elaeocharis acutangula, Eriocaulon luzulaefolium, Lindernia* spp. and *Murdannia* spp. grow. In such situations *Commelina paludosa* often grow in large populations.

(3) *Subtropical Evergreen Zone*: The main types of secondary vegetation in this zone are the grass savannas, bamboo forests and pine forests, which are dealt with separately below.

GRASS SAVANNAS occupy vast areas along the southern part of the plateau and these are not mixed with any shrubby or arborescent plants, but only certain herbaceous plants. In pockets along valleys, depressions and steep slopes patches of primary broad-leaved forests can be seen. Usually these are clearly demarcated from grasslands. The grass species of this zone are mainly of short height, rarely reaching 50-60 cm. They reach their full dominance by autumn when almost all the species are in full bloom. By late winter, they get completely dried up and fire raging every-where rapidly reduces the hills to smoking black wastes. Sporadic recurrence of fire and grazing result in substantial check to the succession of these grasslands to scrub or woodlands. Thus the over-riding factor in the successional dynamics of these grasslands in keeping them permanent, is fire. Frequent fires and grazing also tend to select species which are capable of regeneration from underground parts. Hence after burning, the relative frequency of different species may be altered, i.e. the species present may be completely eliminated or many new ones may invade. In some places where the soil layer is shallow, burning makes it liable to erosion by heavy rain, washing away the top soil and leaving the hillslopes as barren rocks.

The common species of grasses found in this area are *Leersia hexandra, Imperata cylindrica, Setaria pallide-fusca, Sclerostachya fusca, Ischaemum* spp., *Erianthus rufipilus, Isachne albens, Eragrostiella leioptera, Arundinella* spp., *Echinochloa crus-galli* and *Lophatherum gracile*. Associated with these grasses, there are many other herbaceous plants with usually perennial rootstocks and regenerating every spring. Among these the most common ones are *Polygonum bistorta, Duchesnea indica, Youngia cineripappa, Emilia sonchifolia, Conyza japonica, Exacum tetragonum, Osbeckia glauca, Polygala* spp., *Centranthera grandiflora, Calamintha umbrosa, Wahlenbergia gracilis* and *Crinum amoenum*. Scattered in these grasslands are many terrestrial orchids like *Arundina chinensis, Anthogonium gracile, Brachycorythis obcordata, Herminium angustifolium, Spathoglottis pubescens* and various species of *Habenaria*. At certain places near Jarain, *Nepenthes khasiana* grows amidst grass.

There are many spots where water-logged conditions facilitate the development of marshy grasslands, where moist-loving Cyperaceae, *Eragrostis* spp., *Juncus* spp., *Luzula campestris, Ranunculus cantoniensis, Drosera peltata, Burmannia disticha, Parnassia wightiana, Centella asiatica, Murdannia* spp., *Rotala rotundifolia, Haloragis micrantha* and *Salomonia cantoniensis* occur in isolated populations. In certain places it is possible to find large populations of *Osbeckia benthamii* with pink and white flowers. Among aquatic plants growing in water-logged streams, ponds and paddy fields, the common ones are various species of Cyperaceae, *Blyxa echinosperma, Sagittaria sagittifolia, Caldesia grandis* and *Potamogeton nodosus*.

BAMBOO FORESTS are best developed in this zone, especially at lower altitudes. Often large clumps of bamboos could be seen in patches along borders of forests and in clearings in forests. The common species are *Dendrocalamus hamiltonii, Bambusa vulgaris, Arundina suberecta* and *Chimonobambusa khasiana.*

PINE FORESTS are found at higher elevations along slopes of hills and these are climax forests of secondary nature. Often these are found in pure stands, but occasionally associated with *Schima wallichii, Rhododendron arboreum, Ternastroemia gymnanthera* and species of *Acer, Cinnamomum* and *Engelhardia.* The floor of these forests are covered with thick layer of pine needles, which usually get burnt accidentally or by human interference during dry season. Wherever the fire frequencies are less, the undergrowth is dense, consisting of many grass species in large populations, associated with shrubby plants like *Lyonia ovalifolia, Butea minor, Dipsacus asper, Inula cappa, Saussurea nivea, Anaphalis contorta, A. adnata, Agrimonia nepalensis, Osbeckia* spp., *Vernonia saligna, Rubus rugosus, Artemisia parviflora* and *Callicarpa rubella.* Other herbaceous plants commonly seen are *Scutellaria discolor, Sanicula elata, Ainslaea latifolia, Ajuga macrosperma, Anotis wightiana, Valeriana jatamansii, Centranthera cochinchinensis, Osbeckia nepalensis, Hedyotis corymbosa, Selinium striatum, Senecio griffithii, Elsholtzia strobilifera, Arisaema consanguineum, Melissa axillaris* and various grasses like *Pogonatherum* sp., *Coelorachis striata, Apocopis paleacea, Capillipedium* sp. and *Sporobolus piliferus, Aeginetia indica,* the parasite on roots of grasses can also be seen at certain places. *Vanda coerulea, Dendrobium* spp. and *Oberonia myriantha* are the rare orchids here.

