THE MOUNTAIN FLORA OF JAVA

Amir Hamzah †

Moehamad Toha

The [illegible] Amir Hamzah [illegible] Toha, together with [illegible] in front of the Observation Post of the Volcano-logical Survey above the crater of Mt. Papandajan [illegible] which yielded [illegible] and where [illegible] were made [illegible] October [illegible]

THE MOUNTAIN FLORA OF JAVA

**CONTAINING 57 PLATES WITH PICTURES OF
456 SPECIES OF FLOWERING PLANTS NATIVE IN THE MOUNTAINS OF JAVA
MADE FROM LIVING SPECIMENS
IN COLOURS**

BY

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At the time draughtsmen of Herbarium Bogoriense, Bogor, Indonesia

SELECTED, ARRANGED, DESCRIBED AND DISCUSSED

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WITH 26 FIGURES, 72 PHOTOGRAPHS AND 57 COLOURED PLATES

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WITH PROFOUND APPRECIATION TO DOCTOR MARIUS JACOBS
THROUGH WHOSE INTEREST AND TENACITY THIS WORK COULD NOW BE PUBLISHED

DEDICATED TO THE MEMORY OF
PROFESSOR CARL SCHRÖTER,
AUTHOR OF 'DAS PFLANZENLEBEN DER ALPEN',
WHOSE 'PFLANZENFÜHRER FÜR ALPENWANDERER'
INSPIRED ME TOWARDS COMPILING THIS WORK

and

PROFESSOR WILLEM MARIUS DOCTERS VAN LEEUWEN,
AUTHOR OF THE MONOGRAPH ON MOUNT PAN GRAN GO,
WHO INTRODUCED ME TO THE JAVANESE MOUNTAIN FLORA
AND SO MUCH ENCOURAGED ITS STUDY
DURING MY EARLY YEARS IN BOGOR

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PREFACE BY THE AUTHOR

This book serves more than one purpose. It was primarily intended as a simple pocket-size botanical guide to residents in Java, and Sumatra, with interest in nature, enabling them to recognize at sight plants which they encountered in travelling and hiking through the mountains, in the forest, the glades, the swamps, the craters, the vicinity of solfatara and fumaroles, up to the arid rocky wastes on the ridges and spurs to lofty heights.

Though this remains the chief aim, in the present generous format, with reproduction of the plates at life size, the scope has distinctly widened and I have added in the text and in the captions to the plates much more precise information and touched on more general matters than originally intended, which I feel can contribute to its educational value for teachers and students alike in Indonesia.

The description of Nature can of course never be done in the shape of a novel, however fascinating the subject is, as novels are fiction and Nature is reality. Nature must be studied and appreciated in the field, supplemented by experiments and checking of assumptions in the laboratory. In my attempt to record and explain a bit of it I can only hope that this representation is scientifically entertaining and that it will stimulate further research. Quite a few problems remain unsolved.

I have tried to avoid as much as possible botanical jargon in conjunction with this purpose. Fortunately difficult things and complicated situations can mostly also be expressed in a simple way.

The Javanese flora, including that of the mountains, is floristically probably the best known and studied one in the world's tropics of an area covering over 130.000 sq.km, coming up next to that of Ceylon. A modern synthesis of its general botanical aspects, ecology and vegetatiology, an exposure of problems solved and unsolved since Junghuhn's work a century ago, is overdue.

The publication of 45 9 accurate drawings in colour and at natural size is a great asset to tropical botany, because many were never illustrated and still more never in their natural colours. In addition I hope that also the text, the figures, the photographs, and the captions contain observations of sufficient interest to botanical colleagues outside Java. Quite a few of the plants depicted range widely from tropical Asia to tropical Australia.

I hope that this book will also contribute to make the Javanese public aware of the rich flora of their island, the mountains in particular, and I hope to stimulate their interest in this heritage, leading to respect and conservation. Natural forest and vegetation should be maintained and protected because it is essential to ensure a regular water supply, and restrict erosion, the greatest menace of the fertile agricultural land in the lowlands. Reafforestation is needed in many places, but is an extremely slow and most expensive affair. It must be prevented at all costs that steep slopes are deforested beyond the 1500 m contour line and, if unavoidable, careful terracing should be employed. Precisely the common farmer *{tani)* on the land (in the *udik)* must be instructed how to manage this and should be given the means for conserving the precious soil of the higher slopes.

Conservation of the mountain forest I deem of such high importance that I have devoted a whole chapter to this subject (Ch. 19).

Finally, I have pleaded in the last paragraphs of chapter 2 to restore the status of the Nature Reserve Tjibodas-Gedé to the authority of Lembaga Biologi Nasional. As will appear from reading this book it has been and should remain an indispensable complement of the Botanic Garden at Tjibodas with which it forms together a unique whole as a study ground in laboratory and field for the biology of Nature in the mountains.

Rijksherbarium, Leiden
May 22nd, 1972

CHAPTER 1

INTRODUCTION

The traveller in Java who wishesf to see the finest flowers, the richest vegetation, that the island has to offer, will naturally turn to the mountains, and he will nowhere be disappointed. At almost any place in the island, high peaks can be seen, at least in the cool morning, to catch the first rays of the sun in a blush of bronze, soon turning deep green. At first, the sky is likely to be perfectly free of clouds, but these usually gather in the course of the morning, to discharge their load of rain for the benefit of the country. The coolness itself is a gift of the mountains to the inhabitants on their slopes, whereby the colder air creeps down into the heat. The clouds are also a gift of the mountains. The dark green forests on the slopes evaporate enormous quantities of water, which contribute to their bluish appearance from afar. The evaporation makes the air soft and moist; winds are forced upwards by the mighty slopes together with the moisture they carry, thousands of metres aloft, where the clouds then grow with silent awe-inspiring rapidity.

The rain has no difficulty in dissolving the minerals out of the crumbling volcanic material. The forest soil, rich in life, will keep the water as a sponge, and give it quietly away to the paddy fields in the plain, loaden with nutrients to feed the rice. In most of Java the paddy fields and plantations have now replaced the primeval forests that once covered the lowlands, to such an extent that in Java the mountains are now virtually the only places where virgin forest is still to be found. In the northern lowlands of Java no forest is left at all. In South Java there are remote quarters in Banten in the West,amongst themUdjonKulon Nature Reserve, where lowland forest still stands, and here and there are patchy remains of virgin forest in the Djampangs and South Priangan, in Nusa Kambangan and fortunately in the new Nature Reserve Meru Betiri south of Djember, but otherwise the lowland forest in southern Central and East Java has disappeared and has been replaced by cultivated land. The southeastern Peninsula, Purwo-Blambangen, carries a rather poor monsoon forest, suffering from the dry monsoon when many trees shed their foliage for a long period. This never happens in the mountain forests, where the afternoon clouds often bring mists and rain, so favourable to all vegetable growth. And the most majestic, most impressive forest I ever saw in the whole of Java is that on the north slope of Mt. Gede in West Java, thriving marvellously in the calm coolness above the Tjibodas Mountain Garden.

Ascending along a trail, crossing small brooks with crystal clear water, in the heavy shade cast by the dense canopy at some 30-40 m height above us, with here and there emergent trees towering above it on massive straight trunks, the forest starts to change at some 2000 m. It becomes lower and lighter with closer placed thinner tree trunks and giant trees become scarce. Many species stay behind, others make their appearance. After passing this elfin forest, or its mossy fades, eventually the whole vegetation becomes dwarfed and in immediate reach of hand and eye. Still higher up dwarfing continues to a heather-like landscape in which herbs and grasses become abundant.

These changes invite scientific study. Where did the summit flora, with plants so entirely unlike anything in the lowlands, come from? How is it possible that species which regularly descend to 1000 metres of altitude, are nevertheless only present on mountains whose summits reach up to at least 2500 metres? Why does the tjemara tree (8-9)* abound on the mountains in East Java but is absent from West? What are the consequences of the presence of the vegetation in the mountains, so frequently enveloped in clouds, for the people who cherish their paddy in the lowlands? Is there a possibility to learn something from climbing the mountains and scrutinizing the plants? What is the way then to study them?

This book is intended to open up the way. Consisting of both plates and text, it observes the golden rule that looking and thinking are inseparable. It aims at being a book which can equally well be called popular as scientific. Certainly it is unprecedented in many ways, and whether its aim will be fulfilled, time will tell. It is more popular than many a scientist who is not an insider, will suspect, yet it contains more theory than many an amateur will guess. It deals with several aspects of the plant world on the mountains in Java which not earlier had been blended to an overall picture.

Data on the mountain flora of Java have been published during almost two centuries, in a labyrinth of literature, in various languages. Among the innumerable publications, there are a few works which for several reasons have a lot to teach. These have been selected to be mentioned for reference, and they will show the way to publications of more limited consequence.

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* Throughout this book a reference to the coloured plates is made by 2 figures separated by a hyphen, the first being that of the plate, the second that of the pictured plant species: in this case look at plate 8 for figure 9 where the drawing is of tjemara, *Casuarina junghuhniana.*

CHAPTER 2

HISTORICAL SKETCH

A well-known definition has it that science is organized knowledge. For this reason, all the knowledge of plants, animals and rocks, of trails and means to survive in tropical country, acquired by generations of native persons, do not make science, unless purposely communicated by way of the established channels so as to be publicly available. This channelling of results began in Europe; gradually the network of organization spread into the tropics: first incidentally, when private persons like Rumphius began to study nature.

The first to be sent from Europe for the purpose of botanical exploration was Carl Pehr Thunberg (1743-1828), a Swede and pupil of the great Linnaeus. Through the intermediary of Dutch patrons he stayed out for years as a surgeon-naturalist (1772-1779) at The Cape, Ceylon, Java and Japan (Backer, 1936a).* In Java he was twice, and during a half-year stay in 1777 it appears that he must have been the first scientific botanist who received glimpses of the Javanese mountain flora, viz. in Central Java behind Semarang, amongst others Mt. Ungaran & Salatiga and in West Java at Mégamendung below Puntjak Pass on Mt. Gedé and at Tjipanas. This is corroborated by his plant list publised 50 years later as 'Florida Javanica' (1825) and the herbarium we studied (Backer, c.s. 1950). He collected amongst others *Agrimonia* (44-1), *Anotis hirsute* (46-3), *Lobelia angulata* (7-9), *Nertera* (48-2) and even *Herminium* (37-5). In passing I remark that Mt. Ungaran is too low for *Herminium* and this must have come from Mt. Merbabu or Mt. Diëng.

Shortly after, in 1778, the Batavian Society for Arts & Sciences was founded by J. C. M. Radermacher and this facilitated and stimulated research of travelling scientists. Another Swedish botanist, Claes Fredric Hornstedt (1758-1809), a pupil of Thunberg who had in the mean time become professor of botany at Uppsala succeeding the son of Linnaeus, came to Java in 1783/84 and had a monthly allowance of the Society. We found no mountain plants in his collection at the Bergius Herbarium at Stockholm (S 1949), though it is known that he was at Mégamendung and Mt. Salak in April 1783.

Less meagre were the results of a Spaniard, Francisco de Norofia (? 1787 or 1788). He came in 1786 from Manila to Java for botanical exploration work with the support of the Governor General Alting. In 1787 he penetrated western Priangan and climbed Mt. Patuha via Bandung. He organized a real expedition of 3-4 months and had a suite of helpers and a Dutch draughtsman. His endeavour resulted in a big manuscript, some 111 plates with water-colour drawings of plants and probably also a herbarium. On return he was ill. At Djakarta he submitted a bill for travelling expenses which was considered so exorbitant, that Norofia left Java for Mauritius, taking all his collections with him. There this gifted, but ill-fated scientist died the year after. What is left of his great endeavour is a very large, most excellent, neatly composed MS in Latin and a set of his plates at the Paris Museum and the British Museum. Furthermore, he published a description of the *rasamala, Altingia excelsa* (23-4) and left a list of newly proposed species and genera, both published by the Batavian Society, the list containing also the vernacular names of the plants. His Javanese herbarium was apparently lost, but from the coloured drawings I have been able to identify all his newly proposed genera (S c.s. 1970).

On the 23rd of October 1793 a French Expedition vessel 'La Recherche' anchored near Surabaja and its crew and part of the staff were more or less interned. The Governor of East Java, Van Overstraten, took advantage of this and proposed to the surgeon-naturalist of the expedition, Louis Auguste Deschamps (1765 -1842), to start a study of the Javanese language and the flora. This engaged Deschamps for three full years (1795-1798). In this period he explored all important high moutains (Idjèn, Tengger, Lawu, Muriah, Merapi, Merbabu, Sumbing, Sindoro, Tjeremai, Papandajan, Guntur, Tangkuban Prahu and Gedé). Some 270 plants were drawn in water-colour (though few from the mountains) and probably he made also a large herbarium. Then he settled at Djakarta as a physician until 1802 when he sailed to Mauritius. His endeavour was, however, ill-fated as on his return voyage to France the British Navy took his collections as war booty and all what is left are his diary and his plates, which I have identified (S c.s. 1954).

Another French investigator was Louis Théodore Le(s)-chenault de la Tour, who was the botanist-naturalist on Baudin's expedition with the vessels 'Le Naturaliste' and 'Le Géographe'. He had fallen ill in Timor and was left behind. After recovery he went to Java and could make botanical investigations in Java with the support of N. Engelhard, the Governor of Northeast Java. He proposed the scientific name *Engelhardia* (later validated by Blume) for a magnificent tree of the mountain forest: the *ki hudjan* (24-1). In 1805 Leschenault with a small party climbed the Idjèn Plateau. Some of the mountain plants collected by him were later occasionally described by French colleagues at Paris; his MS on Java plants is in the archives of the Herbarium in Paris.

* A year mentioned in brackets after an author's name refers to an entry in the bibliography (References) at the end of this work where one can find the full title and reference. Papers of my own are often cited with an S preceding the year.

Thomas Horsfield (1773-1859) was an American; he visited Java for the first time in 1800 as a naval surgeon, and decided to return. From 1802-1810 he made extensive travels over Java in the employ of the Dutch Government. He enjoyed, again, the support of the Batavian Society, which put at his disposal a draughtsman of the Naval School at Semarang. In the British interregnum he served in the suite of Raffles, pursuing his work on Materia medica, botany, and zoology. He made a magnificent herbarium largely in Central and East Java, including collections of at least 16 mountains, from Mt. Karang in the west to Mt. Idjen in the east, superseding Deschamps's experience. After sailing for England in 1819, he became a Keeper of the East India Company Museum in London; he took with him a splendid collection which was put into the hands of R. Brown and J. J. Bennett. However, work on it proceeded very slowly and publication of their Tlantae Javanicae Rariores' (18 3 8-18 5 2) was completely forestalled by Blume's magnificent works. Besides, their important work contains only very few mountain plants and the colours of its plates are not always reliable, a shortcoming shared with similar large works of Blume, Korthals and Miquel. This is strictly avoided in the present work.

Shortly after the Napoleonic period, with the restoration of Dutch rule in Indonesia, the picture of scientific endeavour took an important turn. Hitherto explorers had made researches and returned to Europe, as they fortunately still do. It proved necessary, however, to give science also a permanent foothold in Indonesia itself, to establish an institution, equipped with one or more gardens, eventually complemented by a library and a Herbarium. This natural sciences centre came apart from the Batavian Society which had hitherto been instrumental in aiding occasional explorers. It came into being by the foundation of the Bogor Botanic Gardens ('s-Lands Plantentuin, now Lembaga Biologi Nasional) through Professor Caspar Georg Carl Reinwardt (1773-18 54), by decree on the 18th of May, 1817. He was charged with research on botany, zoology, agriculture, etc. This was also an excellent centre for the study of the Javanese mountain flora, as there are two large mountains in close vicinity of Bogor: Mt. Salak (2211 m) and the twin-summits of Mt. Ged6-Pangrango (2958 and 3019 m). On the north slope of the latter later a mountain garden was established, at Tjibodas, at 1450 m altitude. On May 5, 1817, Reinwardt had already climbed Mt. Salak. Later he examined many other mountains in West Java, amongst others Mt. Guntur which had then a great eruption. His name survives in the name of the botanical journal 'Reinwardtia' published by the Bogor Herbarium.

Apart from founding the Gardens the Dutch Government installed a "Commission for the Natural Sciences' ('Natuurkundige Commissie') the members of which were charged with scientific research on plants and animals, geology and geography, in order to discover the natural resources of Indonesia. Two of its earliest young members, close friends, were Heinrich Kuhl (1796-1821) and Johan Coenraad van Hasselt (1796-1823). They operated in West Java, climbing Mts Karang, Pulasari, Halimun, Salak and Ged£-Pangrango. 'At these tremendous altitudes', they wrote to Holland, "and in those cold regions we have come upon numerous lairs of Rhinoceros, and the tracks trodden by these animals through the northernly vegetation of these parts have served us as a means to reach the top.' They worked so hard to the neglect of themselves that they fell seriously ill and died soon one after another. They were accompanied by exceedingly fine draughtsmen, first G. van Raalten, then J. Th. Bik. The large collections and drawings of these promising, ill-fated young men came into the possession of the Bogor centre and we know the main records of their diligence through the publications of Blume who described their findings. The fine drawings were unfortunately not kept together but are scattered, partly at Bogor, partly at Leyden, but also in other herbaria, e.g. the orchid herbarium of Reichenbach. Their names are commemorated in many plant scientific names, and aptly so in two orchid species of *Dendrobium, D. hasseltii* (36-7) and *D. kuhlii* (36-8), two closely allied beautiful species reflecting their friendship, as these orchids grow together on Mt. Gedé in the mossy forest. Dr. J. J. Smith united their names in that of an orchid genus of Java, *Kuhlhasseltia.*

Carl Ludwig Blume (1796-1862), a medical doctor from Germany, who came to Java in 1818, was soon appointed as deputy director of the Bogor Gardens and in 1822 he succeeded Reinwardt as director. Blume knew many West Javanese mountains personally, e.g. Mts Salak, Ged6, Burangrang, Parang, Tangkuban Prahu, and Tjeremai. He was a man of great intellect and ambition, who enriched his institution—later the Rijksherbarium at Leyden, which he founded in 1829 and of which he was the first director—with everything he could lay hands on. These included, as we saw, in addition to his own, the materials of Reinwardt, Kuhl & Van Hasselt, and his Swiss collaborator Zi(p)pelius, who collected on Mt. Mégamendung near the Puntjak Pass on Mt. Gedé. Descriptions in his 'Bijdragen tot de Flora van Nederlandsch Indië' (1825-1827) are clear but very concise. His subsequent magnificent 3-volume folio work 'Flora Javae' (1828-1851) includes beautifully coloured plates of various plants from the montane regions of Java.

The most comprehensive contribution to the knowledge of the vegetation of the Javanese mountain plants—and hence, for a long time, the conclusion—we owe to Franz Wilhelm Junghuhn (1809-1864), who devoted much of his life to the exploration of Java; a man of immense enthusiasm, of great powers, broad vision, a stern individualist. His 'Topographische und naturwissenschaftliche Reisen durch Java' (1845) contains vivid memoirs of the mountain vegetation, largely extracted from his diaries, and certainly as instructive as the ones to be found in his later 4-volume masterwork "Java, zijne gedaante, zijn plantentooi en inwendige bouw' (1st ed. 1850-1854, 2nd ed. 1853-1854), particularly volume 1. He also published separate papers on plants, vegetation and landscapes in Java. His very important collections were, under Miquel's direction, described by specialists as 'Plantae Junghuhnianae' (1851-1856) and in Miquel's own 'Flora Indiae Batavae' (1854-1859).

Junghuhn's great achievements (Gedenkboek, 1910) are his excellent physiognomic descriptions of landscapes with their vegetation and his geological, physiographical and paleontological observations. Following Humboldt's work on South America he recognized a system of altitudinal zones with the species characteristic for each. He described the ecology of various plants and acknowledged a number of vegetation types of various lands, thus foreshadowing plant sociology. He was the first to give a clear account of the differences between the flora of East and that of West Java. He understood the great value of the forest for a proper maintenance of the hydrological balance and for this purpose he suggested to forbid to remove forest above the 1500 metres contour. As a naturalist he regretted the deforestation, especially in the eastern parts of Java and the increase of waste lalang land and fields. Junghuhn's works are still a mine of information and well worth reading. He loved the mountains until his last breath, at Lembang (Gedenkboek, 1910).