(4) *Subtropical Semievergreen Zone*: The main type of secondary vegetation in these areas are tree and shrub savannas. These formations are defined as grasslands with scattered trees and shrubs and can be seen in the northern slopes of the plateau up to Nartiang-Mynso region.

The grasses of these formations are normally 1 m high, often reaching up to 3-4 m and form a continuous layer dominating over a lower strata of herbs and small grasses. These grasslands are often burnt during dry season. The trees, wherever they occur in scattered patches, have thin round canopies permitting sufficient light for the sun-loving grasses to grow well under them, and in many places where the soil is reduced to lithosols, the ecology in such places is not conducive to the development of trees and in those places pure formations of grasses develop. Wherever the top soil is deep, many arborescent forms develop, forming transition to woodlands and these play an important role in the formation of trees and shrub savannas. Under long term favourable conditions, a nucleus of these tree

species can be seen maintained at certain places, which are precursores for mature well-developed secondary forests.

Among the tall grasses, the common ones are *Themeda villosa, T. triandra, Sorghum nitidum, Erianthus longisetosus, Thyrsia zea, Apluda mutica, Arundinella* spp., *Narenga fallax* and *N. porphyrocoma.* Among the grasses of lesser height, mention may be made of *Eulalia* spp., *Digitaria* spp., *Rytilix granularis, Ophiuros megaphyllus, Cymbopogon* spp., *Andropogon ascinoides, Miscanthus nepalensis, Eccoilopus cotulifer, Setaria palmifolia* and *Polytoca digitata.*

The common shrubby and herbaceous plants associated with these grasses are *Urena lobata, Crotalaria alata, Smithia ciliata, Desmodium laxiflorum, D. sequax, Cassia mimosoides, Cirsium involucratum, Bidens pilosa, Eupatorium* spp., *Sopubia trifida, Artemisia parviflora, Cynoglossum furcatum, Plectranthus terniflorus,* and species of *Hedychium, Arundina bambusifolia* the bamboo orchid with pale pink flowers and *Murdannia divergens. Phoenix humilis* grows in large scattered clumps along open hill slopes at lower elevations and these are replaced by *Butea minor* at higher elevations.

The common trees met with in these grasslands are *Castanopsis tribuloides, Oroxylum indicum, Callicarpa arborea, Lithocarpus elegans, Svida macrophylla, Castanopsis kurzii, Dillenia indica* and *Ficus* spp.

There are a few ponds and small lakes in this zone, exhibiting plants like *Brasenia schreberi, Scirpus* spp., *Scleria* spp., *Carex* spp., *Sagittaria sagittifolia* and *Caldesia grandis.*

D. Cultivated and other Useful Plants

The Jaintias forming one of the numerous tribal societies, have a rich plant lore and are well-versed in the use of plant materials for various domestic purposes: food, clothing, shelter, medicine, etc. This ethnobotanical aspect in itself constitutes a major research programme. Even today, in spite of the considerable sophistication of the local people, a visit to the weekly markets held in very traditional fashion in different principal towns and villages is a fine exhibition of the intimate acquaintence of the local people with plants, in all their diversity.

Fruits of many wild plants are eaten by local people and among them mention may be made of *Docynia indica, Ficus neriifolia, F. auriculata, Garcinia paniculata, G. pedunculata, G. lancifolia, Rubus niveus, R. rugosus, Gardenia campanulata, Syzygium cumini, Lepisanthes rubiginosa, Ardisia floribunda, Meyna spinosa, Debregeasia longifolia* and *Actinida callosa.*

Many wild plants are used as vegetables. The leaves of *Mussaenda roxburghii, Vaccinium donianum, Thunbergia grandiflora, Houttuynia cordata, Sambucus javanica, Medinella erythrophylla, Olax acuminata,* and

Tetrastigma thomsonianum, flowers of *Buddleia asiatica* and *Corylopsis himalayana* are often cooked with meat and fish. Seeds of *Hodgsonia macrocarpa*, *Sterculia hamiltonii* and *S. roxburghii* are also eaten either roasted or cooked. Fruits of *Elaeocarpus floribundus* are cooked or pickled and those of *Dillenia indica*, with their persistent fleshy calyx are cooked and eaten. The aril covering the seeds of *Horsfieldia amygdalina* are eaten raw. The young shoots of bamboos form a delicacy among the local people and they prepare various types of stew out of it. Fruits of *Citrus latipes* and *Zanthoxylum armatum* are used as condiments.

Among the numerous wild plants used by the local people for medicine, mention may be made of the fruits of *Casearia vareca* used for worms, fruits of *Zanthoxylum armatum* for toothache, roots of *Hedyotis scandens* for eye diseases and leaves of *Paederia foetida* for diarrhoea and dysentery.

There are also many types of natural fibres used as ropes for building huts, carrying baskets and for other purposes. Among the common plants which yield fibres are *Boehmeria* spp., *Urena lobata*, *Abroma augusta* and *Bixa orellana*.

The staple food of the people consist of hill rice, maize and milletts, cultivated with considerable effort in the jhumed areas. Due to the initiative of David Scott, the first Agent of the Governor General in Assam, potato was introduced during 1827-28 and now it is the most widely cultivated food crop, other than rice. Sweet potato is being cultivated in the northern slopes of Jaintia hills. Apart from these food crops, various vegetable crops in scattered plots and kitchen gardens are also raised. Of these the common ones are cabbage, cauliflower, peas, beans, carrot, raddish, turnip, and beet root at high elevations, and tomato, brinjal, cucumber, pumpkin, ash-gourd, bitter-gourd and snake-gourd at lower elevations.

Orange together with lemon constitute one of the earliest orchard plants of the area. These are widely cultivated at altitudes between 500 and 1400 m, in Raliang-Mynso in the north and Bataw-Sohka in the south. Bananas also are partly cultivated and partly harvested from the wild and constitute another popular native fruit-crop. Still other fruit trees grown in small orchards are pear, peach, plum and pomegranate at higher elevations and pineapple, papaya and mango at lower elevations.

Among other cultivated plants raised in cleared forest areas in these hills are ginger, turmeric and garlic. In lower warmer areas on southern slopes, especially in Dawki-syndai area there are arecanut plantations, on the tall stems of which the associated betel vines are grown. Betel leaf and arecanut are constant items in all markets and shops, and in very early times have been the agency for the introduction of the tribal hill people to the plains people. Of recent introduction in Lumshnong area, more or less

on an experimental scale, having promise of success is coffee and in Dawki area the introduced S. American root crop, Tapioca.

The less commonly cultivated kitchen garden plants are the tree-tomato of S. America (*Cyphomandra betacea*) spinachs (*Basella rubra* and *Tetragona expansa*) and various types of chillies (*Capsicum*).

The European Christian missionaries appear to have had considerable influence in the lay out of domestic ornamental gardens and introduction of many familiar ornamental trees, shrubs, climbers and border plants. Of those giving a characteristic appearance to the sky line of the town are the giant trees of *Eucalyptus* and *Cryptomeria* with here and there the dense glossy leaved *Magnolia* and blue-flowered *Jacaranda.* In many gardens nicely clipped *Thuja* and *Juniperus* as also *Podocarpus neriifolius* also strike the eye. The common shrubby plants in these gardens are *Cestrum, Hibiscus, Poinsettia, Callistemon, Hypericum* and *Rosa.* The common border plants are *Dahlia, Canna, Gladiolus, Begonia, Impatiens, Tropaeolum, Aster, Pelargonium, Antirrhinum, Crinum, Celosia, Kniphofia,* etc. and many climbers like *Bougainvillea, Rosa, Jasminum,* etc. Local wild orchids like *Phaius, Cymbidium* and *Dendrobium* spp. are also being cultivated.

SALIENT STATISTICS ON THE FLORA

This account of the flora of Jowai is chiefly concerned with flowering plants, with 1517 species in 749 genera and 165 families among the angiosperms. Table 2 below indicates the break-up with respect to the monocots and dicots. The proportion of monocots to dicots is 1 to 2.5 and genera to species is 1:2. Taking into account the entire Indian subcontinent, including Malaya, Hooker (1904) estimates the proportion of monocots to dicots to be 1 to 2.3 and genera to species 1 to 7.

TABLE 2 : GENERAL SURVEY

	Genera	Species
Monocots	198	433
Dicots	551	1084
Total	749	1517

The ten dominant families in the present flora with their respective genera and species, are listed below in table 3. A comparison of this sequence with those given by Hooker (1904) for Flora of British India as given in table 4 indicates interesting similarities as well as dissimilarities. While Orchidaceae occupies the top position in both, Leguminosae and Poaceae

have interchanged their positions, by the former occupying second position in the Flora of British India and third position in the present flora, and Poaceae taking the second position in the present flora and third position in the Flora of British India. Hooker included Fabaceae, Caesalpiniaceae and Mimosaceae together under Leguminosae (*sensu lato*), which though separately treated in the present flora, are combined for the sake of comparison in table 4. Similarly Urticaceae, as treated by Hooker, includes Moraceae, Ulmaceae, Cannabinaceae and Urticaceae, which have been treated separately in the present flora and for purposes of comparison, treated (in table 4) in the same sense as of Hooker.

Table 5 lists the species of endemic distribution in the area. Of these, there are 6 species endemic to Jaintia hills alone and 44 species endemic to Meghalaya. This accounts for about 3% of the plants included in this flora.

TABLE 3 : THE LARGEST FAMILIES

Family	Genera	Species
Orchidaceae	50	141
Poaceae	63	106
Rubiaceae	31	75
Asteraceae	33	66
Fabaceae	25	66
Cyperaceae	10	48
Euphorbiaceae	22	44
Acanthaceae	20	37
Lamiaceae	20	31
Zingiberaceae	13	29

TABLE 4 : THE LARGEST FAMILIES

(Comparison with Flora of British India)

Flora of Jowai	'Flora of British India
Orchidaceae	Orchidaceae
Poaceae	Leguminosae
Leguminosae	Poaceae
Rubiaceae	Rubiaceae
Asteraceae	Euphorbiaceae
Urticaceae	Acanthaceae
Cyperaceae	Asteraceae
Euphorbiaceae	Cyperaceae
Acanthaceae	Lamiaceae
Lamiaceae	Urticaceae