'Vividly I remember the forests', Junghuhn wrote at Leyden in 1851 (Introduction 'Java'), 'which over there are adorned with eternal green, the thousands of flowers, whose lovely scent never abates; through the ear of my mind I listen to the sea wind rustling through the bananas and through the tops of the palms—I perceive the thunderous splash of the waterfalls falling from high precipices in the heart of the country—it seems to me as if I inhale the cool morning air, as if I tread before the hospitable dwelling of the Javanese, while still a deep silence rests on the primeval forests enclosing me,—high over me in the air swarms of kalongs wing-flapping back to the region where they have their abode for the daytime,—gradually life and motion comes in the canopy of the woods,—peacocks strike up their loud shrieks, monkeys resume their lively play and wake up the echoes of the mountains with their morning cries,—thousands of birds start their warbling and even before the sun colours the eastern sky the majestic top of yonder mountain glows already in gold and purple, —out of that height beholding me as an old acquaintance, —my longing enhances and yearningly I look forward to the day when I shall again be able to say: *be saluted, thou mountains!*[9].

A contemporary of Junghuhn was Heinrich Zollinger (1818-18 5 9), a versatile, very capable botanist who in the years 1842-1848 collected on many Javanese mountains, especially in East Java. He was a professional collector selling large sets of his plants for a living. The comparative oblivion which fell to the lot of the modest Swiss was the fact that his work, amongst which are some excellent botanical reports of ascents, was overshadowed by the works of Junghuhn, who could work under much more favourable conditions.

After Junghuhn and Zollinger progress in the Javanese mountain flora slowed down for almost half a century, as if it had been taken for granted that they had exhausted the subject.

In the nineties Melchior Treub (1851-1910), the famous director of the Bogor Botanic Gardens, made efforts towards the making of a 'Flore de Buitenzorg' comprising the local flora from the mangrove of Djakarta up to the summit of Mt. Gedé-Pangrango. This would serve several purposes, as a botanical guide to scientific visitors of the Gardens, and to raise the interest of the public towards biology and thus for education. It never materialized and Treub probably did not realize that it would have to cover a great part of the flora of the whole of West Java. But it led to one excellent result, viz. a revision of all Javanese orchids by J. J. Smith (1905) of which so many inhabit the mountains. Another approach to a local flora was that by S. H. Koorders (1900-1902), who composed a List of Tosari plants of Mt. Tengger. About 1907 he was charged with the compilation of a mountain Flora of Java, but this proliferated into his 3-volume 'Exkursionsflora von Java', a highly uncritical work. Somewhat better is his 'Flora von Tjibodas' (1918-1923), but also this is a mere compilation. At present the entire mountain flora is incorporated satisfactorily in the complete 'Flora of Java' by Backer & Bakhuizen van den Brink Jr (1963-1968).

One facet of the ecology of the Javanese mountain flora was approached by F. C. von Faber (1880-1954), when head of the Foreigner's Laboratory at Bogor; he studied the crater flora of Java (1927). W. M. Docters van Leeuwen (1880-1964), director of the Botanic Gardens at Bogor from 1918 to 1932, made a prolonged study of the relations between animals and plants occurring in the higher parts of Mt. Gedé-Pangrango (1933), paying attention to the climate, flower biology, dispersal of seeds and fruits, periodicity and related subjects. He climbed many other Javanese mountains for comparative purpose and these are referred to in chapter 18. C. Schröter, to whom this book is also dedicated, wrote two attractive memoirs with notes on ecology and vegetation, one on Mt. Tengger (1928/29) and one on East Java in general (1928), on results obtained during excursions which he undertook with Backer when he was already over 70 years old, his second visit to Java.

My first experience with the Javanese mountain flora came already ten days after arrival in Java, December 1927, when Docters van Leeuwen kindly invited me to join him, Burgeffand Kniep on a collecting tour he conducted on the lower north slope of the classic Mt. Salak. This was soon followed by another excursion with Bakhuizen van den Brink Sr to its solfatara ('crater') on its south slope. To both of them I feel highly indebted for the kind and enthusiastic way in which they have introduced me as a newcomer to the Javanese flora. Half a year later I could make a longer stay at the beautiful mountain garden Tjibodas, with its 80 ha surface. From there my wife and I ascended the two high summits, Ged6 with its crater and the cone of Pangrango clad with mossy forest, via Tjibeureum with its swampy theatre below the waterfalls and the hot wells, all in the Nature Reserve adjoining the Gardens. This first reconnaissance made an unforgettable impression (S 1928) and in the evenings in the Kandangbadak hut on the saddle at some 2400 m height we thought and talked about the beautiful plants we had observed, all the problems cropping up about the nature of primary montane forest and subalpine scrub, its ecology, its composition, and the origin and distribution of its species on 'altitudinal islands' with confined to it many species of temperate genera living in cloudy heights. These aspects of plant-geography have ever since been a scientific challenge and led me to research on the entire tropical mountain flora (S 1934, 1961a, 1964, 1967a), both in the herbarium and in the field. I have not visited all mountains of Java. My experience is derived from stays on (from west to east) Mts Halimun, Salak, Gedé-Pangrango, Tangkuban Prahu, Patuha, Papandajan, Tjeremai, Slamat, Diëng, Ardjuno-Welirang, Dorowati, Tengger-Smeru, Jang, and Idjèn-Suket-Merapi. But on several I was many times and on some I could stay for prolonged periods which permitted detailed field work. Prolonged stays of one to two weeks were distinctly rewarding, permitting to comb at more leisure and with greater attention than is possible on swift crossings of the terrain, the brooklets and gullies, the marshes and ridges, and all other 'biotopes' off the trodden paths. A prolonged search on the very large Papandajan highlands (S 1930, 1932) uncovered a wealth of mountain plants which were never before found in West Java or even in the whole of Java on the more hurried trips by dozens of botanists before, onwards of Reinwardt's visit in 1818. My attention towards it was drawn by *Primula* which was occasionally found by a volcanologist. And the golden rule is that where one interesting plant is found more must occur: this led to the Papandajan exploration. The experience is, furthermore, that it is usually not the exact summit or summit ridge which is richest but the gullies and forest some 50-100 m lower down. Another hint, already made, is that one should pursue botanical detective work off the trodden path. I found in this way five new records of interesting mountain plants even on Mt. Gede (S 1941b, 1948a, 1952) which was assumed to be completely exhausted botanically. Surely Gede is not exhausted: certain marshlands and glades can be observed on its east slopes from the Gemuruh rim and these are completely unknown to botanists.

Though Mt. Papandajan is decidedly richer in temperate mountain plants as compared with Mt. Gedé, the latter is as magnificent as one can desire and is only at one hour drive by car from Bogor. Furthermore the mountain Gardens with their laboratory and the labelled trees in the Nature Reserve, the trained personnel, and other facilities stamp Tjibodas as the best centre for research work on mountain flora. Koorders's Flora and Docters van Leeuwen's book are here of considerable help and there is a good Catalogue of the Gardens.

As Tjibodas is so much bound up with the history and present research on mountain plants it seems not out of place to devote some paragraphs to its history. This goes back to the times of the famous Curator of the Botanic Gardens, J. E. Teysmann (1808-1882), a gardener employed at Bogor since 1830, never leaving the Indies since, except for a collecting trip to Siam. One of his jobs was to provide the Governor General with vegetables. And this led him to experiment, laying out a chain of garden plots at various heights, Tjiawi at 500 m, Tjisarua at 900 m, Sindanglaja at 1200 m, Tjipanas (the country-seat of His Excellency) at 1100 m, Tjibodas at 1450 m, Tjibeureum at 1750 m (left of the left waterfall), Kandangbadak at 2450 m, and even on the summit of Mt. Pangrango at 3000 m (Teysmann, 1855). He made these experiments onwards of 1830, those at Kandangbadak and Pangrango summit at about 1839, where Junghuhn found to his disgust on the summit his fairy-tale *Thibaudia* treelets partly replaced by cabbage, cauliflower, and planted trees of apples, apricots and pears. From that period must also date the famous beech (Coster, 1926). Teysmann was primarily a practical man but appeared to possess a truly scientific curiosity and eager power of observation. He tried all kinds of plants he could lay hands on, useful and ornamental, and many temperate crops. He transplanted some native plants (1856) from East Java *(Styphelia, Herberts)*, but said later that these failed to establish. On the whole these experimental plots at high altitude in the mossy forest were unsuccessful and they were abandoned at some time or another. The fruit trees grew stunted, were soon covered with lichens and obviously missed their seasonal growth. Remains of them are, however, still extant: on Pangrango summit there are still two *Fragarias*, a *Rubus (zi.fruticosus)*, *Cotoneaster*, *Pyrus mains*, and until some time ago the beech *(Fagus sylvatica)*. Near Kandangbadak stand a large *Cupressus* and *Rosa canina*; the hut is surrounded by a wilderness of *Rumex alpinus*, a nitrophile plant growing in similar fashion as around the Swiss alp huts; also at Tjibeureum some odd Teysmann relicts were found in my time, but none of the peaches, white lilies, roses and *Tropaeolum* mentioned by Docters van Leeuwen (1933: 8-9, 11), only *Neomarica caerulea*.

Of all these garden plots only Tjibodas, which was on the lower border of the forest, proved a suitable permanent site and this developed into a magnificent garden, for show, conservation and experiment. It served later ijiter alia also to save the cinchona introduction by Hasskarl. Junghuhn, who was in charge of the latter, insisted to plant the seedlings in the forest; ecologically this was well founded but practice showed it to be disastrous. Teysmann planted them in the open in beds where they grew like weeds, a method ever since followed.

In the 1870's the later director of the Bogor Gardens, R. H. C. C. Scheffer (1844-1880) had the gardens laid out in about the shape as they are now.

In 1889 Treub's suggestion was approved by the Government to incorporate the magnificent tract of forest covering 240 ha, adjoining the Gardens and reaching to the hot wells at 2000 m. It was later declared an official Nature Reserve.

In the nineties Koorders plotted and numbered trees in it which were critically named. In 1891 a spacious rest-house annex laboratory were installed where visiting botanists found quarters for study and a local herbarium and library for their orientation. In 1904 the large hut at Kandangbadak was built. In 1917 for the centenary celebration of the Bogor Gardens, scientists from all over the world contributed to a fund for a modern laboratory at Tjibodas, which was opened officially in 1920. In 1924 a small field laboratory was installed at Lebak Saät, near Kandangbadak, at 2400 m, while already in ± 1920 (?) Docters van Leeuwen had a small private abode built on the summit of Mt. Pangrango for his biological research.

In 1926 the Nature Reserve was extended in size up to the summits of Mt. Gedé-Pangrango covering some 1200 ha. It is precisely this Reserve which has been subject to so many scientific studies, that makes Tjibodas a treasure for international science. Such well-equipped and well-studied stations exist almost nowhere else in the tropics.

Shortly after the war, July 7, 1946, the Curator's house and the laboratory at Tjibodas were burned down by extremists for no good purpose. They were rebuilt in the years 1948-195 2.

In this concise historical survey I have by no means exhausted the literature on Javanese mountains and their exploration. More references to it are found in the book by Docters van Leeuwen (1933), in my own work (1934), and in 'A brief sketch of the Tjibodas mountain Garden* (1953) in which my wife and I gave a full history of Tjibodas with a bibliography.

About 50% of the plants depicted in this book are from the Nature Reserve Tjibodas-Ged6.

It is distinctly regrettable that with the rather recent transfer of all Nature Conservation matters to the Forestry Service, the unique Tjibodas Nature Reserve is no longer curated by Lembaga Biologi Nasional. It seems to me merely a formal matter to exempt this from the general rule and I make here an urgent plea for restoring it to the Botanic Gardens. To international tropical biology it is 'Holy Land' and it is the 'Mecca' for all those who want to make study of the Javanese mountain flora.

CHAPTER 3

THE JAVANESE MOUNTAINS AS VOLCANOES

Before coming to the vegetation and the plants we have to elucidate the environment: the substratum and the climate.

The Javanese mountains offer themselves in a great variety, but are all of one sort, namely volcanoes. This needs a concise introduction, because later various terms of volcanological phenomena will be used when biotopes are described. An extremely fine book on the Javanese volcanoes is that by Taverne (1926).

Mountain peaks occupy only a small portion of the total surface of Java, as an estimated 92% of its surface lies below the 1000 m contour, about 7% is at a height between 1000-2000 m altitude, and only a mere 0.7% is above 2000 m. The lofty kingdom of the real mountain flora consists therefore of several dozens of small, isolated summits, like minute cool islets above a tepid sea.

The location of the main volcanoes is given in fig. 1; of 34 volcanoes activity is known since 1600.

On the Indian Ocean side of Indonesia the islands are arranged according to two parallel ridges, elevations of the earth crust *(anticlines)*, and the islands are accordingly arranged in two arcs. The outer one is largely a submarine ridge carrying a few islands, those from Simalur to Enggano along Sumatra, Christmas I. south of Java, and Sumba and Timor. They are non-volcanic in origin and due to folding and uplift and are built up of sedimentary materials (sand, clay, chalk, gravel, etc.).

The inner arc is an anticline consisting basically also of a non-volcanic spine, the Barisan chain. In North Sumatra this mountain range reaches lofty height in the Gajo Lands but the Barisan proper dips southeastwards to attain sea-level about the Sunda Straits, continuing underground so to say under Java and the Lesser Sunda Is. as far as the Moluccas.

With the tensions and dislocations in such anticlines during the folding and upheaval *(orogenesis)* there occur weak points where the molten magma under enormous pressure can rise in columns *(magma shafts)* piercing (and partly melting) upper layers and bursting forward to the earth surface.

Hence in Sumatra we find many volcanoes from Atjeh to Sunda Straits strewn amidst the mountains of the igneous rock of the Barisan Range, but in Java and further eastwards all mountains of the arc extending to Wetar I. and curving then upwards to Banda I. are volcanic in origin.

If little gas is dissolved in the magma it pours out as a *lavastream* (phot. 71), if much gas is dissolved the eruption assumes the character of an explosive ash eruption (phot. 45 > 53) because on reaching the surface with its normal atmospheric pressure the gases expand suddenly and vacuolize and fragment the magma into particles and pieces of different size: from fine *tuff to* sand-like *ash* to *pumice*, *Iapilli*(± I/IOOO-I/IOO m^8) and *bombs* (> 1/10 m^3).

The ejected ash, especially the coarser particles will fall back on the mountain summit (phot. 66) and thus the active high volcanoes are crowned by very large, bare conical ash screes of unsorted lapilli, sand and rocks building up the mantle (phot. 53 & fig. 2-3), the finer dust dispersing much farther.

Volcanoes are capricious and the cause of their eruptions

Fig. i. The main mountains, all vnlcflnrjts, of Jiva *viiiii* then ultimo[1]? *m* **metre*.** Sr-ifc I : j*ooao»(that fr *I* cm = jo km- Two **content!** »TC drawn, the **outer** thin one encircling all upland country above 750 m altitude, che intict thtek tined ones all cnuntry above t;oom altitude, Summit* indicated by dots. Drawn ftom [H] Alias van Tmpnch N«lcrlarid\ 19J8,

u RtUwLarl, 1546 m
i. KaranR* 1778 m
3. HJHIILUJI VG'esi, 1929 m
4. Kalimun East. 1710 m
f. Siluk, illT m
6. ticdc-Pannranjc^* twin **VOtctaO.** IOIM m
7, Tangkubin I'MIUL. 208^ m (di *c Mv. tQ ir Htjr.ui lir.uiL', **1064 Til)**
K, HuliM **TUflggUJi** 75O<J m
v. **Ttanpoam,** if^.-t **m**
ID. Patuhn, 1454 m
11. TiJu. 104a rn
13. M?labax. ZJ30 in
IV \Vajan$_K$, 118i m
14. **Kjinijafia, JIK; m**
1^, rapdn-cla]'3'£i. **jfiu m**
[£. TjiVur*i, 1B11 m
17, Cwtttlfp 2149 m
iB, Galun^unn, 1241 m
19, Tjcrtinai, J078 m
20. Slinut,)4)2 m

11. Dicng Pliicau (with nummii G. Prnhu), zjfto m
*3b Sin-dcifO$_t$ ji^t m
2;. Sumhing, 3J77 m
14, **1** .ii^;ii;i]i$_L$ **iojo m**
1 Mcrbahu$_t$ 4142 m
I6K **Motapii** i^M IN
17, Muti^h, 1602 III
18. I.jiuu. 326^ m
>9- WilLi, 1^65 in
io- AP d|i &nv'To, 1281 m
31. \nL|Li[LU.\Vc]irynf;. ruin Vtikino, JJJ9 m
J,'' ticlud, 1751 m
SJ- Ka-wi-Tlumk^ **rvin VQlctUOj** 2S68 m
34. Ttnggcr (with bronujj, 177a *m*
jj. Smcru, 3676 m
36. **Jimp** Plateau (uiih summit Ar^upuro), joflS m
ii- RaunR$_F$ H^[1] ^
38. Idjcn Plateau {with aammu Siik^ci, jyjo m
59 Mcrapi f Kuwnh kljcn md Hanti), sBoo m
40. **Bftlima,** LL47 en

cannot always he traced, they may nr may n<n follow tectonic earthquakes. Then; is also no regularity in eruptions; a volcano which is thought extinct may get active -u'.iin qokc unexpectedly centuries later; others get truly extinct because their magma shaft has been blocked nr dislocated l>y deep subterranean shii'is :m<! cut off M • .in their feeding source, the magma chambers in (tie bowtls of the earth, at to-jo km depth.

The ejected material shows also great variety, even among successive eruptions, ami la vast reams and ash eruptions may be produced by the same volcano, wherein I lie mantle of the volcano liecumes CO consist of a large number of strata of different composition (Kg. i-j). If volcanoes emit many lavastreams in succession, as can lie observed on Mt- Ciuntur (phot. 71), there arc obvious intervals before one &im« exactly on top of another. In talus one often observes that in the time interval (he upper **pad** of each tavastream was exposed for a long time to weathering, as strata of solid rock are alternating with those of soil.

In Java the usual rock is andesite (an add tot it), basalt (a basic rock) being an exception. The a rule site may be sometimes very rich in silicium as in the unfertile sands of Mt. Kelud and the Ban tum tutfj.

Volcanoes in Java are otren clustered, like in Priangan; they may lie in a rinv, like Mis SindotO, Suinliing and Merbabu, and the four cones (if the Ardjuno-Welirang complex, obviously corresponding with a linear fracrurc zone in the earth's crust. They may be situated close together and form twin-volcanoes as for exam pit* Tarub and t.amongan, Mctung Krmna and Dicng, Tcngger and Smc-ru> Raung and Idjen. This may be caused either by deep underground forking *m* I;ranching of one magma shaft (fig. $), or they may gmw from separate magma shafts, from either a common or from scparvue magma chambers. These fused or *compoiite pott'twota* often form extensive highlands and plnrenux and are very irregular in outline against the sky as compared with the majestic single cones, such 35 for example Alts Sin mat, Tjcremai. l'enanggunang, and Fangrangu proper.

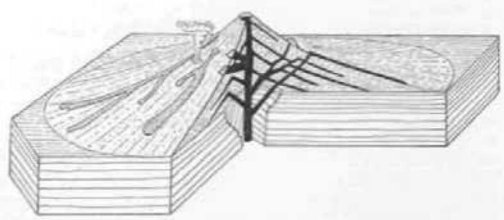
AlflO us to ultimate height of the volcanoes there is *an* astounding variety, some are small, others may grow to enormous size as Mt. Kerintji in ('enrral Sumatra ($800 m), Mi. Rindjani in l.ombok *(1716* m) and Mt. Smcru in BfSI Java (5676 m). The summit zones of these very high conical active volcanoes consist always of a debris cone with screes of ash and lapilli, all loose material, laborious to climb (two steps forward, one back) onwards of about }coo- }2<to m {Kerintji in Sumatra, Slamat, Smdru in Java and Rindjani in l^imbok).