TABLE 5 : LIST OF ENDEMICS

No.	Species	Family	Endemic to Jowai District	Endemic to Meghalaya
1.	*Adinandra grifithii*	Theaceae		+
2.	*Aechmanthera leiosperma*	Acanthaceae	+	
3.	*Aeschynanthus parasiticus*	Gesneriacaee		+
4.	*A. superba*	,,		+
5.	*Anacolosa ilicoides*	Olacaceae		+
6.	*Baliospermum micranthum*	Euphorbiaceae		+
7.	*Calliandra grifithii*	Mimosaceae		+
8.	*Callicarpa psilocalyx*	Verbenaceae		+
9.	*Camellia caduca*	Theaceae		+
10.	*Ceropegia angustifolia*	Asclepiadaceae		+
11.	*Citrus latipes*	Rutaceae		+
12.	*Cynanchum wallichii*	Asclepiadaceae		+
13.	*Dactylicapnos torulosa*	Fumariaceae		+
14.	*Daphne shillong*	Thymelaeaceae		+

No.	Species	Family	Endemic to Jowai District	Endemic to Meghalaya
15.	*Eria ferruginea*	Orchidaceae		+
16.	*Eriobotrya angustissima*	Rosaceae		+
17.	*Glochidion thomsonii*	Euphorbiaceae		+
18.	*Goldfusia glabrata*	Acanthaceae		+
19.	*Gymnostachyum venustum*	,,		+
20.	*Habenaria khasiana*	Orchidaceae		+
21.	*Hedychium dekianum*	Zingiberaceae	+	
22.	*Hyparrhena griffithii*	Poaceae	+	
23.	*Ilex embelioides*	Aquifoliaceae		+
24.	*I. venulosa*	,,		+
25.	*Impatiens acuminata*	Balsaminaceae		+
26.	*I. khasiana*	,,		+
27.	*I. laevigata*	,,		+
28.	*I. porrecta*	,,		+
29.	*Lindera latifolia*	Lauraceae		+
30.	*Liparis acuminata*	Orchidaceae		+
31.	*Paramignya micrantha*	Rutaceae		+
32.	*Phanera khasiana*	Caesalpiniaceae		+
33.	*Phlogacanthus wallichii*	Acanthaceae		+
34.	*Photinia cuspidata*	Rosaceae		+
35.	*P. polycarpa*	,,		+
36.	*Pogonatherum rufo-barbatum*	Poaceae		+
37.	*Pogostemon strigosus*	Lamiaceae		+
38.	*Pteracanthus griffithianus*	Acanthaceae		+
39.	*P. nobilis*	,,		+
40.	*P. rubescens*	,,	+	
41.	*P. urophyllus*	,,		+
42.	*Rhynchospora griffithii*	Cyperaceae		+
43.	*Rubus khasianus*	Rosaceae		+
44.	*Salix psilostigma*	Salicaceae		+
45.	*Senecio jowaiensis*	Asteraceae	+	
46.	*Sympagis maculata*	Acanthaceae		+
47.	*S. monadelpha*	,,		+
48.	*Tarphochlamys affinis*	,,		+
49.	*Tetrastigma obovatum*	Vitaceae		+
50.	*Trachyspermum khasianum*	Apiaceae		+
51.	*Trivalvaria kanjilalii*	Annonaceae	+	

DISCUSSION AND CONCLUSIONS

Hooker (1904) considered the flora of India to be a mixture of floras from surrounding areas, enriched by the migration of plants from China, Tibet and Siberia in the north, Malaysia in the south and Africa and Europe in the west. Chatterjee (1940 & 1962) taking up this view, has made an elaborate analysis of the flora of the entire Indian subcontinent including Burma, Ceylon and Pakistan and relying upon the herbarium material available to him concluded that 'there existed an original flora which got

mixed up and became partly masked due to the invasion of plants from outside' (1962: p. 37). He bases his conclusion on an analysis of the percentage of endemics as indication of the distinctiveness of the flora and also the natural barriers of lofty Himalayas and to vast Indian ocean separating the subcontinent. He has estimated that for the entire area, a percentage of 61.5% and for the eastern region of Assam and Himalayas 28.8% are endemics.

Any review of the phytogeography of Meghalaya should be in the context of its historical geomorphology (see ch. III). Two factors—the ancient Gondwanaland with which Khasi and Jaintia hills formed a part and the Great Ice Age—have influenced the formation of the present flora of this tract. Due to its being a part of the great Gondwanaland, the flora of this region shows affinities with the Malaysian and peninsular Indian floras, as well as to a lesser degree with Australian and African floras. During the Ice Age, vast plateau and mountainous areas in the Sino-Himalayan region were covered with ice. This and the subsequent retreat of ice had a two-fold effect: (i) the migration of northern Siberian and Sino-Himalayan species southwards along with the advancement of ice; (ii) the subsequent movement of southern Malaysian elements northwards along with the retreat of ice. To quote Wulff (1950: p. 154): 'The advance and retreat of ice occupied a period of thousands of years, during which, as a result of changes in climatic conditions, plants and animals migrated, as the ice advanced, from the north to the south and from the upper altitudinal zones to the plains and valleys, and, as the ice retreated, returned, in part to the north and to higher elevations.' Turrill (1953: 2·78) stated: 'The southern drive of the flora must have had a telescoping effect, crowding the alpine on to the subalpine, the subalpine on to the warm temperate, and so forth.' This seems to explain the reason for the occurrence of many temperate northern species even at comparatively lower elevations in the subtropical zone in Jaintia hills, as shown by Bor (1942) in his comparison of the floras of Khasi and Naga hills.

The Meghalaya flora thus shows affinities with nearby Sino-Himalayan, Burma-Malaysian and to a lesser extent with peninsular Indian floras. It also shows relationship with distant areas of Australia, Africa and America. These affinities are best illustrated by an enumeration of some of the common elements. Of the Chinese and Himalayan genera found in Jaintia hills, are *Kadsura, Actinidia, Corylopsis, Mahonia, Manglietia, Camellia, Skimmia, Holboellia, Eurya, Loxostigma, Hydrangea, Anisadenia, Hovenia, Caryopteris, Codonopsis, Dactylicapnos, Anisopappus, Achillea,* etc. and many species in different genera.

Of the Malayan elements occurring in Jaintia hills, are genera like *Nepenthes, Vaccinium, Engelhardia, Xantolis, Daphniphyllum, Pueraria,*

Balanophora, Talauma, Pittosporum, many *Zingiberaceae,* etc. and the species like *Exbucklandia populnea, Valeriana hardwickii, Mosla dianthera, Mellissa parviflora, Rubus niveus, R. rosifolius, Neillia thyrsiflora, Craniotome versicolor,* etc. Some species like *Cryptolepis elegans, Dichroa febrifuga, Pottsia cantoniensis, Macrosolen cochinchinensis* and *Actinidia callosa* range from China to Malaysia through Meghalaya and some other species, *Boehmeria* sp., *Adenanthera pavonina, Pholidota imbricata, Deeringia amaranthoides, Burmannia disticha, Haloragis micrantha,* etc. range from Asia to Australia and New Zealand.

The flora of this region has significant affinities with peninsular India and this is shown by the discontinuous distribution of *Kadsura heteroclita, Eurya japonica, Dillenia indica, D. pentagyna, Gardneria ovata, Helicia nilagirica, Xanthophyllum flavescens, Elaeocarpus rugosus, Aspidopterys indica, Munronia pinnata, Parnassia wightiana, Leea crispa, Schefflera wallichiana,* etc. which occur in peninsular India and Assam, especially Meghalaya.

van Steenis (1962) has discussed transpecific floristic affinities in support of the theory of land-bridge across Pacific Ocean, an alternative to the theory of continental drift, in his elaborate essay on the 'Land-bridge theory in botany.' Interesting examples of transpecific dispersal are *Boschniakia,* a root-parasite of Orobanchaceae, which has one species in Jaintia hills and E. Himalayas and another solitary one in N.W. America. Similarly *Pyrularia* (Santalaceae) has a solitary extra-American species, *P. edulis* in Jaintia hills. The following genera which occur in Jaintia hills have relative species present in the New World also: *Zanthoxylum, Berchemia, Itea, Disporum, Gelsemium, Buddleia, Meliosma, Lespedeza, Sapindus, Eurya, Lyonia, Lysimachia, Hydrangea, Aralia, Photinia, Houttuynia, Talauma, Saurauia, Arisaema, Berberis, Osmanthus, Schoepfia, Turpinia, Calophyllum, Salomonia,* etc.

Affinities with Africa, though comparatively less are shown by *Flacourtia, Nepenthes, Ochna, Dipsacus, Meyna, Synedrella, Heritiera, Geniosporum, Phoenix, Gerbera, Sphaeranthes, Striga,* etc. and the species, *Cudrania cochinchinensis, Albizia lebbek, Atylosia scarabaeoides, Elatostema sessile,* etc.

Another feature of the flora is its richness. This was remarked about a century ago by Hooker (1854 & 1904). However, at that time, the flora of the E. Himalayas was unknown. As a result of intensive explorations of Botanical Survey of India, in various parts of the E. Himalayas, Sikkim and Bhutan and the more recent work of Japanese botanists (Hara, 1966) in Sikkim and Bhutan, we know now that this richness of Meghalaya flora is shared by the mountain areas of E. Himalayas also.

A striking feature of the flora of Jaintia hills (as also in general of Assam) is the presence of many primitive flowering plants *i.e. Manglietia, Michelia, Alcimandra, Paramichelia, Talauma, Kadsura, Sarcandra, Holboellia, Houttuynia, Exbucklandia, Loropetalum, Corylopsis,* Annonaceae, Myristicaceae, Piperaceae, Lauraceae, etc. Takhtajan, who visited Khasi hills in 1966, has also noticed this significant feature (Takhtajan, 1969: p. 166), and considers the area including Assam, E. Himalayas, Upper Burma, and Yunnan to Fiji Islands in the Pacific, showing excessive concentration of primitive angiosperms, to be the primary centre of origin of angiosperms or to put it in his own works, 'the cradle of flowering plants.'