The erupt 1. <n point at the summit or on the slope is generally a funnel- or howl-shaped hollow, ilie crater *(hm-tiii,* tig. *1}* often with an oblique to half-moon-shaped *crattt-rim,* caused by the outblow at eruption phases by which the ejected material on the summit builds up tn higher elevation lieyond the top of the magma column. The diameter of craters varies from a few hundreds of metres to a few km. In some cases a solidified, cooled

Fi^. z. Schematic diagram of a Mtconn of m active volcanic nummii, the ennica] KulUiw (enter) surruunJcd by the rim, itnoltc emitted by (lie **lent,** ihc (black) mij;ma shaft brintlit Jjl tJieupci, Ihc nimitk comixlng ufi pactict uf ash In ye« of JiifoHii conitttcncy an<l **ten.** vetting livinnuns, all ejected dining earlier eruptions.

magma is pushed slowly upwards without an eruption and then the summit is crowned by a dome-like *craterpjujr* such as found in Mts Gnlunggung and Sumbing,

One volcaruc cone may have more than one crater, by branchings of the magma shaft in the *maitllt* and form satellite cones, either within a large crater (Mt, Raung) or on the flanks of the mountain (fig* 5).



Fi^. $. Schematic section <*i(* ihtf Mruciurc uf A stttiplt\ virile **Mace*** volcano with a branched central *haft; *1* hranchci hive given rifcc **la** :i :-3n. 1h satellite Hank **conn,** *ii which thr left in ciupii^n. The v^jlcanic mantlt *i* built up *uf* layen i>f ash *Ami* lapilH, interspersed with A few igvasKcjtm, On the left fovoaticadiuua the lurnice uf the tkipe. All nuum.1 And **Mild udaiM** black (after EEscher. 1914).

The violence of volcanism can be tremendous, exceeding by far the power of any atnmic bomb, if one thinks of the cuasmiphir eruptions of Mt. Krakatau in I8BJ or Mt. Tamboni in Sumbawa in **1*15.** Tlie most disastrous ire those where with the eruption entire crater lakes (sometimts filled with hot add water) are thrown out, resulting in huge mudflows *(Jjot iaiiar)* avahnching with high speed and irrcsistable force (phot. 68} down the siopes for tens of kilometres (jo km from Bur ni Tilong in the Gajo Landsl), sometimes even reaching sea-level. In Java they are found predominantly in the cast. In the lxautiful work <*A* Vissering {191 o) the activities are recorded of the Mcrapi, Kclud and Smem lahars *(ktsttks);* amongst those of Mt. Smeru the best known are Besuk Sar and Besuk Semut, the latter in 1909 destroying every thing which came in its way over tto sq. kilometrest Their enormous air pressure may fell forest flat along their path. Such lahars may also originate if continued production of ash in the summit cinder zone lias piled up and becomes loosened by saturation during very heavy showers *(cold lahar)* (phut. M).

Still more sinister are the *fodus* (miee ardente) when heated rock of the summit is blasted off by expanding gas and tumbles down, on its way disintegrating and descending as a hot dust cloud with very high specific gravity, gaining in temperature in rolling down **wilt** tremendous speed. *Lucius* lay bare all forest in their way and even set it on fire, as observed by Loogen on the south slope of Mt. Smcru io September 1341.

On the summit and Hanks of active volcanoes also less violent, minor but still for the riura important, features are the *solfalam*, whete evaporated sulphut and sulphur oxides arc escaping (phot. 61); they are tiften bound up with other gaswells, emitting nitrogen and its oxides, small amounts of chlorine gas, etc., the total amount of which must be distinctly greater than the air pollution in industrial countries. The sulphur oxides are dissolved in the water of mist and vapour and blown around the solfatara, prickling the eyes. In other cases there are boiling *miid-*itlh* in which sulphur is dissolved.

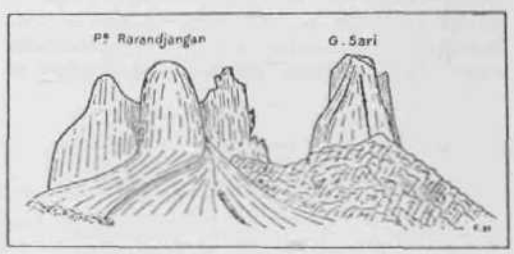
The hot rock underneath—sometimes very hot indeed, as in 1'apandsjan crater where at a few metres depth hundreds of centigrades are observed—causes *fn/mirales,* blowers of water-vapour which are of course especially well visible on wet, misty cold days and stronger in the wet season than in the dry one (phot. jR, 59). Finally there are *hot wills* mostly smelling of sulphur.

A special very large type of volcanoes is found in East Java whete Mt. Tengger and Mt. ldjtn (phot. 46) possess a so-called *caldera,* in which the 'craterrim' enclosing a iiutrish plateau is *a* dimension larger than a normal crater, viy. 10-1; km diameter, neatly approaching in size the smaller craters of the Moon. These summits have a wide truncated apes.

Inside these calderas as well as on their rim, secondary **volcanoes** ate often formed, on Mt. Tcngger e.g. Bromo, Batok and Widodaren, on Mt. Idjen: Sukct, Merapi, Kawah Idjtn, Pendil, etc. The caldera is partly due to vokanism, but gains its final shape by central tectonic subsidence. Within the caldera rim the plateau is silted up by ejected ash and lapilli from eruption points, and so are the craters themselves at the end ot" their eruptive phase. In this way *sand scat* originate, cither small (e.g. tin **top** nf Mt. Merapi-tdjin which has four of them) or very large as the huge Sandsea on Mi. Tcngger (phot. 46). Initially these sand seas arc barren (phot. 47 & JI) and because the **sandy** tufts are very porous—as well as the whole body of the volcano—they are also very arid: even after heavy rains water quickly drains away (phot. 4}). However, with the gradual silting up of rhe interstices in the mantle, permeability decreases, water becomes stagnant and crater lakes may be formed (phot. 69), especially in ihc extinction phase of the volcano. These arc in turn silted up by ash rains from mote distant crater eruptions, by which the lakes become more and more shallow (phot. 31). By further decay of the crater rim *M* the weakest place lake water succeeds in Ic-.iking and finally cutting through the rim. In this way a small stream is formed draining the lake, leaving the flat bottom as an *atooii,* a smaller or larger plain or plateau, surrounded by a broken rim (phot, IJ-iR, jo). This brotik or stream then reveals the origin of ihc akion (in East Java often coveted by tussock grass and called *siis-alun),* as it cuts through the material frum former eruptions sedimented in the turmer lake. An exemplary case is Tcgal Aloon Aloon on Mt. Papattdajan where the draining streamlet cuts through at least no thin 'layers' (neatly packed as in a layer cake, *fort lapis,* or *sptkkatk).* Each layer has the larger particles at base and the finer on top, because sorted during scdimentaiion in water, each layer the result of one ash rain. Between these layers one may find the subfossilized leaves of the mountain scruh treelcts (S 1931a}. Phut. 29.

To this panorama of active volcanism serving to csptain the origin of a multitude of **biotopea** in the Javanese mountains, must be added some words on the decay of volcanoes, in addition tu the origin of the aloons in extinct enter sites already mentioned above.

Extinction leads to *senility:* silling up of the interior of the mantle diminishes porosity, hence leads **to** the origin of wells, streams and stagnant water at steadily *higher* altitude. The very gradual cooling of the magma core leads reversely to 'descent* of solfatam and fumarolcs which eventually only persist at the Haie of the mountain. In the long process of the cooling of the interior 1 he heat of the magma shaft is longest preserved in the centre of the base of the volcano, the last vestige being hot wells. The place of extinct solfatara can easily be observed in the forest, by bleached, kaolin-like earth and a correspondingly meagre forest. If only hot wells are found at the mountain base, it is a testimony of senilityfMtsSan^Rabuwanaand Mumh), The complete senility ends in a *volcano ruin* and this is caused by *diffcrru/iu/ trillion.* As we have seen the mantle of a volcano (fig. i & j) is composed of a series of ash, rapidly cooled Inpilli, and lavastreams, and is fine-crystalline, unsolidified, and falls an easy victim In erosion. On the contrary, the core, the magma sWi(s), *a* cooling very slowly and is a solid andesite rock of large cry slab



Fig, +. Scheme of • volcanic ruin, iht mimma thaft* bot in KMrig crositm. **leading** i" viKaf-ioif-nhapedandcsiieconttaj Mt. Secilloin PilcmWi!. <•'. AKufwn "Mi SanKgabuTirini, ihc I'liiid pcakt G. Bongkok *tt Q,* Parani!. SVC. of Purwikim, »nd the Ti Lang-Rarandjingnn cV Sari knolls near SumcdanR (offer Escher, 1954).

which is far more resistant against erosion. By erosion the mantle of the volcano is so to say peeled off from the core. What happens in the last stages is that the solidified shafts come to stand out above the decaying mantle as one or more sharp peaks. At first the mountain is then crowned by a short rock peak, in shape resembling the former German helmet (the Tickelhaube'); at a later stage the cores become to stand free on their own. Mt. Serillo in Palembang is such an example of a senile volcano and east of Djakarta and Bogor is a complex of such sometimes inaccessible rock peaks marking the former existence of a Tertiary large volcano west of Mt. Sangabuwana (G. Rumpin, G. Aseupan, the sugar-loaf peak, etc.; S 1934c). Also near Plfcrfed there is a cluster of steep peaks, vestiges of a former huge volcano. Usually such peaks are now hardly 1000 m high, some are even much lower, and hence do not carry a true mountain flora; that was lost during the decay of the high mountain of which they formed only the core. Phot. 72; fig. 4.

Though one might think that measured by the accumulation of colossal quantities of ejected material volcanoes would grow rapidly to great height, this must be measured by the geological time scale. The time from the initial beginning and the senility stage of a sizeable volcano must be usually calculated to be one or more millions of years. And whereas eventually all fall into decay and others emerge, we must envisage that onwards of the Miocene period Java must have been a clustering of volcanoes. At some times it has not been a continuous land but an arc of larger and smaller volcanic islands like the inner arc of the Lesser Sunda Islands is now.

Above I have written about the disaster sometimes wrought by catastrophic volcanic eruptions, ash rains, lahars and ladus, which form a menace to the farmers. The Volcanological Survey was and is an active one, but can only prevent to degree, for example, by controlling the level of dangerous lakes as those on Mt. Kelud and Kawah Idj&n. Instruments are installed in remote, manned huts and concrete shelters to record small volcanic earthquakes and increase of surface temperature, forebodings of possible forthcoming eruptions, in order to release timely warning signals to the people in threatened sectors. But nobody can estimate the size and nature of what the tremendous forces have each time in store. So people are sometimes inclined to think of volcanism as an evil. Nothing is less true, as volcanism rejuvenates the fertility of the soil, by producing fresh mineral matter which by weathering will eventually be transformed into fertile soil. All the lowland soils are finally derived from volcanic action, all the clays, the marls and the rest; the source material for them comes down with the lahars, the ladus and with the rivers, often during floods (bandjirs). Besides, the river water contains the dissolved minerals from the mountain soils, as a natural fertilizer of the wet rice-fields.

So, volcanism is not an evil, but a blessing for Man. Java owes its fertility to it and can feed its teeming millions through it. Islands without the blessed volcanoes can never bear such density of population.

How did the plants manage in the chain of Javanese volcanoes?

Mountain plants had to follow their changing pattern, because they are bound to height, and they had to disperse from a decaying mountain to a new one coming up. This dynamic historic reality can of course not be fully reconstructed in detail, but it is clear that mountain plants are usually older—existed previously—than the mountains on which we find them now, as I have exposed in my study on the flora of Mt. Kinabalu, in North Borneo (S 1967a).

Another botanical generality which can be derived is that the greatest wealth of high-mountain plants will be found on the most ancient largest volcanoes, especially on those clustered together or those which are composite, with stabilized physiographic features, and extended highlands or volcanic ruins attaining sufficient height, hence provided with glades, marshes, swamps and streams, offering the full scale of biotopes. Because of the elevation effect (chapter 6) their peak(s) must at least attain some 2300-2500 m altitude and their highlands preferably be situated at some 1500-2000 m altitude. This explains why the botanically richest mountains of Java are Papandajan, Dieng, Ardjuno-Welirang, Tengger-Sm6ru, Jang and Idjfen. Reversely for example: the senile Mts Muriah, Halimun and even Salak are too low, Mts Kelud and Guntur are both too low and too active.

This thesis is of course not valid for the flora of the montane forest, in which for example Mt. Salak is distinctly rich.

Soils are not the subject of a special chapter. Their quality will be casually mentioned under the various accounts of vegetation. On the whole mountain soils do not offer very special niches or soil types with a special flora. Many are very young and unconsolidated. Near craters, on screes, lavastreams and lahars there is often no proper soil and no soil profile.

CHAPTER 4

THE CLIMATE

The tropical lowland climate is the most generous one (•» plant lift mi our globe. This has been so foe geological ages. The tropical flora has therefore never suffered deterioration by Ice Ages, desiccation and other calamities. This is the basic reason for its astounding richness, in fact it has been the ancient cradle of <he present plant world and the scene **of** a long and stead)' evolution **of** plant forms, at least of the seed plants.

IE is often pictured as monotonous with oppressive heat and can be so for periods in certain places, but no year is the same as the preceding one and forecasting is as difficult as in temperaic countries.

The montane climate is of course more varied than that of the lowland and results from a very complicated interplay of many variables on a base pattern uf"(i) a short-day diurnal regime, (ii) a regular decrease nf the shade-temperature with altitude, and (iii) an annual alternating regime of the southeastern!}* trade wind **or** dry monsoon during the northern summer (June to September) and the wet northwestern monsoon (November to March).

The last (annual) regime is very variable from year tt) year and, besides, the effects of both annual and diurnal regimes are essentially influenced by the *topography* of the mountains, causing *stnu-iiiy n»m* on windward sides and drought on leeward sides, effecting *c/oitditits!, sunshine „ precipitation, air humidity,* tivW, and *evaporation.*

Meteorological data (Braak, 1925-192;) show for each factor large extremes, and averages do not represent any 'normal climate*; averages only mediate extremes.

Rnally, also vegetation contributes to climate: apart from the fact thar forest damps off extremes in temperature and air humidity, it condensates also water from fog, a feature not entered in meteorological figures.

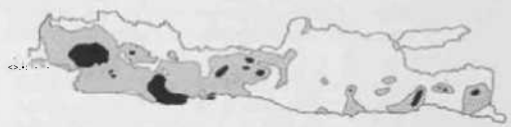
Admittedly the mountains have on the whole a cool climate. This is different fur plants and **active** rain; IIILTC is nothing 'cool' when hiking over rocky craterficlds, upen plateaus or a steep summit ash cone in the middle of a windstill day with the intense glow of the 'old Sol" overhead. But even the ascent along a trail in the shade of The forest at 1 normal steady climh of joo m gain in altitude per hour makes one sweat because of the very high relative stir humidity, and siiH so at night, when climbing along a forest trail with torches to see sunrise on the crest, where an Icy wind may blow and one freezes.

For plants the climatic variety is less in the forest, but still extrcmciy varied in exposed places, as to sunshine, wind and temperature, and that at short notice.

tt is clear that 1 can give here only a broad outline uf **retain** more common climatical rules and **situation*.**

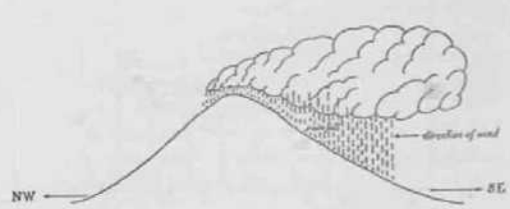
The relation of plant; tn climate will mostly be treated in the chapters on vegetation under the various bintopes, ahitlc iha conation, etc.

Rainfall can be measured by tile total annual amount in mm. In the Javanese mountains this is generally over ZQOQ mm, mostly even over jooo mm. Both **for.** the flora and for the soil formation these figures give insufficient information, because it docs not tell anything about the *dUtfibittfattthroughtJteyfdr:* it maybe evenly distributed over the ii months, but the jooo mm may also he concern rated in very rainy)-6 months, leaving the 01 her pan of the year with scarcely any rainfall. See for types of rainfall Boerema (1916) and for rainfall records Bcrlagc (1949). Biologists and soil scientists are therefore accusromed tn measure the wetness of the climate by the number nf months with minimum rainfall, more precisely by the number ot rainy days in the four consecutive driest months of the year, in other words by the length and strength **of** the dry period. Sec tor the meteorological records Bocrema (1931) and for details nf Ixitanical methodology and plant response the work of Mrs, Schippers-ljrnimettse (1965). The map in fig. j shows in a aimpiificd way the distribution **of** the



E'ig. j. V.VMJ'C **of r*iny days during ihc Fouj** drtersi **conHccmivc** rcvinths of the year. Ml ink *a-20* rainy d.iys **shaded 20-40,** and **hWL 40-83.**

numl>er of rainy days in Java: the major part of western Java shows even in this driest (better: less wet) period of 120 days 10-40 rainy days, with certain (black-dotted) areas within with even 40-R0 rainy days, including all mountnm*. In Tht: eastern luitt 1I± j;iv:i rhese almost ever-wet or cverwet areas t>ccur, however, scattered, as isolated 'wet islands' and it is conspicuous that they are situated on the south side of the mountains. This ***a*** because even the dry southeast wind in the dry season gives off rain against the south and sourhwest slopes by stowage (fig. G), that is by condensation beyond saturation point through cooling at higher altitude. Thus the higher southern slopes of Mts l.awu, Wilis, Ardjuno, Smiru, Jang, and Idjin become wet pockets ('islands') and consequently allow growth of mountain rain-forest plants. The northern



Fig, **6. Scheme of** Bttitt-ftgc! [jiiiLill lid u'iiidu':irj **tJda fa)** a seasonal **climate (Mt. Muiis. in Timor, drawn by Vrni B»),** slopes of these mountains are in this period of course **exposed** to extra dry iir masses. F"r example in **August** Polcudo at 7^0 m altitude on the south slope of ML ldjen receives 41G mm, hut Majurms at iotk> m 1 in the north slope (in the 'rain shadow'} only if mm. Local topographical factors may cause a similar effect inland, for example making the lower mountains Dorowati and J.amongan cvcrwcl.

Also in West Java the effect is visible, hut much weaker. S.C Eg. 7 & K.

Wild plants react on disrrihurion of rainfall, hut so do of course cultivated plants. Backer & van Slootcn (1924) gave for commercial tea cultivation :i minimum of jo rainy days in the 4 driest consecutive months of the year, and these l< loliiius ire exactly those where *Ncjlailhti* (33-;) occurs. Besides for agriculture ami forestry the mapping nfwinfall by this method is of essential value fur the understanding of the formation and qualities t>f soils, as Mohr has shown.

In West Java **the** mountain climate is everwet with an silmnsr equal rainfall of c. 3000-4000 mm per year up to jooo m altitude. And this is rather equally distributed throughout the year, with a short less wet period in July-August hut which still has 10 or more rainy days per month.

For the summit: of Mr. Pangrango the situation is expressed in fig. 7 & 8. From fig. 7, in which rainfall is expressed in mm/month, 'here appears to be still a distinct fall during the four dry months from June till September. However, if the rainfall during the same observari on period 1912-19)0 is measured by the number of rainy days, as done in fig. 8, it appears that the drought effect is heavily damped off, as there ire in the driest munrh July still 14 rainy days, which means th.it there is every other day a measurable amoum of r:iin! And tlitre!" must be added, as I will show further on, an additional amount of water which l>ecnmes available to the Pangrango plums by ab-

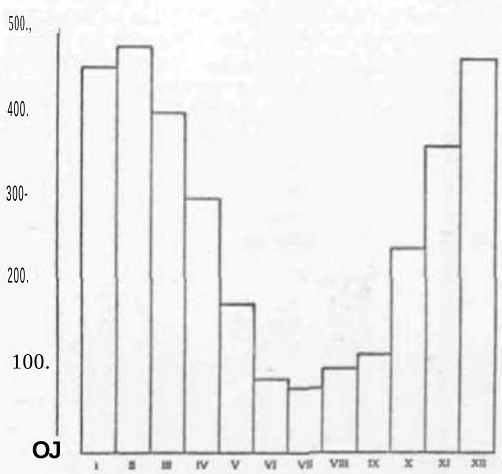


Fig. 7. Monthly avctagc* nt" rjiniUll ill mm on surtimii *vi* Mt. **Pangrango Jan. at 301;** m, **during I IK period 1917-19)0,**

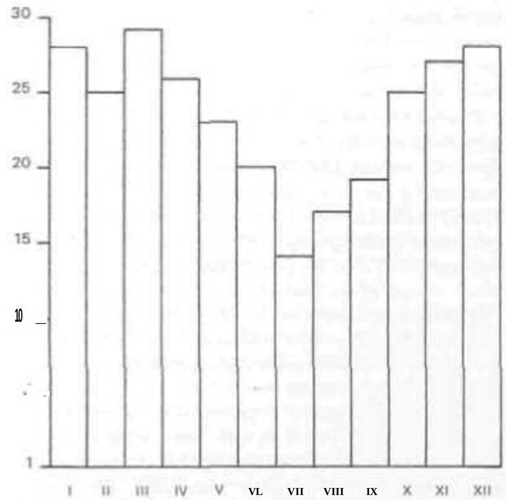


Fig. 8. Avcraxc number of rainy tjnyi per month irji **tuminit of Mt. PnngranKO, W«i |nvi, HE J021 m.** *'Vhc* **rotiil nnniril** *is* **iSi. Period** 1917-1930.

sorption from tht air and especially condensed from fog by the folbgc and the moss uf the forest. Unfortunately no figures of these **two uldidonil soonei of** water arc available.

Daily rainfall is usually in the afternoon, making hiking profitable in the hours l)eforc noon by rising early. In December-January there are often periods of rain the whole day round.

Great variations urc possible and exira dry years occur (in ilic period 1 US 1-1940 observed ten times); sec also Schmidt & van der Vecht (1951). It is quire an experience to hear at Tjibodas the huer crackle untJcrfont feir a few days, to sec *Agalinjk* (tt-t) with limp leaves and filmy iLtns shrivelled. Hut m my astonishment plants which I individually marked recovered completely from this temporary desiccation. Rennet (1932) studied the microscopic details of such wilting phenomena at Tjibodns and could prove rhe restoration with either saturated air or litjuid water. Rainforest trees react on spells of excessive drought by dropping more leaf than normal clearly to keep their evaporation in balance, similarly as observed in Australi.i.

In l-.J:r |.iv:i r.fiaLiil .it hiijli .flri'a.1|:<]I,-l]0-.J-.I*, more l i J;ll in West Java, but the difference between the dry and the «i pi-iiinl i\ In 1Less expresse1l ai **(.'oitipjrcii with the** situation in the lowland.

On sheltered plateaux and in depressions rainfall is nstutally less rhan on the outer slopes (rig. 9).

Climate is capricious and rainfall may be very uneven. For example in July-September 1914 the summit of Mt. l'angrangoat 3015 m received a total of 13 mm, but in 1911 during the same three months 460 mm. During tlic whole or die very dry ycaT 191J this summit received a nicrc Total of 1979 mm, but both in 1916 and 1917 over 4000 mm.

The maximal capacity of tropical showers is only fili^htly

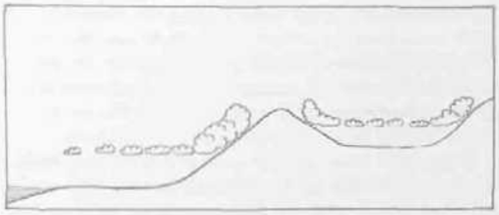
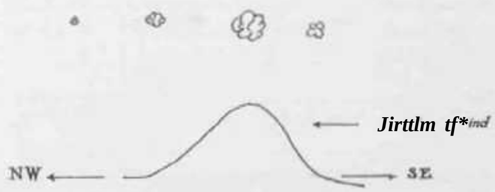


Fig. •,. Aicent of cloud **bull** fcotn the sci towudi **i** coastal mountain and on **i** pUiciu (Ptnjulcnfpn, ijoo m; niter Brisk).

exceeding those of Europe, but frequency and duration ait larger. A shower of ;o mm *fa* exceptional in Europe but common in Java. Rainfall maxima in Europe pec 14 hours are 140-545 mm, in Java stowage rains may attain 310-511 mm. Mnst evcru'er areas hove an 3nmv.1l rainfall **0V3(** jooo mm; the largest amount is found on (he saddles *ai* Mts Slamainnd Difng in Central Java, via. <joii-66j6mrn.

Which places of a mountain receive more rain, die slopes or the summit, has heenthe subject «f a vehement controversy between Junghuhn and Tcysmann: this is a matter of methodology and both were light *'in* a way: Junghuhn in that slopes receive more precipitation measured in mm and Teysm.tnn in that the number of rainy days increases with elevation.

Chnis originate almost entirely by cooling of ascending air, but summits are proportionally less cloudy thun si. .|U-s. ascontknxui'in results ins colbr **ofstnmsdouda, «ped-** *illy* in the dry setfson, ac an *altitude* of c. 2000 m. Sometimes small clouds are formed at or above the summits which cither dissolve or drift away in succession with small inicrvals(ftg, 10). In the wet season, however, a thick dimd cap may envelop mountain summits for days or even weeks.



Dg. TP. Schema *it?8* rci7ipj^arj' *clnud formaihm* aborc *3 small peak* In **Times** »nJ otiicrved b) the aullnif piver the mminii ui Mr. I'i-njm^uiEiin^ near Mi. Ardjuno (drawn by Van Bd).

Above the sea the altitudt; < >t **cunntU** fluctuates between 4;C-»TO m, above the coastal plains lwtwecn 700-1000 tn, but on high mountains, stations from 700-1000 m are usunlly free from fog and the cloud belt is situated at an :i!ti(u<tc of 1000 m(fig. 9). There is, Itencc, a snrt of telescoping effect caused by mass clcvitinn.

In [lie rainy season there is no fixed level for a proper cloud belt **md** i-unnili soon grow to thick clouds to far above the summits. In the dry season there is a more definite cloud bdt between c. IJOO and IJOO m, impeding formation of clouds above that level.

In the morning hours there is a marked difference **between** the cloud formation on the cast and west side of mountains, as the cumuii have a tendency to appear earlier on the casr slopes, both with west and east winds, due to the more intense insolation rm the cast slopes.

Mountain plateaux arc seldom covered by fill?, especially not when surrounded by ridges, and clouds art cither high above ihc^ruundor the air is dear (fig. 9). Stowing rlouils remain on **the ilopei** round these plateaux and **ue it** night ptnLTilly overturned nit' from the plateau. A carpet cloud may sometimes, in the morning, creep over the ridges of their rim **tacked bj** the ascciuting **til** on the plateau but is soon dissolved: such early *ckttd-Jiilh* occur especially **00 the** Tengger (phot. 49} and [djen caldcr.is (S 1555c). By the strong eradiation during the night *3* thin layer of cold air is often formed on plateaux at 1000-ajoo m causing morning ground log and formation of dew.

The *rthtivt air humidity* is usually very high in the high mountain friresr, especially at night by the lowering of temperature. This is also found on peaks because of the ascending heated lowland air cooling at higher altitude. In the dry months the high peaks show an increase nf **humidity** during the daytime, but may be very dry during ihe niglit as shown in fig. 11 **of** the mossy focesi clad sum-

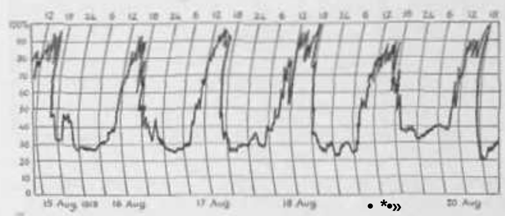


Fig. II. "Hit- iil:;iivi. **ill** huitiidhf curve during tin day*, *i*Aug. 15-20, I91J, on the summit of Mi, Pungrnngu, Wc*if Java, at $0:5 in; .II.LI.H r(1 Uriu Tur E}IC **dry** hcasfjn: during itic daytimcr humid Rif **ucendi** ulimu the slopes, during **the** night ihe upper lir of ja% humid iry tiai siiprcmmr ("ftet Uriik}.

mit of Mt. P.mi;rjnf;o in West Java; on July j ist, 1915, even only 6% was measured. In Kast Java air humidity may be below io% at altitudes of 1500-5600 m in July-August

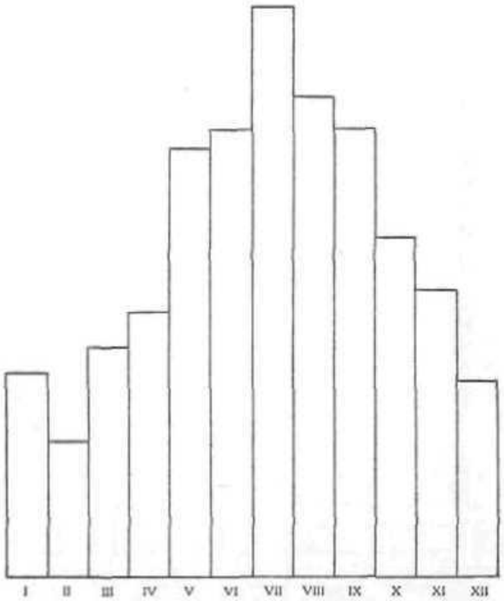
On plateaux the relative .iir humidity in the daytime is decided!)- less than thut *i/n* slopes and peaks but the humidity of the mosily stagnant air incir.iscv during the **night** by **cooling and** evaporation of dew and water exuded by hydatbodes **of** plants themselves. The fallinj; of dew is remarkably common for which nightly eradiation and windless nights arc responsible.

Generally the daily variation is much higher in the dry as compared with the wet season. On Ml. Pangrango, on Sept. iBth, 1918, it varied from 8 to 100 "...

Mooing bite and mist occur easily above lakes and swamps, on plateaux, Hats, glades and in valleys, especially :ilicr evening rain followed by a **deal night**

Stmshtnt. It is of course dear that as a rule the amount **sf** Minsliine will be highest in the dry months and the

distribution curve river the months of the year will show *i* reverse as compared wirh that of the distribution of rainfall, as rainfall will lie associated with dotidiness and fog. This is also expressed nn the summit **of PaogDUlgO of** which the figures are given in Jig- 11. if we compare this with the curve of fig. *T Set.*



Fig, IL Muiuhlv average* of nunshiflc ofl top *of* MI. Pangrango, **Wot Jivi, «** JOJJ **m, Pedod** i^n-191).

Eist slopes receive more sunshine than west slopes, as mornings are generally clear and afternoons cluudy. He cause Java is situated at 7° south, north sides receive mure sunshine than south sides. See Schmidt (ijjo) who summarized duration *iif* suraliine *in* **Jara.**

Certain trees seem sensitive to this and respond by a slightly oblique growth of the stem. In the lowland this is observed in certain rubber clones and in the mountains I have suggested this also to happen with *Albiya hphantha*

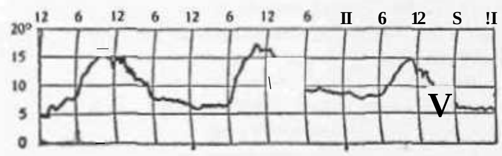
Flowers *oiCcn/iarta* (10-2) and *Tbtijmilra* (34-7) are only open in sunshine, but that depends on heat, not on light [sec explanation to the plates).

Visibility is greatest on dry cle»* days in *« *"3*9* **fewoa** and from Mr. Pan/jrango one may discern the masts of ship) anchoring in the Bay of Djakarta at 75 km in a Straight line and sec (he summit of Mt. Tjcremai in the far linLinceat ijo km. In the dry season dust in the air hangs up HI (OCKI m altitutk-, **erasing** haze.

In **connection wMl** lifiht a hint to photographers of landscape, vegetation and plants: make yuur photographs preferably either in the morning between 9 and 10 ' d t or in the afternoon between 4 and j.)0. Blaauw (1917) gave some hints for colour **photography** and Vrij (1930) tor problem') of black and M'hitc, showing that the amount of IJV is, in the tropics, not less than in temperate countries as sometimes suggested.

TtBtfitrdttirt. Naturally, the average (sl>ade) rempcr.uurc decreases with altitude. According to rhe standarilwork by C Braak (igij-tpii) the average at sea-level is i6.3"C and decreases with 0.61 "per 100 m height, to become 14.1° at 1000 tn| from then on the decrease is 0.52" C per too no, hence temperature Incomes zero at c. 4700 m, which ci >rresp[mils with the etemnl snow level in the alps **of** Irian. ***Snow*** is unknown even on the highest peaks in Java. *Hail* is observed, but is not peculiar to high altitude and may accompany (very rarely) heavy rainstotms even at sea-level in the tropical lowland. There are no indications whatsoever that *glai-iatioit* of the high summiis occurred in Java during the Pleistocene Ice ARE. It is estimated that during this epfurh climatic contours in Malesia were lowered for possibly ;oo m at very high altitude and not for more than 300 m at medium altitudes, corresponding with a universal lowering of temperature **of** 1-3" C.

On summits there occur great fluctuations in temperature, especially in the daily regime during the dry season. This appears fmm the record made during three subsequent days, July 15-17, nf which rhe curve is reproduced in fig. 1). Also cm a sunny day one hour interruption by an enveloping cloud or fog will effect at short notice * distinct fall **of** temperature and the ecology of plants must be adapred m these fluctuations.



l'ij<. i). Tempccntiin curve on summh of Mt. Pangnngo, Wot Javu, it)oij m. during ihicc <I>>», **11-17** July, in the dry jeason.

a. *Frost in tit matattaim*

Trost, on *the* other hand, is of regular occurrence in the Javanese mountains and this deserves some explanation as its origin *is* often wrongly understood (S 1968).

Frost is caused by eradiation inwards outward space in the gradient mentioned above. It causes that above Djakarta the average air temperature at 1000 m altitude is i J* C below zcr< > by day and night the year round, to drop at 10.000 m to it>° C below zero and at)j.000 m to jt" C below zero, a figure comparable to the lowest temperature measured in Siberia. These plain facts, now commonly announced *to* the public in aeroplane tratlic, remind us of the extremely thin **ifed!** in which biological evolution developed on our remarkable planet.

Eradiation is hence proceeding by day and by night, but in the daytime it is compensated by the insolation of the blessed sun.

Eradiation evolves from all exposed surfaces, water, the beach, the soil, the leaves of plants, but also from decayed material as withered grass, dead twigs, etc. It causes them to cool and in this way the air in contact with the eradiating surface is also cooled.

There are five factors counteracting the continuous cooling, all of which can easily be understood.

First, the sun heat coming in during daytime and below the altitude of eternal snow is sufficient to keep frost away, but it follows that this capacity decreases with altitude because the 'starting temperature* becomes more favourable at higher altitudes.

The second factor is that cooled air is heavier than non-cooled air, from which follows that the very thin layer of cooled air in contact with the subjects sinks down and becomes then mixed with warmer air. Furthermore, it is clear that wind will counteract accumulation of frosted air while stagnant air favours the accumulation of it.

The third factor is, that eradiation is hampered by all substances above the eradiating surface which absorb radiation, that is in practice dust, fog and clouds, but also saturated moist air. From this follows again that frost is favoured by clean dry atmospheric conditions.

The fourth factor is that the cooling of the eradiating subjects mentioned is compensated by heat conducted from the substratum and the amount will hence depend on their conductivity. It follows that rocks, water surfaces and living plants will not or much slower cool as compared with dry dead twigs or dry withered grass and dry sandy soil or lapilli which possess high insulating capacity by their low conductivity.

Fifth, there is the topography of the terrain: it is easily understood that it is of pre-eminent importance for the accumulation of cooled air that it remains stagnant, from which appears that hollows and depressions in the terrain are most liable to get a ground layer of stagnant frosted air. Such places are called 'frost pockets'. They are very common in the Javanese mountains in aloons and sawahans, silted up vestiges of former craters.

From the rules mentioned above it can easily be understood that the lower the initial temperature at the beginning of the night and the clearer the atmosphere, the more stagnant the air, and the more flat the hollow is, the earlier one can expect frost.

These conditions are often found together in the dry period and especially on the high plateaux and aloons at 2000 m and higher, e.g. on Mts Papandajan, Diĕng, Tengger, Jang, and Idjèn. Late night temperatures measured close to the soil just before dawn on Mt. Papandajan came down to 5-10^0 C below zero! They last of course not very long. But on such mornings the plains are white with hoar-frost, especially the dry withered grass-blades, and on shallow puddles a thin ice-crust can be formed. The hoar-frost is hot entirely due to freezing of fog or undercooled mist, but also to freezing of water excreted by hydathodes of tips of grass leaves while crenations of *Alchemilla* (44-2) leaves show a characteristic accumulation of ice crystals. The frosty appearance in the brisk air of the early morning is a remarkable sight in the tropics. The phenomenon is of course only observed in the dry season and not every year.

It is in that period that on the plains of the Jang plateau the rutting stags are bellowing, eager to measure their strength and to bump their antlers against each other with a dull sound, after having brought themselves to excitement by browsing on the man-tall stinging nettles, *Urtica* (55-6) and *Girardinia palmata* (55-4), according to Mr. Ledeboer.

How high frost air layers can be built up during one night is not quite certain but 2 m seems to be about the maximum.

At lower altitudes, 1000-1500 m, the occurrence of frost is of course entirely restricted to pockets because many favourable conditions must work together towards the same end. Furthermore, to cope with the higher initial temperature, frost is then mostly restricted to after a sequence of some preceding overcast days alternating with clear nights effecting the lowest possible 'starting temperature* on the critical night.

In passing it may be mentioned that the lowest frost hole known is at Blawan on the north side of Idj&n caldera, at 900 m.

Certain tea and cinchona estates may severely suffer from frost and it is surprising how rapidly frost can set in and how large the variation of temperature can be. At the tea estate Kertosarie (Priangan) Braak measured (with thermometers in cages with slatted blinds) on August 20-21 st, 1923, an afternoon air temperature of 23^0 C and a late night one of — 2^0 C, a difference of 25 centigrades within 12 hours!

At the same tea estate the great majority of frosty nights were observed in July-August (period from 1911-1922). Further it was observed that especially in very dry years (hence clear nights) frost nights occurred continuing sometimes in September and October, the totals being in 1914: 31, 1915: 24, 1918: 38, and in 1922: 27.

A most illustrative paper on frost in Javanese tea estates is by Vrolijk (1934), who described the damage to tea on the Pfengalfengan Plateau (Priangan) in the very dry monsoon of 1934, August 13-14^, when temperature between tea bushes was down to 4-8^0 C below zero. Tea died as far as the base at Kertosari, Sedep, Talun, Santoso, Wanasuka and Lodaja estates. The winter scene was interrupted by the green ridges left free of frost. In the ravines near Santoso trees of 4-6 m height were frozen by overflow of frozen air. High uniform shade of planted *Acacia elata* trees proved to be an efficient permanent protection against frost. Of course the same amount of eradiation is given off by the *Acacia*^ but so far above the ground that by sinking the frosted air is mixed with a much larger volume of other air and does not reach zero point. When severely frozen, tea bushes need deep-pruning to recover.

Another device to prevent frost is the timely laying of a smoke screen to hamper eradiation. The newest device in temperate countries is to make budding fruit trees wet by fine water spray as a thin layer of ice protects the buds. An interesting permanent device was used in the tea estate near Situ Gunung (above Sukabumi on S. Gedé) where the hollow of the tea estate was provided with very deep (3-4 m) channels, some 40 cm wide, to drain the cooled air off the estate.