The floristic subdivisions of India, as accepted by Hooker (1904) are essentially based on Clarke's paper, 'On the sub-subareas of British India' (Clarke, 1898), and includes the western parts of Assam, along with the entire Brahmaputra Valley under his subdivision of Gangetic Plains, and the eastern part with Burma in his subdivision of Burma. Good (1953) in his phytogeographical subdivision of the world, follows essentially Hooker, and combines the eastern part of Assam and Upper Burma together and includes it under the Continental South-east Asiatic Region of his Indo-Malaysian Kingdom.

Thus in most of the accounts of floristic divisions of India, there appears to be more or less a consensus on the Assam (or the North Eastern region) having a distinctive flora, though the boundaries or limits varied from one author to another. Whether this view is correct or is to be modified, has to remain until a detailed investigation is undertaken part by part of this rather difficult countryside with poor communication as yet, and with other handicaps for a botanist. It is clear that there is a need for more detailed studies of small areas, so as to obtain sufficient data for a more confident and decisive recasting of our conception of the Indian flora, apart from many other valuable and enduring useful aspects of such plant inventories.

STYLE OF PRESENTATION OF THE FLORA

The sequence of families in this flora follows the system of Bentham and Hooker (1862-83) with some modifications based on recent knowledge. Genera and species are in the same order as they appear in the Kevs. Short descriptions to only species are provided, based mainly on the specimens studied.

The correct name of the species is followed by its basionym (if any) and reference to the Flora of British India and Flora of Assam, and to recent literature, in some necessary instances. All literature reference following binomials are abbreviated as per 'Guide to citation of literature' of the International Code of Botanical Nomenclature, 1972. Vernacular

names as locally used in *Synteng* or *Khasi* dialects, are indicated wherever known, at the end of citations. Further, habitat notes, altitudinal range within Jowai district, data on flowering and fruiting, are provided. Specimens are cited only in cases of endemics, and some interesting and rare plants. Names of villages or the route are indicated, for collection localities. Also very brief notes pertaining to uses, endemism, etc. are added. Excepting for a few specimens at Kew Herbarium, England (K) and at the Central National Herbarium (CAL) all other specimens, studied for the flora are in the Kanjilal Herbarium of the Botanical Survey of India, Shillong (ASSAM).

Conventional abbreviations to metric measurements have been used: m: metre, cm: centimetre, mm: milimetre, ± : means more or less; fl.: flowering, ft.: fruiting, var. is variety.

Except otherwise indicated, measurements refer to length or height or to length times width, thus 'herb 10-50 cm' means that the plants are 10-50 cm high; 'leaves 2-4 × 1-2 cm' means that leaves are 2-4 cm long and 1-2 cm wide.

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KEY TO FAMILIES

(*Note : This key applies only to the plants described in this flora. Some of the families appear more than once in the key.*)

1a. Plants insectivorous; leaves adapted to catching insects, modified into large pitchers, flat or dish-like sticky structures or bladders.

2a. Erect or scandent herbs, terrestrial or in marshy places, 0.5-5.0 m high; apical part of leaf modified into long pitchers; ovary 3-5-celled. NEPENTHACEAE 112

2b. Slender herbs, aquatic, in marshy places or on wet rocks, erect, floating or subscandent, not more than 25 cm high; leaves not producing pitchers.

3a. Leaves flat, sticky with gland-tipped hairs at margins; petals free, not spurred; fertile stamens 5-20; ovules attached to pareital placentas. ... DROSERACEAE 61

3b. Leaves modified into subovoid bladders with sensitive trap-doors; petals united, spurred at base; fertile stamens 2; ovules on free central placenta. LENTIBULARIACEAE 100

1b. Plants not insectivorous; leaves not modified for catching insects.

4a. Hemiparasites on aerial parts of host plants. ... LORANTHACEAE 122

4b. Holoparasites, on roots of host plants, saprophytes or normal green plants.

5a. Holoparasitic plants, devoid of chlorophyll, attached to roots of hosts plants.

6a. Flowers 1-5 cm long, solitary or in racemes or spikes, bisexual; ovules numerous; fruit capsular. ... OROBANCHACEAE 99

6b. Flowers minute, in spadices, unisexual; ovules 1-3; fruit a nut. BALANOPHORACEAE 124

5b. Normal green plants or plants green with chlorophyll for at least part of their life cycle, or if devoid of chlorophyll then saprophytic (in *Aphyllorchis* of Orchidaceae).

7a. Stems spurious, composed of tightly convolute leaf sheaths; inflorescence solitary, arising from the underground rhizome through the centre of the spurious stem, emerging at top, bearing many large spathaceous closely imbricate bracts; stamens 5 with 1 staminode. ... MUSACEAE 142

7b. Not this combination of characters.

8a. Tall erect shrubs or trees or climbers or twiners; leaves spirally arranged, with large stem-embracing sheaths; leaf-blade usually deeply pinnati- or palmatipartite or lobed, or 2-4-pinnatifid, parallel-veined; perianth in 2 whorls of 3 each, hard and rigid. ... ARECACEAE 156

8b. Not this combination of characters.

9a. Herbs with underground rhizomes or woody climbers, climbing with the help of adventitious roots; flowers very minute, unisexual or bisexual, collected on fleshy spadices and subtended by a large spathaceous bract attached to the apex of peduncle. ... ARACEAE 159

9b. Not this combination of characters.

10a. Herbaceous aquatics rooting at bottom-mud; leaves floating, in radical rosettes or distant on creeping rhizome, simple, peltate or cordate, palmatinerved, not split into narrow segments; petioles very long; flowers axillary, solitary, more than 2.5 cm diam., showy; peduncles long; petals 3 or more, free; stamens 10 or more. ... NYMPHAEACEAE 9

10b. Not this combination of characters.

11a. Stamens and stigma much modified, and scarcely recognisable as such, attached to each other and forming a special structure.

12a. Leaves parallel-veined; flowers irregular, the lower (rarely upper) petal differing from the other two in size or shape or colour; ovary inferior, 3-celled, appearing below the perianth. ORCHIDACEAE 139

12b. Leaves net-veined; flowers regular; the 5 petals alike; ovary superior, 2-celled, located above the perianth, but usually concealed inside a corona. ... ASCLEPIADACEAE 92

11b. Stamens and stigma distinguishable.

13a. Flowers minute, pentamerous, in simple or compound umbels or heads; corolla polypetalous; stamens 5, opposite to petals, incurved in bud; ovary inferior.

14a. Carpels consistently 2; fruit a dry schizocarp with carpels separating at maturity, leaving a carpophore; stigma with stylopodium at base. ... APIACEAE 74

14b. Carpels 1-many, mostly 5; fruits drupaceous or baccate; carpels sometimes separating but without carphophore; stigmas without a stylopodium at base. ... ARALIACEAE 75

13b. Not this combination of characters.

15a. Flowers bisexual in involucrate heads; corolla gamopetalous; stamens epipetalous at base of corolla-tube; ovary inferior; fruit a 1-seeded achene with persistent calyx modified into pappus hairs.

16a. Stamens 5; anthers connate or connivent into a tube around the style ... ASTERACEAE 81

16b. Stamens 2-4; anthers free. ... DIPSACACEAE 80

15b. Not this combination of characters.

17a. Grass or bamboo or such-like plants; leaves linear or linear-lanceolate, parallel-veined, sometime reduced to a sheath.

18a. Flowers in axils of chaffy scale-like bracts and entirely or largely concealed by them; perianth absent or consisting of 2-3 small scales or bristles.

19a. Stem mostly solid and triquetrous at least at base; flowers in axils of solitary bracts and these collected into spikelets; anthers basifixed. ... CYPERACEAE 164

19b. Stem with hollow internodes, usually terete; flowers enclosed by a bract and bracteoles (lemma and palea) and arranged in spikelets; anthers usually basifixed or versatile. POACEAE 165

18b. Flowers either not in the axils of chaffy bracts or if subtended by bracts, exceeding or equalling them and not concealed; perianth present, 4-6.

20a. Aquatic rhizomatous herbs; fruit 1-seeded achene. ... SPARGANIACEAE 158

20b. Marshy or rarely aquatic herbs; fruits 2-many-seeded capsules.

21a. Sepals and petals not scale-like; at least petals conspicuous and yellow. ... XYRIDACEAE 153

21b. Sepals and petals scale-like, none of them conspicuously petaloid, usually green or brown or white.

22a. Flowers bisexual, in repeatedly branched panicle or umbel of heads. ... JUNCACEAE 155

22b. Flowers unisexual, in solitary button-like head at the summit of each scape. ... ERIOCAULACEAE 163

17b. Not grass or bamboo or such-like plants.

23a. Leaves spirally arranged, distichous or alternate, never opposite or whorled; carpel solitary, 1-celled; fruit typically a legume or lomentum.

24a. Flowers papilionaceous. ... FABACEAE 53

24b. Flowers not papilionaceous.

25a. Flowers zygomorphic; perianth segments predominantly imbricate in bud. ... CAESALPINIACEAE 54

25b. Flowers actinomorphic; calyx and corolla valvate in bud. MIMOSACEAE 55

23b. Not this combination of characters.

26a. Plants climbing with the help of tendrils.

27a. Tendrils developing from the apex of leaf-sheaths; flowers 3-merous. ... SMILACACEAE 151

27b. Tendrils not at apex of leaf-sheaths; flowers 5-merous.

28a. Petioles tendrillar. ... RANUNCULACEAE 1

28b. Petioles not tendrillar.

29a. Fruits 1-seeded.

30a. Leaves distichous, peltate or subpeltate at base ... OLACACEAE 40

30b. Leaves opposite or subopposite, not peltate at base. ... ICACINACEAE 41

29b. Fruits 2- or more-seeded.

31a. Leaves decompound; rachis ending in tendrils; fruits capsular, pod-like, torulose. ... FUMARIACEAE 11

31b. Leaves simple, tendril distinct from petiole; fruits variously shaped.