This latter device is also found in nature because in shallow sawahans and aloons frosted air may flow over the lowest point of their rim and is thus drained away as an invisible waterfall. Such overflow places on Mt. Tengger-Sméru are characterized by a profuse growth of *Pennisetum alopecuroides* (22-3) and *Microstegium ciliatum*, which seem well resistant. This does not infer, however, that other native subalpine plants are not equally resistant, in fact all are. I have never observed plants injured by frost except possibly on a barren exposed pass between the summits of Mt. Jang where *Hypericum leschenaultii* (23-6) grew extremely poor, but heavy dry winds may have caused this.

I have also observed this frost air drainage from the patana plains of Nuwara Eliya in Ceylon but there some native bushes had distinctly suffered from frost damage.

Posthumus believed to have found traces of cryogene effects in the soil by frost in some sawahans on Mt. Tengger, but I found his evidence inconvincing and believe the small holes he found in the lowest part were small waterholes trampled by deer. An effect which I ascribe to repeated freezing is the *mummification* of withered plant parts which get an ash-grey colour and when touched and rubbed easily fall to a fine amorphous dust. These powdery skeletons I first found in a large-leaved *Hedyotis* in the Gajo Lands (S 1939), but later I observed the same phenomenon in grasses (*Pennisetum* (22-3) and *Festuca* (22-12)) in frost pockets in Java.

b. *Comparison of temperate and tropical frost*

One might assume that native plants which easily stand tropical frost at altitudes of 2000-3200 m will prove to be hardy in temperate countries. But this is not so. The Javanese *Primula prolifera* (42-4) is, even in England, not or practically not hardy. Tropical frost is of course given in small bits, for a few hours each day soon followed by warming up, whereas the frost of the temperate zone is seasonal, when growth is mostly at a standstill. I believe it is the lack of adaptation to a resting period that makes tropical mountain plants unsuitable to withstand temperate seasonal frost. I point in this respect to *Primula prolifera* strains from the Himalayas which are hardy and also to the well-known fact that even very hardy Swiss alpine plants sprouting in early spring are often severely damaged by dry late frost (without snow) when spring growth has already set in.

c. *The origin of the highland grass glades*

The origin and persistence of the highland grass glades is by laymen sometimes ascribed to frost, but this is based on a serious misunderstanding as will be explained in chapter 12 a & c: they are due to fire and maintained by fire and grazing deer.

d. *The influence of vegetation on climate*

There is no unanimity of opinion whether the macroclimate is influenced by the presence of vegetation, e.g. by stimulating cloud formation through evaporation, etc.

But it is beyond doubt that vegetation, especially forest, is of manifest importance for the amelioration of climate in favour of the land, for the forming of soils, for preventing erosion and landslides by the roots, for preventing wind erosion, for creation of many ecological niches for specialized plants, and for serving as a huge sponge buffering off-flow of water thereby regulating the supply of wells, streams, and rivers on which the welfare of lowland cultivated area depends.

Rainfall is measured by meteorological instruments in the open. These figures are in the mountains always lower than in the forest. Braak (1920) himself already casually remarked that in East Java wet fog profusely condenses on the tjemara twigs on Mt. Idjen resulting into a constant dripping. This is certainly also true of leafy forest in the cloud belt though possibly to a less degree. It must be considerable, however, in the mossy forest which is often a saturated sponge without actual rain falling.

Absorption of atmospheric water also happens in the high forest, as is shown by the careful observations under cover made by Went (1940) in the forest above Tjibodas whereby it was shown that orchids suspended in air and protected from rain are capable to absorb atmospheric water from saturated air.

There is a third situation in which supply of water does not appear from meteorological figures and which also means an addition to them. That is the formation of *dew* in the early morning, an effect which is of course well-known from arid regions; I observed this in profusion in the dry blue-bush country in South Australia. This occurs especially on flat or slightly depressed plateaux, for example on Mts Papandajan, Diëng and Jang, where ground fogs are common due to eradiation followed by an increase of air humidity beyond saturation point. Though the water produced is partly derived by guttation from the plants themselves (see p. 15) the air is the major source of dew.

Unfortunately no exact figures are known to estimate how much water is supplied to the vegetation by these three sources.

e. *Plants as climate indicators*

The response of plants to temperature will be treated in chapter 5.

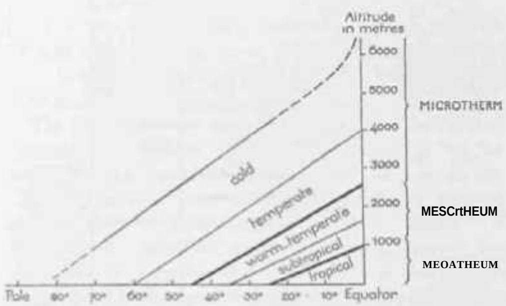
As to rainfall and air humidity already some remarks were made above. Mossy forest is a sure indicator of an everwet climate. So are massed epiphytic ferns and orchids and microscopic epiphyllous algae and lichens. Among the ferns clear indicators are the filmy ferns *(Hymenophylla-ttm), Dicramptrrh,* and *Cltkluiiia.* Furthermore *Neprmhts* (3J-5) a(id many other evcrwet forest undergrowth plants, such as *Agalmyla* (11-1), *Ehtostema* (j6-*), *Piha mtlaslo-mni^es* (56-4), *Gatce/j jmianica* [37-4), *Argisitmrta (46-6 &* 7), *Corybai* (}4-6, 37-1) and many others.

The 5tile occurrence of beard-moss, the grey lichen *Ustiea,* in trees indicates a wet climate tn some degree, but **not** necessarily an ***mrwn* climate.**

CHAPTER 5

ALTITUDINAL ZONATION

As .invwlitrc in the world decrease of temperature with altitude will have a zonation or girdling effect, in a rough way imitating in a vertical direction the zonarion caused by latitude, from the equator to the poles. 1'ig. 14 represents a schematic illustration of the identification of akitudina] v. iiii latitudinal zonw.



Pig. 14. Scheme of gdnjtiri! itirrmo-ccnlogiral concepts: *mimllxrm planti* arc thainciciis™ of cold and icmpciaic climatic condltluu, *mtiattar/a planli* nf warm-lcmpcratc and Kubrrnpicjl cliiPSTlc con-diiioni, *mr$i!btrm p!natl* ace ret[tided to the tropical 2onc.

The lifc-Apacc of these ftHflrirJT'l b hurt: <]iji'rjmmatu-.i]k cocifr latcd with latitude and tropical altitude. Mcsnthcrnn 1J In the njua-lotiul Mjnt equfcnlMI to *Impital-numliM,* icinjicriiK-TniiTDihcrm to *frapi(fif-fiit/iifpitw,* culd-micrutherrn to *irvpfcai-alpHK.*

The response of the plant world to these temperature zones results into a sorting out of plants of different 6O logical sensitivity or tolerance. Tliere appears to be a great degree of agreement between Latitudinal and altitu-dinal response which again proves that temperature is the essential, underlying cause. Sonic plants or plant groups cm iinly ilirivc In hot regions, have a *mcgatlnrm* ecology, and arc heaped m the equatorial zone but occur there consequently only at low altitude. Others prefer ;L coi^l climate, have *x ssttillxrm* ecology, are confined to middle latitudes, and consequently occur at tropical-ninntanc altitudes, A third gruup lias a *mkrolherm* ecology and definitely prefers high latitudes and is restricted to the cold climate of high altitudes.

The experience is that these ecological preferences are deeply rooted in the genetics of plant lineages and have generally remained constant in [heir evolution. Ample proof of this i* found in die fossil record acid in the present distribution uf the lineages, of bodi genera and families. Conversely one might conclude with Scward that plants can be used as thermometers of the past, which conclusion grants the study of altitudinal donation a profound im-portance for the understanding *nf* their distribution, past and present. This is again of manifest importance for fathoming the way in which they attained their present stations on our globe, f-urthcrmore a reliable and full fossil record may yield essential dara on pabteoclimates.

The tropics filter a unique insight in rhese problems, because all nones, from the tropical to the frigid, are often present, in Indonesia c.$(. in West Irian whetc vegetation can be studied frum the tnipied bench up to several lofty peaks capped by eternal snow and glaciers and where a climatic treeline and snowline are developed under sutund conditions.

One can view biological zorurion of forest by three aspects, (i) the altitudinal zonation of terrain dominant trees, or (ii) as to overall floristic composition, ur (iii) to [he physiognomy of vegetation, whereby it must be realized thai the physiognomy of vegetation depends in last instance of course on tloristic composition.

The mountain vegetation is, however, of such mised character that the singling out of for example *rasamaia* (1J-4) or *Podocerptis imbricates* (i]-i) or *Podetorpus iterii-fnHiii* (ij-t) would do injustice to species of *Utbocarpus, Cttstannpsis* and other characteristic trees, each of these having its own altitudinal ecology, as well as to the equally important smaller trees, shrubs and herbs. Tor that reason it is advisable *u>* analyse the Htira us a whole and not to discriminate between species.

It must be turthcr realized that breaking up a continuum, as nature largely is, into zones means to define demarca-tions only ti> *2* certain extent, marking transitions where one Kone passes into the next. This can naturally only IJC achieved in an arbitrary way in taking both Soristics and vegetation into account, in a similar way as is done in vcgctatiology with formations and associations. Demar-cations mean then statistically defined narrowest fixation of transitions for convenience.

This would be all well and fiui.d if natural vegetation were undisturbed, but in chapter } we have seen that the Javanese mountain vegetation is to no mean degree disturbed by volcanic phenomena, so that fur ciamplc the application of the term 'alpine' to a treeless zone below the climatic tree line becomes invalid. More precisely, the treeless upper zone in Java is not comparable at all with that in New Guinean alps where it is defined by climate alone.

Let us try to define floristical zones and then see how far these can be integrated with vegetation zones, the subject with which Junghuhn was mostly concerned and which von Humboldt had initiated early in the 19th century with his work on the American Andes.

The statistical methodology for this, in Europe first used by Sendtner, is simple: of each species the lowest and highest records are tabulated as both lowest and highest localities mark a break. All records are then summarized, the total of figures being of course twice the number of species used for the statistics.

I have applied this method of analysis in my 'Origin' (1934) to about 900 Malesian mountain species and the result is given in Table 1. Admittedly this was confined to species belonging to (microtherm) genera of which no species is found below 1000 m. I have no doubt, however, that a statistics of all Javanese plants will yield a similar result. This could be easily made now, on the basis of the recently published Flora of Java and would be an attractive subject for an advanced student.

In this tabulation I have also integrated the zonation of the zones below 1000 m and furthermore identified the floristic results of the figure columns with vegetation zones. The names of the zones I have adapted to the concepts used in Europe where there are two fixed climatic demarcations, viz. the tree and snow limits. Below the tree limit there appear to be two other demarcations, viz. at about 1000 and 2400 m respectively.

The first, between the lowland/colline and the montane zone, at 1000 m, is largely floristical, as the true tropical lowland *(megatherm)* plant families as e.g. *Anacardiaceae, Burseraceae, Capparaceae, Combretaceae, Connaraceae, Dilleniaceae, Dipterocarpaceae, Flacourtiaceae, Marantaceae, Myristicaceae, Rhiv^pphoraceae,* and many others are restricted or almost so to the zone below 1000 m. Conversely a number of cold-loving *(microtherm)* families and hundreds of genera are found only onwards of the 1000 m contour and their names must sound familiar to botanists in the northern hemisphere; to mention a few: *Anemone, Aster; Berberis, Cirsium, Galium, Lonicera, Myosotis, Primula, Ranunculus, Stellaria, Valeriana, Veronica, Viola-*, or to botanists of the cool and cold parts of the southern hemisphere, as for example *Caladenia, Gaultheria, Gunnera, Microlaena, Microtis, Nertera, Tbelymitra, Wablenbergia.*

The second break in the forest zone separating the montane and subalpine zone, at 2400 m, is distinct by floristic change but also by a change in the physiognomical aspect of the forest which below that altitude has a high canopy with lower storeys, but beyond it continues as a lower, denser, thinner-stemmed, lighter forest with only a rather even canopy.

It should of course be emphasized that these demarcations should not be taken too literally and are statistical, hence arbitrary as to precision, but on the other hand they undeniably reflect the general aspect of botanical zonation.

Local factors may cause local deviations, for example a narrow, shaded gorge will depress the botanical contours, limestone rock may push them somewhat up, and volcanic activity or deforestation may obscure them.

TABLE 1

Orographic boundaries of the Malesian mountain flora as found with the Sendtner method. Floristic demarcations are correlated with vegetation zones. See further the text.

Altitude in m	*Lowest limits*	*Highest limits*	*Totals*			
I -				LITTORAL ZONE (Seegrass and Algae)	MARINE ZONE	
—I—I				MANGROVE	TROPICAL ZONE	
I-I				STRAND-flora		
1-5				BARRINGTONIA-formation & DUNES		
5- SOO				LOWLAND ZONE		
500-1000				COLLINE ZONE		
1000	"4	20	'34	Closed high-stemmed forest poor in moss	SUBMONTANE ZONE	NATURAL ARBORESCENT VEGETATION
IIOO	13	11	24			
I2OO	44	11	55			
1300	33	16	59			
1400	48	13	61			
IJOO	61	39	100			
1600	2J	11	36	Closed high-stemmed forest above 2000 m alt., with decreasing stem-diameter and increasing quantity of moss	MONTANE ZONE	
1700	34	19	53			
1800	40	24	64			
1900	16	9	25			
2000	4?	32	77			
2100	21	29	50			
2200	10	22	32			
2300	11	16	27			
2400	3*	£2	I20			
2500	29	40	69	Dense low forest with single higher trees, often mossy, or Conifers	SUBALPINE ZONE	
2600	8	3°	38			
2700	12	38	50			
2800	9	25	34			
2900	0	6	6			
3000	21		67			
3100	34	19	53			
3200	5	14	19			
3300	18	/*	7*			
3400	7	4	11			
3500	2	6	8			
3600	2/	13	3*	FOREST LIMIT		
3700	9	27	36	Low shrubs isolated or in clumps or Conifers		
3800	7	22	29			
3900	1	22	23			
4000	4	J*	/*	TREE LIMIT		
4100	0	0	0	STONE-DESERT with mosses, lichens and few Phanerogams, mainly grasses and sedges.	ALPINE ZONE	NATURAL ALPINE HERB VEGETATION
4200	0	1	1			
4300	0	0	0			
4400	0	0	0			
4500	0	0	0			
4600	0	0	0		NIVAL ZONE	
4700	0	0	0			
4800	0	0	0	ETERNAL SNOW		
4900	0	0	0			
5000	0	0	0			

The major climatic zonation for Java can be defined as follows:

o-iooo m *Tropical zone*
(500-1000 m *Colline sub^pne)*
1000-2400 m Montane %pne
(1000-1500 m *Submontane subvene)*
above 2400 m Sub alpine zone

It is of course clear that the figures obtained are also relevant to cultivated plants, though these occur only at lower altitudes, as the highest fields in Java are not found above 2000 m (in contrast with the Himalayas, Tibet and the Andes). But similar statistics made it clear that the 500, 1000 and 1500 m contours are also reflected in cultivated plants and coincide with the subdivisions of wild plants, tropical, colline and submontane.

In comparison with extratropical mountains the subalpine forest zone in Java and other Malesian islands is of large extension.

Obviously the extension of the subalpine zone is largest in the tropics, decreasing with latitude. In Formosa we found it represented for c. 300 m altitude *(Juniperus-Berberisjy* but in the European Alps it is a very narrow band of *Rhododendron, Juniperus nana, Salix, Alnus viridis,* and *Pinus mugo.*

CHAPTER 6

THE EFFECTS OF MOUNTAIN MASS ELEVATION

There are three botanical effects connected with the altitude of mountain systems, two of which concern the altitude at which plant species are found, while the third concerns the physiognomy of the forest.

The first is known from Europe as the 'Massenerhebungseffekt' (Schröter, 1926); according to this law the timberline and snowline lie appreciably higher in the Central Alps than on their margins (700-800 m) and this goes parallel with isotherms. It is of course likely that it is also valid for individual species of mountain plants. The effect has also been found in Scandinavia. It may also be found in New Guinea. For Java it has no importance, by absence of such huge mountain systems. I mention it because I have in the past (1934) confused this with another effect which I have later called "mountain mass elevation* (1961a) and which is quite different.

In contrast with the 'Massenerhebung', which concerns upper limits, this second effect is concerned with the lower limit of plants on isolated mountains and mountain massifs. It was first observed by Backer (Backer & van Slooten, 1924), who simply stated that *kemlandingan gunung, Albi^ia lophantha* (26-4) with a total altitudinal range from 1100 to 3100 m, occurs *exclusively* on mountains or mountain complexes of which the highest peak reaches 2500 m altitude, but can descend on such mountains down to 7700 m. In figures expressed the effect amounts to 2500 minus 1100, is 1400 m. Hence, it does not occur on any mountain or mountain complex of which the highest summit is 1200-2400 m high. This poses the problem why *Albijja* is absent from any mountain up to 2400 m, althought it proves to be capable to grow much lower down on the high mountains.

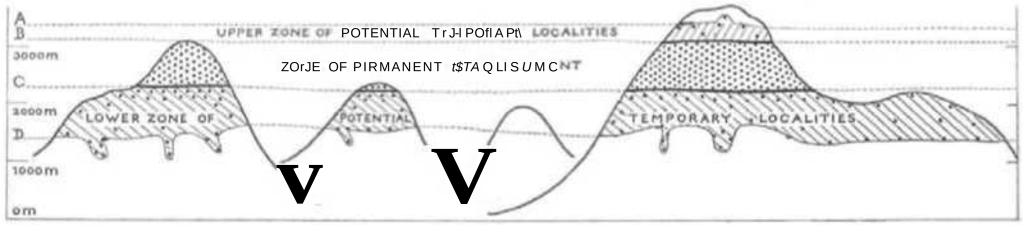
Detailed examination of records showed this peculiar effect also to be valid for all other species examined. I have tabulated below a few figures to illustrate this, the first column giving the total altitudinal range of the species in Java, the second the height of the lowest peak on which they are found, and the third the effect, all in metres:

Albi^ia lophantha (26-4)	I100-3I00	2500	1400
Myrica javanica (32-5)	1000-3300	2I00	I I00
Lonicerajavanica (8-2)	I000-2000	2000	I000
Thalictrum javanicum (43-6)	1800-3300	2550	750
Ranunculusjavanicus (43-4)	1700-3000	2400	700
Myriactis wallichii	1800-3000	2400	600
Lonicera acuminata (8-1)	1600-3300	2200	600
Primula prolifera (42-4)	2040-3050	2600	560

For the explanation of this phenomenon (S 1961a) I must recall that all organisms have a range of optimal conditions where they are permanently settled and beyond that a marginal zone where through natural dispersal of spores, ftuit or seed, sometimes spots are reached where the very local and temporary climatic, edaphic or topographic conditions just allow for its local growth, but where one cannot speak of permanent settlement. As we have seen that temperature is the main factor for altitudinal plant ranges in Java, cool spots near wells, the shade of rocks, gorges, waterfalls, etc. may offer opportunity for such temporary marginal settlement where indeed frequently the lowest localities are found. Usually plants do not grow very well in such places beyond their proper temperature requirements and not rarely they remain sterile or even do not flower. But as the supply of seed is steadily replenished downward from the higher zones, such localities may seem permanent.

There is a similar zone of temporary settlement upwards where sheltered spots or favourable soil or rock conditions may allow for temporary growth above the permanent zone of establishment; for example in the open air hothouses near fumaroles (p. 52b). The situation is illustrated in fig. 15.

It is of course quite likely that mountains now only 2400 m high were formerly higher and previously had *Albi^ia* in their upper zone. What has then happened is easily to understand: as soon as the mountain fell into decay and eroded to a critical altitude below 2500 m it lost the zone



Ftg. I). Sehinoiic than r>f the iltiiuclinil diitrihuii.>n of i mount-jin pljnr, ii! imputing itic clcvitinn cflcct. The Jcmit^ of dotting it in proportion in the number of Individual Icjcalitiei.

of permanent establishment of *Albi^ia* by which ihc **annual** replenishment of seed from **abort** stripped. Subsequently the existing local temporary settlements were lost **one by** one **without possibility** of creating new ones.