32a. Fruits 3-winged; capsules separating into 1-seeded indehiscent coccii. ... RHAMNACEAE 44

32b. Fruits wingless, fleshy.

33a. Stem sympodial in growth; corolla valvate, free; stamens free, not on gynophore; ovules on axile placenta. ... VITACEAE 45

33b. Stems monopodial in growth; corolla imbricate or if valvate, then gamopetalous; filaments completely or partly united, often on gynandrophore.

34a. Flowers with corona; ovary superior; seeds arillate. PASSIFLORACEAE 71

34b. Flowers without corona; ovary inferior; seeds not arillate. CUCURBITACEAE 72

26b. Plants not climbing, or if climbing, then not with tendrils.

35a. Gynoecium consisting of 2 or more free pistils, each of 1-celled carpel.

36a. Plants with milky latex; corolla gamopetalous; carpels free with connate styles. ... APOCYNACEAE 91

36b. Plants without milky latex; corolla polypetalous; carpels free, with separate styles and stigmas.

37a. Aquatic or marshy plants; leaves parallel-veined.

38a. Aquatic plants with floating leaves; flowers in spikes, brown; stamens 1-4; carpels 4. POTAMOGETONACEAE 162

38b. Marshy or aquatic plants; leaves not floating; flowers in umbels, racemes or panicles, white; stamens 6-9; carpels 10 or more.

39a. Leaves oblong-lanceolate; flowers in whorls or umbels on elongated peduncles; fruits of many follicles. ... BUTOMACEAE 161

39b. Leaves hastate-sagittate, ovate or orbicular; flowers in racemes or panicles; fruits of many achenes. ... ALISMATACEAE 160

37b. Non-aquatic and non-marshy plants; leaves net-veined.

40a. Flowers unisexual or bisexual; sepals often petaloid; filaments connate into a gynophore, at apex of which the sessile anthers and/or pistils are inserted; fruits large woody follicles. ... STERCULIACEAE 27

40b. Not this combination of characters.

41a. Calyx connate into a tube; stamens perigynous. ... ROSACEAE 56

41b. Calyx not connate into a tube; stamens hypogynous.

42a. Stamens 11 or more; usually numerous.
43a. Flowers unisexual; carpels not completely closed along ventral margin. ... SCHIZANDRACEAE 4
43b. Flowers bisexual; carpels completely closed along the ventral margin.
44a. Leaves stipulate.
45a. Stipules intrapetiolar; flowers in many-flowered cymes; filaments terete. ... OCHNACEAE 38
45b. Stipules not intrapetiolar; flowers solitary or paired; filaments flat. ... MAGNOLIACEAE 3
44b. Leaves exstipulate.
46a. Herbs or woody vines; leaves pinnately compound, ternate or if simple, then petioles tendrillar. ... RANUNCULACEAE 1
46b. Trees or shrubs; leaves simple; petioles never tendrillar.
47a. Sepals 3, valvate, usually caducous; seeds with copious ruminate endosperm. ... ANNONACEAE 5
47b. Sepals 5, imbricate, persistent; seeds without ruminate endosperm. ... DILLENIACEAE 2
42b. Stamens 10 or less.
48a. Leaves digitately 3-7-foliolate. ... LARDIZABALACEAE 8
48b. Leaves not so.
49a. Leaves pellucid-punctate with oil glands (visible when seen through against light). ... RUTACEAE 56
49b. Leaves not pellucid-punctate.
50a. Slender twining herbs or shrubs; leaves usually palmately nerved. ... MENISPERMACEAE 6
50b. Trees, shrubs or scandent stout shrubs, never twining; leaves pinnately nerved.
51a. Flowers unisexual or polygamous; styles lateral. ... SIMAROUBACEAE 37
51b. Flowers bisexual; styles terminal or subterminal.
52a. Panicles axillary or in axils of fallen leaves; seeds arillate. CONNARACEAE 52
52b. Panicles terminal; seeds not arillate.
53a. Leaves spirally arranged; fertile stamens 1-2. ... ANACARDIACEAE 51
53b. Leaves opposite; fertile stamens 5. ... STAPHYLEACEAE 49
35b. Gynoecium consisting of one pistil of one carpel, or 2 or more carpels united completely; styles connate at least basally.
54a. Calyx and corolla not prominently differentiated; either calyx or corolla or both absent (to page 45).
55a. Ovary semi-inferior or inferior (to page 42).
56a. Ovary semi-inferior.
57a. Anther-cells opening by 1 or 2 superposed lateral flaps; gynoecium of 1 pistil of 1 carpel. ... LAURACEAE 118
57b. Anther-cells opening by longitudinal slits or valves, never by flaps; gynoecium of 2-many united carpels.
58a. Leaves exstipulate; pinnately nerved with an intramarginal nerve. ... MYRTACEAE 65
58b. Leaves stipulate, palmately nerved, without an intramarginal nerve. ... HAMAMELIDACEAE 62
56b. Ovary inferior.
59a. Stems twining, with huge subterranean tubers; flowers in long spikes, racemes or panicles of spikes; capsules with 3 wings. ... DIOSCOREACEAE 148
59b. Not this combination of characters.