If this general explanation is correct, it should be also valid outside Java and indeed an important investigation ljy my pupil Rackhuys (1968) has shown that it is also valid for the Swiss Alps and for the distribution 1 if certain Swiss species of *Taraxacum* (1970) and a snail (1969). It *h* similarly found in a New Zealand *RiimtiKidits.*

I Tom this discussion fine may gain a glimpse oj what will happen to species on degrading mountains in the course til" erosion, and the perilous life mountain plants lend during the dynamic events in the physiography of the liarth's crust, a subject for which is referred to chapter 16.

An other aspect of the elevation effect is that it is irrelevant of the size or sinicrure of the diasporcs, as the fruit of *A/f»\ia in.* a pod with fairly large seeds, *I^nicera* and *Myrka* have lierries, ***Primula*** capsules with line seed, *Riiminttilits* small dry nutlets. *Taraxacum* plumed achencs. and *Myrinitis* fruits with adhesive aehenes. This is for me one of the strong arguments against the assumption that the nature of the diasporcs, the units of dispersal, be it spures, seed or fruit, has much to do with efficiency of dispersal. In Java the distance between a high mountain on which 1 species is profuse is often not so very far from a Imver peak on which such a species is absent: between Mr. Salak and Ml. Pangranpn only 26 km as the crow flies, both extinct volcanoes, or almost so, and otherwise very **compatible;** they are separated by a puss of joo m altitude. This conclusion is of great importance for the discussion of distribution of mountain plants in chapter 16.

Recently, Wood (1971) has advanced that the elevation effect could aiso be explained by a change in palaeoclimare, viz. *.1* previous warmer |ieriod, by which the lower mountains could have l>een stripped of their microtherm plants which could then later nut be replenished, but the only major event in palacoclimate in Java was a slight cooling by the Ice Age, which would have had the reverse effect. Besides an cilett of 600-1400 m Cnuld hardly be effected by minor climatic fluctuations. Instead of theoretical speculations it would have been more interesting (0 set: the result of an analysis of the mountain flora of the |-.,IM African volcanoes on which Wood seems to possess detailed data.

A third effect of mountain mass elevation is concerned with the physiognomy of vegetation which on small isolated peaks on islands may imitate that of the elfin forest of the high mountains. This is a consequence of the lower cloud level over the ocean. I refer t<j chapter 12b and fig. 19.

CHAPTER 7

FLOWER BIOLOGY

3. *Periodicity of Centring*

Flowering time and the periodicity of flush (the appearance of young foliage) show great differences depending on the species, on the elevation and topographical location and on climate. Sometimes there is an inbuilt imcrn.il rhythm as Holttum (1930, 194c) has shown in his valuable survey of periodicity phenomena it Singapore.

Many factors are involved, there are the individual differences and moreover rhe diversity increases with the stretch uf land taken into account. It the dates of flowering all over the 1000 km length of Java are summarized this mostly reads 'January till December*. However, this does not at all mean that the species is in full flower everywhere throughout the year, as appeared too well when the specimens for the drawings in this book had to be collected

The major stimulating factor for flowering, the climate, varies from year to year and the Howcnn^ period extends mostly over several consecutive months. Grasses nowered in plenty on Mt. Papandajan in June-July, but in October 19)93 few culms were well in Hower in otherwise withered tussocks. *AeitbyiianlbfS raMtatti* (21 -6) abounds in the forest above Tjibodas but in July 1959 3 long search was needed to obtain a few open flowers which I needed for this book.

Plomdog is mosdy periodical with usually one major period pur year in local areas. The more limited die area IS the more regular the pattern will be, as was shown by Docters van Leeuwen (1935), who produced figures for many species fur the summit none of Mt. Pangrango through the year. But the curves of these figures also show that of almost ill spedes some flowering specimens could he found all the yenr round or almost so; only very-few show a distinct peak with no flowering in other months.

f'.t'uiiatt. Of the climatic factors rainfall is the most obvious, but we must realize that this is connected in a degree with cloudiness and hence sunshine and alsn air humidity. Without experiments it seems impossible to me to discriminate among these factors. From Table *1* it

TABLE 1

Abundant of fawtrin% through ibt war of lome common ***tpttiti in Ibt sttmmii font ej Ml. Paitfranfp. Will Java, ill J-f j t m. iV« figure mrtmi no fluttering tibitrmi, Ibt flaunt 1, 1 ntsj j rtipatirtly rlanijr kith, far an*i tibimfanl fowrring. Pitied if} f-tfjf*** *(afur Dottert* row *Leeuwen).*

^ Month* / Groups	1	2	)	4	5	ú	7	l	•1	ID	11	11
Group!												
Gaulthcrin lcucocarpa {17-1]		2	2	*i*	3	2	2	2		1	*i*	i
1 i inir.T:i javinim (S-l)	)	1	2	*i*	3	3	1	3	2	a	1	1
l'irl\Ei.niim chincow *(nl-7)*	3	3	5	3	S	i	3	3	2	1	!	3
Ranunculus jiivankui **(49-4)**	3	3	3	*l*	*l*	J	*i*	2	2	1	1	
GftHp *lt*												
AnaphilisjovininiOo-i)	—	—	1	i	*x*	!	*i*	1	—	—	—	—
HypCTicum **leKhenauUl** (23-6)	1	t	1	1	S	3	*i*	1	1	1	1	1
ixptlMpcmiliin llavi~.i-.au (33-4)	—	—	—	1	)	1	1	—	—	—	—	—
Phcninia inrc^rifolin (44-))	1	1	2	2	2	2	1	—	—	—	1	1
Swertia javanica (20-3)	—	—	—	—	2	3	2	—	—	—	—	—
Thciyinitn iavanica (3 4-7)	—	*j*	3	l	J	1	l	t	—	—	—	—
Vacc i 11 lulu l a u r iful iu in (] 7-4)	—	—	1	1	J	1	—	—	—	—	—	—
Vacdnium varingucfolium (17-8)	1	1	1	2	5	1	l	1	1	t	1	1
GtvupII!												
***V.uiyj,* MCdminatfl (52-6)**	3	*1*	1	1	1	l		1	2	2	2	3
<l.ll .li 1it r i 1 n ui 11 i.;l.i! i- -iik-. (•7-4)	3	i	3	2	*1*	—	—	l	1	1	1	3
(n'Ti nu quadrif^iria *(10-1)*	3	J	1	1	1	1	1	*i*		)	5	j
Primuku pTijlJfcm **(42-4J**	3	3	2	1	1	1	1	1	!	1	3	*i*
Sympinco* cnchinchintnyis **Hp.** scs^ifotta (jl-4)	*i*	—	—	—	—	—	—	—	—	J	3	*i*

appears that there are mainly three groups of p!ants, (i) those which are indifferent to climate, (ii) those of which The main flowering falls in the dry season or largely so, and (iii) those of which the flowering is distinctly favoured by the wettest season. From this table **appeta** the **favourable** aspect that the botanist may find almost all species in flower in any month, though not in equal abundance. The seasonal periodicity is far from strict, each species has its own pattern nnti the distinction of the three groups is arbitrary*

The common pattern gained here and elsewhere is that (lowering is best with the change of the seasons, especially the dry spells and dry season seem to stimulate the final **gtowtb** of already developed flower buds. Also the first rains after the dry season may stimulate **Bowtt** buds, e.g. of *Rhoiltidrndniit.* May-June is usually the best period ill over Java, September the poorest.

Also the flush of several trees develops in these months and the forest **of** the liighcr zone of Mts Gcdii and Pangrango is then suflused with a red glow by the flush of *Vateiitinm varingiatfel'wm* as shown on plate 17-8. But also oilier trees come into Hush and these may be differently coloured in shades of purple, brown sntl green: compare *Enrya* (11-6), *Weittmatmia* (])-7), *SympS<Kiis* (51-4), *Pyrtnaria* (53-3), ^ftr(i-K), and *WightTa(51-5).*

In East Java where the influence of the dry season is more ptunouncedj figures would probably be sharper, aliliough less so in the high forest because this is ccjually wet as in West Java, Unfortunately there ate no such valuable observations available as for Mt. Pangrango.

A characteristic perioiliciiv is shown by *Wigbiia* ()i-s)> a leaf-shedding tree (phot. 70), bare in August-September and then flowering abundantly together with the developing flush, mostly in Scptcmtjcr.

From this example it should nnr lie concluded that flowering of deciduous trets is strictly periodical I can fully confirm Koorders's observation that leaf fall of a leaf-shedding tree with flowering and flush soon **following,** as in *Actr* (1-8), occurs erratically, even tor trees growing dose Together. It can happen any month of the year,

Etttation. Docteis van Leeuwcn (19}): 85) stated that there is an influence of elevation in that e.g. *Printuia* (41-4) starred flowering earlier at 2400 m than at 3000 m, the difference amounting sometimes 10 more than *3* month. He mentioned this also for a *Cartx,* for *Thtsliclrum* (43-6) and for *Strobilentlxs itrmui(\-^}.* To me this influence does not appeir impressive.

Expeinre. In chapter 4 ! have explained that east slopes receive more light than west slupes, but hitherto no 1 iliscr-vations are made to trace the influence of this factor on flowering periods uf plants.

Cold spells. It is known that certain plants at lower altitude, the pigeon orchit! *(Deitdrobiiim truntttiatiim)*7 cultivated coffee, *kemunmg*, etc. come gregariously into flower after a cold spell, often due to a rain-storm, wliich acts as a 'trigger[1] incentive for sil] 'waiting' buds to come into flower a fiscd number of days later; see Coster (1916a). In mountain plants this incentive occurs of course tux) frci|uem to become visible; experiments ate needed to show whether it exists among them,

ShsTl-day and lon^dir/ plun/s. In horticultural practice this inherited reaction of plants to the length of daylight plays an important **rede.** In flower culture commercial advantage is taken of this by artifii ially lengthening of the day through light, or reversely, shutting off the light to imitate a short-day cycle; this is a common practice in temperate countries when preparing planrs for eitport to arrive in the desired condition.

Of course all plants in tropical countries are confronted with short-day conditions. But obviously the native ones are not bound to this as *Primula* (42-4) and others flower well under long-day conditions in cultivation in Europe and grow also wild in extratropical regions, for example the Himalayas.

On the other hand it was held that long-day plants from temperate countries were ill-adapted to grow in tropical mountains because of their short-day conditions. This was the explanation of the failure to grow fruit trees in the mountains of Java. But I am not convinced that this is the reason. Teysmann said that the soil on the summit of Mt. Pangrango, where he experimented, was too poor. I saw on Mt. Tatamailau, in Portuguese Timor, that at 2000-2400 m many fruit trees were planted along the roads for anybody to have, apples, pears, plums, peaches, etc. I also observed that Portuguese bring seed and save seed of fruits for planting, a habit to which they became accustomed from the time of their great explorations, and anyway they have succeeded by trial and error. Now Tatamailau lies under dry season conditions and this may well be favourable for growth of fruit trees, imitating the seasons of Europe.

The long-day fruit trees are adapted to distinct seasons and are deciduous. It appears then possible that the seasonal stimulant is the real factor of success rather than the length of the day. Kostermans told me of a curious recent method for growing apples by artificial defoliation at Pudjon (above Malang, in East Java): half of the crown is defoliated and the other half is left with leaves in order to keep assimilation going. The defoliated half then produces flowers and fruit.

No experiments have been done on the dwarfed specimen of the European beech *(Fagus sylvatica),* about 1840 planted by Teysmann on the summit of Mt. Pangrango, on which Coster (1926) reported. Its periodicity in producing flush was thefe in complete disorder. But many introduced long-day plants from the temperate climate of Europe are thoroughly naturalized and propagate freely, as for example *Foeniculum vulgare^ Fragaria vesca,* and *Digitalis purpurea* (Rappard, 1939).

The simultaneous flowering of the remarkable pluriannual (hapaxanthic) species of *Strobilanthes* has been treated under the caption of plate 1-4. The year rhythm of this flowering has nothing to do with climate, and on the months in which the final flowering takes place I am unfortunately not sufficiently informed to judge whether a trigger mechanism is involved; this could well be the case as the gregarious synchronous flowering occurs obviously district-wise.

b. *Pollination*

Some sceptic words should open this chapter as in this field there is much controversy, mainly due to the fact that a function is involved in the interrelations between plants and animals in which many factors should be considered. Far more experiments thanin descriptive botany are needed in order to correlate observation and effect. It infers also more variables, for example climatic conditions through the year and variation in plant populations, necessitating careful critical observations in many localities, a thorough knowledge of the autecology and ethology of assumed pollinators, a careful check on incompatibility, etc.

The mere fact that an insect regularly visits a flower does not tell us whether these visits are necessary for its fertilisation. And this is of course the crucial question we want to solve. If the fertilisation is effected by other means, the observation tells us only something about the diet of the insect. To know its menu and preferences of food may be of interest to the physio-ecologist, but it is a one-sided relation and irrelevant to evolutionary botany.

These interrelations have not seldom proved to be very complicated and it has experimentally been found that flowers often may allow for more than one kind of effective pollinators, for example in the cactus *Carnegiea* bats, birds and insects. Conversely, most insects are not bound in diet to one plant species, which would hardly be possible as most flowers are only available in any quantity during very short periods of the year. On Mt. Pangrango the bumblebee *Bombus rufipes* for example frequents flowers for pollen as food, as well as others with easily accessible honey, and also *Lonicera* with concealed honey. Hagerup detected unknown, unexpected or easily underestimated agencies; on some small Atlantic islands he found that in very bad years with heavy gales and rain insects were virtually absent, but rain and wind proved to be capable of effecting fertilisation, taking over the 'normal* role of the insects. His meticulous observations on *Trollius* prove what peculiar relations are sometimes involved.

I must state that unfortunately in very few cases conclusive research, including observations and experiments, has been performed on the Javanese mountain flora and that the length of discussion is often inversely proportional to factual evidence.

The main argumentation is often based on observed flower visits and a consideration of "syndromes', that is morphology, colour, scent, etc. of the flowers, which is certainly decisive for attracting animals, but factually give only an indication of the preference of their menu, which is admittedly bound to a restricted number of plants.

Furthermore, it is in my opinion not justified to accept a single examined case somewhere in the world as sufficient proof and model for all other plants which possess to more or less degree characters of the syndrome. For example, orchids are supposed to be universally adapted to cross-pollination. Though this is generally true, I may point out that J. J. Smith (1928) has found self-fertilisation (autogamy) in many Javanese species, and there is no reason to call this a biologically inferior way of propagation. He mentioned this in his imposing list to occur in *Thelymitra* (34-7), *Spirantbes* (35-10), *Peristylus, Taeniophyllum* (36-14), *Scboenorchis* (35-9), *Galeola* (37-4), *Pbreatia* (35-8, 39-9). It occurs also in pelorial and abnormal forms, and in cleistogamous flowers. Many *Leguminosae* which look so well adapted to insect pollination have proved to be self-pollinated in bud whereby later insect visits become irrelevant. Recently, a distinct suggestion for autogamy was made in a genus of trees which occurs also in the Javanese mountain forest, viz. *Meliosma,* by Van Beusekom (1972: 372).

Also the syndromes may be deceptive: grasses are generally held as distinct wind-pollinators but Brink, Lieftinck and I have observed that several are eagerly visited by insects in Java. Furthermore, it appears that not a few grasses are self-pollinators, amongst them also mountain species.

This shows also the danger of generalisation, as even within one genus species may behave differently. Catkin-bearing trees are often held to be wind-pollinated, but it is certain that the showy inflorescences of oaks of the genus *Litbocarpus* and of the chestnuts of the genus *Castanopsis,* which are so frequent in the Javanese mountain forest canopy, are abundantly visited by beetles and flies which are attracted by the disagreeable (spermatic) smell of these inflorescences. Palms have often been considered as primarily wind-pollinated (Baker & Hurd, 1968) but this is objected to by Van der Pijl and others; he suggested to me that the often fragrant inflorescences of rattans, of which the very large *Plectocomia* and some species of *Calamus* occur in the montane forest, should be investigated for beetle-pollination. Beetles also frequent flowers of *Annonaceae* (2-3) and may be responsible for their fertilisation.

The high forest is of course a very complex biotope, it is virtually a complex of biotopes. Underneath the canopy the atmosphere is quiet and possibly not very favourable for wind pollination, though slow convection currents of air always occur (see caption under *Curculigo,* 1-10). I cannot judge whether insect life of potential flower pollinating insects is rich under the canopy. To my untrained eye it seems rather scant. The blossoming canopy seems to me the location of the feasting insects: this is, however, also wind-exposed: see under *Acer* (1-8).

Then there are two other features which should be taken into consideration for our estimate. The first is that fertile specimens of most species of forest trees occur in a very scattered, sparse way which is inherent to the heavily mixed character of the primary montane rain-forest. This has induced Baker (i960) to assume that effective self-pollination plays a large role, though admitting that in too few cases it is verified that self-pollination is effective. I may add, referring to the former chapter, that also flowering of these trees is mostly not simultaneous but very erratic, giving strength to Baker's thesis. Autogamy, hence inbreeding, of rain-forest trees would also be important as a means of segregation of populations ultimately leading to new races and even to the formation of groups of allied species which can in this way evolve in the same habitat together (sympatrically). An observation by Van Beusekom (1972) in *Meliosma* might sustain this.

Ashton (1969) estimated that in the Sarawak lowland rain-forest 26% of the species is *dioecious,* that means that there are either male or female plants, which would mean that the pollen must be conveyed from the male to the female plants. If the vector wind would be negligible, this would mean the necessity of pollination by animals, at least if it would be certain that apogamy is rare or absent.

In the Javanese mountain flora there are instances in which cross-fertilisation seems a necessity, viz. (i) dioecious species, (ii) monoecious species, (iii) species with heterostylous flowers, and (iv) species of which the fertility of stigma and stamens is spaced.

Dioecious plants mentioned in this book are quite a few:

Antidesma (18-5)	*Freydnetia* (40-5)
Arisaema (2-6/8)	*Homalanthus* (19-5)
Balanophora (5-1)	***Myrica* (32-5)**
Casuarina (8-9)	*Myrsine* (32-9)
Coprosma **(46-8)**	*Nepenthes* **(33-5)**
Daphniphyllum (19-3)	*Piper (41-fi*
Dendromy^a (48-7)	*Podocarpus* (13 -1 *fz)*
Dodonaea (49-5)	*Stephania ($y\)*
***Eurya* (5 2-6)**	

Among these *Casuarina, Coprosma, Daphniphyllum, Dodonaea, Myrica, Myrsine,* and *Podocarpus* are likely to be wind-pollinated.

Balanophora fungosa var. *globosa* must also be dioecious, but only female plants are found and this plant must consequently propagate apogamously.

Monoecious plants which carry in one individual plant both unisexual or functionally unisexual flowers, female and male, have also a rather fair representation in the mountain flora, in this book for example:

Altingia (23-4)	*Harmsiopanax* (3-2)
***Begonia* (5-4/6, 6-1/2)**	*Kadsura* (29-3)
Breynia (i%-6)	*Laurembergia* (23-3)
***Car ex* (14-1/9)**	*Lecanthusfjyz)*
Cucurbitaceae (18-2/4)	***Madura* (30-7)**
Distylium (23-5)	*Mussaenda* **(48-1)**
Elatostema (55-3)	***Nertera* (48-2)**
Engelhardia (24-1)	***Pilea* (56-3/4)**
***Ficus* (32-1/4)**	*Pittosporum* **(41-4)**
Glochidion (18-7)	***Schisandra* (2-10, 29-4)**
Gunnera(zyi)	*Tetrastigma^yfi*

Among these *Altingia, Distylium, Engelhardia, Gunnera, Harmsiopanax,* and *Laurembergia* are likely to be wind-pollinated.

It must be kept in mind that some genera in this list may appear to be not strictly provided with unisexual flowers, and there are cases of polygamy where part of the flowers is bisexual; there seem to be transitions and variations in this respect.

The third group of species has two kinds of plants, *long-styled* and *short-styled,* and this obviously necessitates cross-pollination, provided there is also incompatibility. It is for example found in *Wendlandia* (48-6), *Allaeophania* (46-2), some species *oiLasianthus* (47-5), *Ophiorrhi^a* (48-3) and *Psychotria* (48-4).

Under the caption of *Primula* (42-4) I have made some remarks on the efficiency of the absence of heterostylism in *Primula.*

The fourth group of species possesses *protandrous* or *protogynous flowers,* which means that in their bisexual flowers either the stamens or the stigma are ripe earlier so that in anthesis a flower passes from a male stage into that of a female or the reverse. In both cases pollen must be conveyed from one flower to an other, though not necessarily from one plant to an other. This certainly is found in Javanese mountain plants but the percentage cannot well be estimated. Examples are found in *Annonaceae* and various tubiflorous families as *Labiatae, Scrophulariaceae, Verbenaceae, Gesneriaceae (Aeschynanthus,* 21-4/6, *Agalmyla), Gentianaceae (Swertia,* 20-3/5), and *Loganiaceae {Fagraea,* 28-7).

Among the groups mentioned above cross-fertilisation is of course partly by wind, but admittedly partly by insects. Compulsory insect-pollination of most orchids and all *Ficus* species is of course beyond dispute. The arguments that bee colonies may remain confined to single trees with mass flowering seems not valid, because many bees travel over fairly large distances, often following fixed rounds.

Following the work of Faegri & Van der Pijl (1971) as to ecological flower classes I enumerate some data, pointing out that none of them was ever subjected to the full experimental research as mentioned in the introduction to this chapter. Professor Van der Pijl was so kind to provide a number of data and suggestions.

Bats. To this group belong the wild bananas, growing up to c. IJOO m, with their coarse, drab, musty and free-hanging inflorescences. The small flower bats of the genus *Macroglossus* cling to the *'djantung*[9], leaving claw marks. The real flower bats find their upper limit somewhat lower, but fruit bats of the genus *Cynopterus* occur higher and take over. The latter fit more to the climbing *Freycinetia insignis* which offers solid food in its sweet, drab-pinkish bracts. Whether this also holds *iotF.javanica* (40-5) is unknown to me; Van der Pijl assumes visits by *Pycnonotus.* The large-flowered *Fagraea blumei* (28-7) is nocturnal and spreads a sourish smell caused by diacetyl (Derx, 1950), pointing to attraction for bats.

Moths. Moths (mostly *Sphingidae)* with long tongues are bound to whitish or greenish, long-tubed flowers with a sweet nocturnal scent. Some orchids provided with a long spur answer this description as *Habenaria* (38-6, 40-2); in this group belong also *Hedychium* (57-4), *Lonicera* (8-2), *Pavetta* and *Tarenna, Pittosporum* (41-4), *Fagraea elliptica* (28-6), and *Symplocos* (52-3).

Butterflies. Erect vividly coloured trumpet-shaped flowers point to pollination by butterflies. A narrow tube or spur makes the honey inaccessible for bees, but allows for the long tongue of butterflies. To this group belong *Mussaenda* (48-1) and *Impatiens platypetala* (6-5).

Just as in the European Alps butterflies gain in importance during bright weather but mainly as temporal immigrants from lower altitude.

Bees. Carpenter bees, species *otXylocopa,* nesting in dead wood, are found up to 1600 m, but above 1400 m are gradually replaced by bumble-bees, mostly *Bombus ruficeps*, which is in the higher summit zones a most frequent flower visitor on many plants, according to Docters van Leeuwen (1933). Just as in Europe *Bombus* proves to be the more cold-resistant bee and it dominates in the mountains as a flower visitor, even active throughout the rainy season and in harsh weather, when other bees are inactive. It visits *Eurya* (52-6), *Swertia* (20-3), *Disporum* (27-8), *Melastoma* (31-6), *Dichroa* (50-3), the *Rubus* species (PL 45), *Hypericum* (23-6), *Vaccinium* (17-6), *Gaultberia* (17-2), etc. Further on we shall see that the visits are not always necessary for seed-setting.

Also bees of the genus *Apis* are very common but less indiscriminate and hardy than the bumble-bees. On Mt. Jang they are extremely frequent on the gregarious *Elsholt^ia pubescens* (24-6). Both I saw feasting on a flowering *Acer* (1-8) on Mt. Papandajan.

Of course not all plants in a single place flower the year round. As we have seen this is different for different species, but of many species some flowers are found in every month of the year. And though it may be true that *Apis* colonies remain confined to single trees with mass flowering, it has also been proved that other bees travel fairly large distances, often following fixed 'rounds', as is the case with certain birds, butterflies and bats.

Flies and beetles are attracted by flowers (or spathes) which emit a bad smell of decaying substance and carrion and these flowers often temporarily catch these insects in traps. To this class belong the flowers of *Aristolochia* (4-1) and the inflorescences of *Arisaema(z'6/i).* According to the flower colours and other details orchids of two genera would belong here, according to Van der Pijl, vi2. *Corybas* (36-6, 37-2) and certain epiphytic species of *Bulbophyllum* (36-4) which emit the characteristic smell.

The role of beetles for pollination in *Annonaceae,* which are obviously often protandrous, seems to be significant. Also the role of beetles in pollination of another primitive family, the *Magnoliaceae* (29-5) should be investigated.

Wasps. The orchid genus *Cryptostylis* (35-5) became famous in Australia, because the lip of the flowers imitates a female wasp and male wasps are attracted and deceived by this and a certain female scent, leading to pseudocopulation and effective pollination. The Javanese species are not investigated on this point.

As has been mentioned before figs are living in true symbiosis with wasps and those of the mountains make no exception to the rule.

Birds. Many species of the mistletoes are visited and pollinated by birds of the genus *Dicaeum* (of the family *Dicaeidae),* as further explained in the caption under *Macrosolen* (29-1). See the excellent work on this subject by Docters van Leeuwen (1954). Not only the red-tubed *Macrosolens* are visited; he observed *Aethopyga* on the brown-tomentose flowers of *Scurrula lepidota* at 2400 m (see for *Scurrula* 29-2).

Most of the flower-visiting birds belong to the sun-bird family *Nectarinidae* which occur up to 3000 m in the Javanese mountains, but they are less specialized than the humming-birds of the Andes and furthermore the Javanese mountains have fewer flowers inviting their visiting.

Likely bird flowers would be the red, long-tubed gesneraceous species of *Aeschynanthus* (21-4/6) and *Agalmyla* (21-1) but so far there are no pertinent observations except those of Elliott McClure (1966:191) in Malaya, who made unique observations from a platform built at 40 m height in a large dipterocarp tree. He observed dense clumps of *Aeschynanthus* species in several trees, noting that their flowering was not in phase. He found that these flowers were attractive to three species of spider hunters of the genus *Arachnothera (Nectarinidae)* 'who probed the nectaries with their long bills. Green *Le2.fbitds{Chloropsis;* family *Aegithinidae)* also liked the nectar and obtained it by puncturing the side and base of the corolla.' All these observations were made by binocular, entailing no further research.

Furthermore, there are some gingers, with their bright red inflorescences near the forest floor, as *Amomum* (57-2) and *Nicolaia* (57-5) and *Hornstedtia* on which birds were observed by Jacobson, Van der Pijl and others.

At high altitude pollination relations become less favourable by the colder conditions with frequent fog, which often inactivate the already scarce insects. Docters van Leeuwen (1933), who provided a very large amount of data from Mt. Pangrango, found the usual pollinators to be absent, the bee *(Apis)* appearing from time to time, but probably as a temporal migrant. Similarly as in Europe the more cold-resistant bumble-bee *(Bombus rufipes)* is the most frequent flower visitor and is active even during the rainy season. It was found on *Dichroa* (50-3), *Disporum* (27-8), *Eurya* (52-6), *Gaultheria* (17-2), *Hypericum* (23-6), *Melastoma* (31-6), *Rubus* (PL 45), *Swertia* (20-3), etc.

As in the Alps of Europe butterflies occur at high altitude, but are largely temporal migrants from lower altitude. A narrow bond is, however, found between a Noctuid moth and *Habenaria blumii.*

The sun-bird, *Aethopyga,* is observed to visit quite a number of flowers in search of nectar, such as *Rubus* (PL 45), *Albi^ia* (26-4), *Vaccinium varingiaefolium* (17-8) and *Lonicera* (8-1). The absence of true ornithophilous flowers stands in poor contrast to the situation in the American Andes. The nearest approach to such flowers is *Rhododendron retusum* (16-6) which is regularly visited by *Aethopyga;* the bumble-bee also visits these flowers, but punctures them. The vividly coloured orchid, *Dendrobium hasseltii* (36-7) is suggested to be bird-pollinated, but it should be checked whether the observed visits leads indeed to pollination.

As in other regions subject to a rigorous climate flies do participate *zndDiptera* frequent flowers of *Eurya* (5 2-6) and *Symplocos^z-4).* Some are adapted flower visitors but most are not, though keen on nectar. *Anaphalis* (10-1) is crowded with them on bright days, but it appears that self-fertilisation is the rule.

Epiphytic orchids excepted, self-fertilisation is obviously the rule for most of the species studied by Docters van Leeuwen on the summit zone of Mt. Pangrango; they are capable of propagation without insect visitors. This conclusion carries weight as Docters van Leeuwen did experiment with the Pangrango plants.

Besides the already mentioned cases of practically autogamous species many others escape in this way from bad pollination conditions, *Disporum* (27-8), *Lonicera* (8-1), *Swertia* (20-3), *Photinia* (44-5), *Ardisia* (32-7), *Ranunculus* (43-4). Also the famous *Primula* (42-4) is homostylous and autogamous. Autogamy is evident also, by the full fruit-setting of the summit orchids as *Myrmechis* (36-12) and the sun orchid *Thelymitra* (34-7) which opens only at a bright day like the gentian *Gentiana quadrifaria* (20-2).

At higher altitude pollination by wind is generally assumed to be the rule in grasses and sedges, but here again this generalisation rests on insufficient evidence. Mr. Veldkamp tells me that in highland grasses, *Microlaena* (22-9) and many others self-fertilisation seems to be the rule.

Concluding I must repeat that for our precise knowledge of the interesting interrelations for pollination and fertilisation of plants, data are distinctly insufficient, of which the length of this poor summary is a fair testimony. Indonesian biologists are invited to make a thorough study of the problems involved. They are certainly not easy to solve.

Here again the best site to perform such a research is the Tjibodas Botanic Garden, where a laboratory is available to sustain field work by experimental evidence.

Appendix

As we have seen there is a great variety in pollination devices and several are sometimes represented within one genus. This is nothing special as usually any appreciably large genus shows an ecological array, for example as to habitat, habit, dispersal structures of diaspores, leaf-shedding, etc., a sort of fan-shaped attempt to develop in different directions towards various specialisations and adaptation to various niches.

We should refrain, however, to use ecological characters as a major argument in distinguishing genera or splitting them up, as Stearn (1969) has recently done in *Gesneriaceae* of Central America where he opened a sort of new field of what could be called eco-taxonomy. He distinguished two genera mainly by the way in which they were pollinated. Though he found 'no apparent discontinuity between *Columnea* and *Alloplectus*, he proposed 'to define *Columnea* more narrowly than is customary, by including in it only species of this ornithophilous habit', saying further: 'To accommodate the species not fitting into *Alloplectus* and *Columnea sensu stricto*, *Dalbergaria* and *Pterygoloma* might then be restored.'

The acceptance of this procedure would lead to similar splitting of genera like *Aeschynanthus, Aquilegia, Clerodendron*, *Cordia, Erythrina*, *Fagraea, Lasianthus*, *Lonicera, Mucuna, Psycbotria, Strongylodon*, *Symplocos*, etc. which also contain groups of species possessing different pollination devices. I add that Leeuwenberg (in litt.), a specialist on American *Gesneriaceae*, also rejects Steam's procedure.

CHAPTER 8

INTRODUCED ALIEN PLANTS AND WEEDS

As has happened in so many tropical mountains many foreign species of plants have settled and have to a degree become naturalized, some only temporarily or slowly, others have gained territory in a Napoleonic way, and some have become real pests to cultivation.

As could be expected they find their niche primarily in disturbed places or in unstable marginal habitats of nature (landslides, lahars, river banks, etc.). This is due to the fact that almost all these introductions do not fit in the climax forest vegetation and cannot be integrated.

It is sometimes suggested that the climax is already so full and all its niches occupied that newcomers cannot accommodate. This idea must of course be erroneous as it must have happened continuously in the history of natural plant distribution and I have mentioned some examples to prove this (S 1969: 104-105). The tropical climax rain-forest is, I believe, an insatiable environment and available to all plants whose life cycle is adapted to this environment. As we cannot imitate the time scale no exact proof of this rule can ever be given. The occurrence in the Tjibodas mountain forest of the American *Eupatorium sordidum,* the Sumatran *Anemone* and yellow-flowered *Imp a Hens,* or 'forest coffee' in that of Sumatra is merely suggestive. Well-adapted plants are of course those which are true climax components in their native country and such plants may escape from botanical gardens. However, almost all aliens prove to be also marginal in their home country.

The interference of Man with nature in opening very large tracts of land for cultivation has had of course an enormous impact on growth of weed and has extended the area where they can grow to unimaginable size, but not above 2000 m where the highest villages are found.

Above 1000 m regular cultivation of rice goes up to some 1200 m, rarely and without great profit to 1500 m. Dry field cultivation *(tegalan)* goes up to some 2100 m, mainly of cabbage and other vegetables, potatoes, and maize. The cultivation of cereals at 1500-2200 m has proved to be unsuccessful.

On the other hand estate cultures occupy large areas: coffee is mainly grown between 800-1600 m, tea from 200-2000 m, cinchona from 800-2200 m.

The study and knowledge of weeds and their naturalization has several interesting aspects. How do they arrive and what are the main sources from where they came, when did they arrive, where do they establish, what is their success?

Their study is of course also of great importance for all applied botany, including horticulture, estate crops, agriculture and forestry. They may be beneficial as ground cover, for shade, or reafforestation, but may also possess undesired qualities as suffocating crops or carrying and thereby increasing pests and diseases. Kooper (1927) utilized weed communities for defining qualities of soil for the cultivation of sugarcane. Many introduced weeds are used as vegetables for lalab, especially by the Sundanese, others have come into use for medicinal purpose.

An excellent illustrated book on montane weeds of tea estates was composed by Backer & Van Slooten (1924) followed later by one of sugarcane estates by Backer (1928-1934); in the latter naturally only a few species occur which also grow in the mountains.

Information on introduced weeds in Java was first given by Backer (1909) by listing the names and adding source and date of introduction, later supplemented by a summary (1936) on important sources in Java from where aliens spread.

Intentional import from Asia started probably already in Hindu time of which the medicinal sweet-flag, *Acorus calamus,* in Telaga Dringu, and possibly *Mentha cordifolia* on Mt. Diëng still bear testimony. From the Portuguese period dates probably the popular watercress, *Nasturtium officinale,* still growing, mostly under care, in stagnant parts of mountain streams. Also the Spanish trans-Pacific galleon route via Manila and the Moluccas possibly contributed some aliens which later spread into the mountains as *Elephantopus scaber;* of a few the vernacular names are still reminiscent *{Manihot, pohon ketella,* corrupted from 'plant of Castilia'). See Merrill (1954). The Spaniards and the East India Company probably added only a few aliens to the mountain flora as they worked in the lowland. See the detailed account by Backer (1936).

The great invasion started with estates in the mountains of coffee, tea and cinchona in the earlier part of the former century, which brought along intentional import of ornamentals, green manures, shade trees, plants for ground cover preventing erosion *(Eupatoriums),* fodder for cattle-breeding, and unintentional contamination with import of seed, living plants and other cargo. Further grass seed and hay was imported for horses, some aquatics for fishponds. About 1850 *Lantana camara* was introduced by a civil servant who wanted prickly hedges with beautiful flowers in his district; the vernacular name *salijara,* an assumed corruption of the man's name De Serrière still reminding of this effort. Some decades ago *Crassocephalum crepidioides* was introduced by planters on Mt. Gedé because they judged it a benign, harmless weed for undergrowth under tea.

The main sources of diffusion of aliens were according to Backer (1936) the Botanic Gardens at Tjibodas (1450 m) and kitchen-gardens at Tjipanas situated below it (1000 m) mainly through Teysmann's efforts, the tea and cinchona estates in Priangan round Tjinjiruan (1600 m), abandoned estates, gardens and homesteads. Furthermore, the fields for potatoes and vegetables and the unsuccessful trials to grow cereals in the highlands of Central and East Java (Diëng, Ungaran, Sfclo Pass, Trètfes on Mt. Ardjuno, Tengger and Idjèn). Special attention deserves the former private garden of the horticultural botanist M. Buysman at

Nongkodjadjar (1906-1916) on Mt. Tengger at c. 1400 m; he imported an immense number of plants from all over the world and must be held responsible for the import of many alien mountain plants. Several of these still occur very locally there, as *Salvia tiliaefolia,* but others easily spread over Mt. Tengger in the disturbed soil of fields and other waste places, and the bare soil of volcanic ash, of which Backer gave several examples. Part of the Tengger Sandsea which is least suffering from fresh ash of Mt. Bromo, the so-called Rudjak, is full of alien plants, stands *olFoeniculum* (phot. 48), etc.

How to distinguish native and alien plants is hardly a matter of concern in Java. Habitat, plant-geography and the Herbarium are the main tools to discriminate.

Aliens are usually not integrated in natural vegetation but confined to roadsides, talus and other disturbed places. Plant-geography tells us that *Silem gallica,* a native of Europe, *Marsypianthes chamaedrys* from tropical America, and *Spergula arvensis* are doubtless aliens.

Conversely, it may not be concluded that all plants from waste places are aliens, as several native mountain plants become weedy on bare and disturbed soil along roadsides, talus, in fields and plantations. Such *'apophytes*[9] are e.g. *Gentiana quadrifaria* (20-2), *Alchemilla* (44-2), and *Gunnera* (23-1) in ditches on Mt. Diëng, *Vakriana hardwickii* (56-6), *Potentilla indica* (44-3) and *Veronica javanica* (51-4) in Priangan tea estates, and *Cerastium indicum* (8-4) on Mt. Tengger by roads and in hedges along with the naturalized alien *Calceolaria gracilis* from America.

The date of import of aliens can often be established by records in the herbarium, though not always precisely as it takes some time before the first specimen is collected by a botanist. This appeared when I collected (S 1967) all data on *Crassocephalum crepidioides,* a composite which managed to become a common, thoroughly established annual weed from sea-level to high up in the mountains in less than 20 years. In only one case there is no unanimity among botanists: Backer (1936: 53) seemed to believe that *Agrimonia eupatoria* (44-1) was an alien in East Java, deriving this from the fact that Reinwardt, the first to collect it (on Mt. Tengger) in 1822 found there also *Spergula.* For plant-geographical reasons I cannot agree, as it shares its distribution in Java and its disjunction with the Himalayas with many other truly indigenous mountain plants.

It is sometimes assumed that aliens threaten native vegetation, but this is an exaggeration. On the other hand they can never again be eradicated, but that is an other matter. Aliens are powerless against the primary rainforest; they invade only disturbed places, clearings, estates and fields and may be a nuisance there, e.g. the mentioned *Lantana* (up to 1700 m) and *ki rinju^ Eupatorium inulifolium* (up to 1800 m). When such lands are abandoned they may indeed cover them in dense thickets, but they also serve as the cradle for new forest to come up (phot. 22). This may be by secondary growth succession of tree ferns, *Trema> Ficus,* etc., but when situated sufficiently near to random seed trees of original forest they may allow for a short-cutting succession and abundant upgrowth of *seru (Schima,* 52-7) or *ki hudjan (Engelhardia,* 24-1) as I observed near Tjipadaruiim (1800 m) on Mt. Patuha.

How large the actual number of introduced plants in the Javanese mountains is I do not know, but their number runs in the hundreds, and it will doubtless increase in future. In the Flora of Java it is carefully noted whether a plant is alien and indicated whether it is naturalized or only an occasional passing stranger.

CHAPTER 9

CLIMAX, SUCCESSION, PIONEER AND NOMAD PLANTS

Under succession is understood the dynamic process to restore the climax vegetation in all places where there was none or where this was removed or disturbed by either Nature itself or by Man.

The climax vegetation is in this context defined as the richest vegetation which is in agreement with the original plant cover for each locality according to its climate and soil.

This infers, that in the climax vegetation the autecology of each of the component species is adapted to perform its full life cycle in the climax and is capable to perpetuate as long as habitat factors remain constant.

It follows that of each individual species specimens of different age will be present, from germling to the full-grown stage: each species must, as we say, be represented by its 'age classes'.

From this must be concluded that germination of climax plants of the high forest must be shade-tolerant, a most important quality as we shall see later on.

In the tropical mountains there is a very large variation in the number of situations and therefore of kinds of succession of which I will mention a few.

Succession can start on a fresh lavastream, on lahars, sterile ash screes, etc.; this start is then from scratch without previous plant growth.

It can also start in small clearings in the forest or where a gap in the forest was caused by the crashing down of a large tree by wind or lightning. In the latter cases the immediate vicinity of the disturbed place offers a large supply of seed of the climax trees around while the soil still carries rhizomes and stumps and part of the undergrowth of the previous climax forest remained intact and standing.

In human terms one could compare these two situations with restoration of the skin from severe burns versus a mere superficial scratch, the healing process itself with the succession.

Between these two extremes there is a varied panorama: regrowth may start after fires have raged, it may follow after an estate or fields or grazing grounds have been abandoned, but also where nature itself caused destruction, for example on landslides, along rivers or mudstreams, and the like.

As we have seen in chapter 4 that altitudes in Java do not allow for an alpine climax vegetation we can confine ourselves to a succession leading to restoration of forest, high montane forest and elfin forest.

Succession is in first instance a concept regarding the *structure* of the vegetation: in a clearing, abandoned field, on a landslide etc. the first pioneer plants to appear are aggressive herbaceous often annual plants between and under which other rapid growing woody plants ('weed trees') find simultaneously or shortly after opportunity to germinate and settle, together forming a *thicket* or shrubbery of a few metres high. This and the secondary forest types are in Java well known as *belukar* or *hutan muda.*

If sufficient shade is provided the way is paved for germination of seed of the climax forest trees and this is the start of the second stage of the succession, namely the increasing floristic complexity. In the meantime (3-10 years) the weed trees continue their rapid growth and develop into a young secondary forest, *belukar* or *hutan muda*, some 10-15 m high (phot. 22). It appears that several weed trees at an age of some 10-25 years are full-grown and die, paving the way for some others with longer life-cycle which, without interference, grow into an old secondary forest, *belukar tua* (some 25-75 years), but almost all of these will then have also reached maturity when some 15-30 m high, and fall one after another a victim to age.

All through this time there has been a steady growth of the climax trees: their seedlings slowly grow up into unbranched, thin, pole-like trees, striving for light, with a small crown on top because of the shade of the secondary forest trees hampering assimilation. They bide their time, while after some 50-75 years their crown becomes more and more exposed, amongst others by the gradually decaying and thinning out of the secondary forest trees. Then their crown expands and their columnar bole gains in diameter, and thus a canopy is finally formed by high climax trees, although not so heavily mixed and rich in species as the one from the past. An excellent book and subsequent paper explaining this process were written by Kramer (1926, 1933) on the forest of Mt. Ged£.

In passing it may be remarked that the very high unbranched bole even of the emergent trees, as of *Altingia* (phot. 2) derives from its upgrowth as a thin pole tree in the shade of the high forest. If a seedling of some years old, which is no longer light-intolerant, is planted in the open branching starts immediately and no such bole is formed, as can be observed in *Altingia* on the lawns of the Tjibodas garden.

The above is the **full** description and approximate time-scale of the succession in the high forest in an ideal situation on a favourable location, e.g. after selective logging, with a sufficient supply of many different seed trees of climax trees in the immediate vicinity.

I have argued (S 1958: 159) that this succession reflects the natural regeneration in the primary forest under undisturbed conditions apart from the normal changes. But as one can imagine there are many deviations of the scheme. For example in a high *Eupatorium* thicket on an abandoned cinchona plantation in the immediate vicinity of high forest, without secondary forest species around, a random seed tree, let us say of a profuse seed producer like *Schima* (5 2-7), may sow its children in this thicket and then a curious, thickly set, thin, even-aged, one-dominant 'pole-forest' may overtop- the *Eupatorium.* By this short-cut the secondary forest stages are skipped. I have also seen this happen in the primary forest on Mt. Jang with *Engelhardia* and found it described after wind-falls in Malaya. In an other situation the succession starts in an area where hardly any or no primary forest seed trees are in the vicinity, or when the succession has to start after the soil was badly eroded in the previous years. Then it is clear that time for the restoration and structural features will deviate from the ideal picture.

In still other cases Man's activity will interrupt or halfway destroy successions which are under way, for example in the shifting cultivation system *(ladang,* Malay, *huma,* Sundanese, *gogo,* Javanese). In cattle-breeding areas animals will browse seedlings and arrest succession in an early stage of development; if this land-use is permanent the arresting of the succession will also become permanent. Its floristic composition will shift in favour of unpalatable plants, because of the selection by cattle, on hunting grounds by deer. A similar thing will happen in areas subject to regular fires where the floristic composition will be deviated towards accumulation of more or less fire-resistant plants. In short, there is no end to variation.

The *time* needed to complete a full succession will also vary with altitude, as growth is slower with decreasing temperature; in cold summit zones on rocky and unwithered soil pioneer vegetation and regrowth is extremely slow, as we will see in a later chapter.

Thusfar we have mostly considered the structure of succession via weeds, thicket, young and secondary forest, representing a series *(sere)* from zero to more complex and taller vegetation.

If we ask whether this is bound to a fixed series of specific plant species, one following the other, the answer is no: it varies from place to place and is completely random and opportune and it simply depends on which plants are locally available. Among these it is a matter of who comes first and this prevails all through the succession, both for secondary forest and climax tree species.

While it appears then rather useless to describe the floristics of all kinds of successions, progressive, arrested, deviated, degraded, etc., it is necessary to consider what species are these short-lived weed trees of secondary growths and how they do manage under primary forest conditions, and where they do come from.

In doing so it appears that they belong predominantly to genera of a rather restricted number of plant families among which *Urticaceae, Moraceae, Ulmaceae, Eupborbiaceae, Gramineae* and *Verbenaceae.* There are also a number of introduced plants, but many or most secondary forest plants are native in Java. This leads immediately to the question where these native refugees lived in the primeval forest. The answer is that they occurred and still occur *marginal* to the forest, on rock walls where no further succession could proceed, along rivers which continuously change course, on earthslides, in places where overmature trees crashed or windfall caused openings in the forest, and in Java especially in places where through volcanic activity forest was destroyed. All the forest on Krakatau is of course composed of such secondary growth plants.

Because of the fact that they can only occupy territory and places during a short period, namely during the succession after which they are replaced and suppressed by the climax forest, they are *wandering plants* for which reason I have called them *'nomadplants** (S 1956a; 1958a). Their marginal life is perennial as nature always offers such small open niches, but their stations are mostly temporary.

They are naturally well-adapted to this kind of life, possessing all kind of pioneer devices to make this nomad life possible (S 1941c). Besides that they are almost all shade-intolerant for their germination, they grow fast, produce flowers and seed already at an early age, and continue to do so throughout the year. Their seeds are well-adapted to profuse and rapid germination and to local dispersal by wind or birds, or remain viable for a long time. Also they often easily regenerate by suckers. Furthermore they are rather indifferent to both climate and soil. For all their vigour, pioneer plants have their weaknesses, viz. a craving for light and bare soil for their germination; they remain shade-intolerant and have a brief life span.

Almost all pioneers or nomads are indeed short-lived, but there are a few which are decidedly long-lived, e.g. *seru{Schima₉* 52-7), *tjemara (Casuarina, %-cj),Fagraeafragrans₉* and an *Adinandra.* Once established these individual specimens remain in the very old secondary forest and participate in the canopy. However, because of the inability of their seed to germinate in the dark of the depth of the forest floor their regeneration is shut off: they remain without progeny.

Their presence is then one of the criteria by which the botanist is able to distinguish between true primary and old secondary forest or nearly primary forest: they betray the past by their nomad autecology. There are other axiomas and criteria, which I have formerly illustrated by many examples from Java (S 1961).

From what is said above it is clear that the nomad species has great benefit from Man whose activity in cutting forest and occupying land has immensely extended the niches to which nomad plants were confined in Nature and led to an immense increase of their specimens. This conversion is detrimental for the original flora. In Borneo and Sumatra the *ladang* (shifting cultivation) system is occupying huge surfaces and to a minor degree the similar *huma* system in West Java acts in the same way. Areas subject to this system will finally carry only permanent secondary forest wherein the primary forest plants, especially the sensitive ones, are lost one by one. Botanically they are of no interest. They become easily degraded to lalang wastes.

For reafforestation the forester often makes some use of the principle of succession, preparing first a ground cover or thicket preferably of *Leguminosae* to provide shade and enrich the soil and then plant the desirable timber trees.

CHAPTER 10

FIRE IN THE MOUNTAIN FOREST

The mixed high mountain rain-forest in Java is only by exception inflammable in abnormally dry years and as we will see in equally exceptional cases through volcanic activity. This is so because, in absence of grass, the only ignitable substances forming the 'pile* is the litter and this is very scarce and insufficient to lead to a forest fire.

In agreement with this situation properly none of the high evergreen forest trees possesses any signs of fire-resistant characters; even the scattered trees of the conifer *Podocarpus* (13-1/2) are not inflammable. Only *seru (Scbima,* 52-7) is capable of suckering; further tree ferns have proved to be capable of withstanding fire by virtue of the fibre-coated trunk and the scales and leaf-bases which protect the apical growth centre. A few charred but living tree ferns occur(red) as the last vestige of the forest on fire-swept grass-covered Tegal Aloon-Aloon of Mt. Papandajan (phot. 51). In passing it may be said that in the Irian highlands pure tree fern stands may develop because of this quality.

In the elfin forest the situation is more favourable for fire to be effective, as the forest is lighter and there often is an undergrowth containing grasses and sedges, herbs and also moss. Besides, tree stems are thinner and at higher altitude desiccation during exceptionally dry years is more severe. But again, fire-resistant capacities are not found among the elfin wood trees, except in *Albi^ia* (see p. 43a). In very rare cases when really put on fire the charred tree skeletons show no regeneration as I observed on Mt. Papandajan (descent towards Tegal Bungbrun) and on Mt. Gedé. In the Aloon Aloon on the latter mountain the dead forest was invaded by Javanese edelweiss, *Anaphalis javanica* (IO-I) appearing to be a pioneer. Decades later there was not much to be seen of regeneration of the elfin wood trees, showing that this process is obviously extremely slow and suggesting that the huge stand of *Anaphalis* in the Gedé Aloon Aloon (phot. 30) may be for the greater part a secondary pioneer growth.

Concluding we may say that there is, in the climax mixed-forest vegetation, in the first place no pile of any dimension for extending a fire, even if ignited.

This leads to the question how fires can originate. For this there are three causes: (i) *volcanism,* (ii) *lightning,* and (iii) *Man.*

As to *volcanism* it is true that it may cause fires by lava-streams, ejected very hot boulders rolling down a slope, and especially by hot dust clouds (nuée ardente). The latter have indeed been observed to set forest on fire as described by Loogen (1942). But fire through volcanism is so rare that this source can be neglected, the more so as the fire cannot extend far into the forest by lack of a pile.

Lightning has been reported for setting forest on fire in Canada, the U.S.A., Finland (mostly coniferous forest), and Africa. And one might suppose that this also occurs in Java. But in the many observed cases of lightning, due to the high frequency of thunderstorms in the Javanese mountains, none led to a fire, first because lightning is always accompanied by heavy showers and further again by the crucial lack of a pile.

In his classical research on fire in the Javanese mountain forest Burger (1930) therefore correctly dismissed lightning as of any importance for fire. He concluded that Man is always the cause, whether or not acting on purpose. Cigarette butts or matches may be thrown away carelessly, fires are made on the way at resting halts, for camps, against the cold, etc. and may be perfunctorily extinguished or not at all, but also pyromania, tribal or village warfare, vengeance, establishment or clearing of pastures, hunting purposes, pyrolatry, or incendiary fire for the regenerating of *Albi^ia* (see chapter 12b), all contribute to the share of Man in setting vegetation on fire. This will be easier in times of drought than in the rainy season.

But again, as stressed above, *fire alone is not sufficient: there must be a pile to enable spreading.* As already hinted at above: *Man is not only responsible for causing a fire\ he is also responsible for the origin of the pile,* by his agricultural activities in clearings, as grasses and herbaceous plants invade his fields and form a pile in the fallow intervals. The same holds for cattle breeders, but they come to the fore when grassland already exists. Both cattle breeders and farmers usually take sufficient care that such fires do not spread. In abandoned fields and the more so in cattle country a pile is usually built up.

However, regular fires occur also in the grassy Aloon Aloon *(glades)* on Mt. Papandajan where neither cattle nor fields have ever existed (phot. 51 & 27). I have been lucky enough to learn there the full story of the initial stage of the highland grasslands. Though it is nothing new and has been described from other parts of the world, I will tell it in detail because the observations are made in the Javanese mountains and illustrate how 'nature can be read' in the field.

These glades occur in the depth of the beautiful, unbroken, primary, heavily mixed forest. They are situated on flats or depressions which are in all probability very ancient crater lakes silted up in the course of time. On Mt. Ipis, one of the low knolls of the Papandajan complex, four hours on foot from Papandajan-crater, is such a completely virgin, untouched depression (an ancient small crater), of some 300 by 75 metres; its flat bottom carries no forest and is marshy after rains. It was unknown locally to the Sundanese who accompanied us; it was detected by the volcanologist Mr. Ecoma Verstege. Docters van Leeuwen (1930) named it Tegal Primula and described its flora. The hollow is completely forested almost to the edge of the flat marshy bottom (phot. 25), but the forest is separated from the most marshy places by a fringe of sedges and native grasses, e.g. *Helictotrichon* (22-2), *Bromus* (22-8), *Brachypodium* (22-6), *Festuca* (22-14), *Hierochloe* (22-16), *Deyeuxia* (22-7) and many herbs, amongst which *Primula* (42-4), *Allaeophania* (46-2), etc. Several of these and some of the sedges are tussock-forming and had built up thick tufts with many withered leaves between the living culms. It is beyond question that if one wanted to put fire to this in the *dry season,* one would be successful. And this fire would singe the surrounding forest causing a fringe of charred, dead wood. This would substantially add to the pile as dead charred wood is easily inflammable. If this process would be regularly repeated it is clear that the grass fringe would extend at the cost of the forest, as grasses are by virtue of their underground rootstocks fire-resistant while eventual seedlings of trees are very sensitive to fire. Thus the fire, followed by grass, would so to say 'eat its way' into the forest and up the surrounding slopes.

The most important conclusion, however, is that Man would not only be responsible for igniting fire, but secondarily also for increasing the amount of inflammable material: *raise a pile.*

About an hour walk from Tegal Primula is Tegal Pandjang, also a flat, covering about 5 ha, drained by a small stream which originates at its farther end in a boggy part and meanders away, deeply cut into the sedimentary ash layers deposited aeons ago in a former lake. It is entirely grass-covered except for some shrubs, amongst them *Anaphalis* (10-1). It is completely surrounded by a high forest edge before which is a rather narrow shrubby fringe (phot. 26). On closer examination this shows charred dead wood as well as charred tussock bases in the glade. The grassland is very mixed, but there is also some alang-alang confirming the pyrogenic regime. And the same situation is found on Tegal Aloon Aloon, two hours on foot from there, with the difference that this covers a surface of several tens of ha (phot. 27 & 51).

Obviously we have here three stages in replacement of forest by *pyrogenous* grassland: a potential site on Tegal

Primula, an actually burned larger site on Tegal Pandjang and a still more extended one on Tegal Aloon Aloon.

This leads of course to the question why a pyrogenous glade started on Tegal Pandjang and not on Tegal Primula. The answer to this is that Mt. Ipis and the Tegal Primula on it is and was of no importance for the Javanese people. Through Tegal Pandjang, however, leads a traditional old forest trail for a route between the Pfengalfengan Plateau and the Garut valley over the mountains via Papandajan crater to Tjisurupan for trading salt, tobacco and goods, in all requiring some twelve or more hours on foot. On this long route the brook on what is now Tegal Pandjang was the natural place for a halt and served (still serves, I assume) as a most suitable fixed resting place underway where good water was available for cooking and coffee, and also level, dry, open ground fit for resting and camping. In early time this spot was rather closely surrounded by forest but a small fire could be kindled with some grass lining the steep talus of the brook and fed with what was available in the way of dead wood, probably among this old branches of decaying *Anaphalis.* A fire was also necessary to keep tiger away at night. This place was the focus from which the grassland extended in a very gradual way, as a charred place encourages to use it another time and favours the growth of grass. Neglect of extinguishing fires speeded up the extension of the grassland especially in the dry season, as then the fire was also used for keeping warm. The young grass, the salt contained in the ash, the open air and the water in the brook also attracted deer, kantjil and banteng to this place and so it became secondarily suitable for game, which led hunting Javanese to regular burning for that purpose. This was the situation in 1930. Camping in this wonderful isolated spot, shivering in the cold early morning, seeing the sun rise over the closed primary forest, the brisk air sharpening the mind for scientific observation; during the daytime the cool forest next to the sunny glade; in the silent afternoon hours with dusk the kantjil shyly peeping out of the forest border. Experience ever to remember, sincerely hoping that young botanists may follow my trails and see for themselves.

How long it took for this glade to gain its size of some $ ha we do not know, but my estimate is at least a century, possibly many more.

What will happen to it if left alone? And here follows the end of the story and the closing of the circle. Because after my first visit I decided to make, if possible, a global field experiment. I charted the border and noted the composition of the shrub fringe as carefully as possible, marking also trees immediately behind it. Then I secured the collaboration of the responsible forest officer who gave strict orders to the people of the district against any burning and hunting, declaring it a protected forest reserve. In the following years I have observed that this fortunately had result, the grassmat becoming very thick with much withered leaves and culms.

After one decade, in 1940,1 made the final inventory of what had happened. The observation was that there was a distinct advance of the shrubby border pushing into the plain by unexpected young thick stands of *Euonymus japonicus* (2-9), with a few *Myrsine* (32-9), *Vaccinium* (17-6), *Litsea* (26-3), *Ardisia* (32-7) and *Anaphalis* (10-1) etc., but not for more than some 10-20 metres. Between these shrubs I found here and there a tree seedling of unknown identity. But there were hardly any seedlings of shrubs or trees in the grassland on the plain, where the thick cover of decaying grass is not suitable for their germination, also because being exposed to the sun is not fitting their light-intolerant mode of germination. Another factor may also contribute, namely frost. The glade suffers from frost which is unknown in the closed forest and started to occur shortly after the initial fase of origin of the glade. This may kill young seedlings of forest trees; we measured on frost days near the soil temperatures as low as 5^0 and once even io° C below zero in the very early morning.

Obviously a 'wound' in the forest heals like one on the skin, from the margin slowly inwards. This leads also to the conclusion that it is useless to put caged experimental squares in the middle of fire-protected grasslands remote from forest borders to check how long it will take before primary forest trees will take advantage and settle. I saw this done in the pyrogenous Ceylon patanas for this purpose, where it also proved to be of no avail.

The observations on Mt. Papandajan may look insignificant details, but I believe that they are of crucial importance as a model of how the process starts and of the agencies by which it proceeds, like the study of how a tiny landslide on a mountain may be decisive for the later formation of an immense valley. In geology and biology and many other natural sciences causes and agencies are often extremely small but avalanche to enormous size by accumulation in the course of time.

These observations have led me to the view that the extensive mountain grassland areas are all doubtless due to the action of Man, in all probability largely originated through fire for hunting purposes, and are to a much less degree derived from his later cattle-breeding and agricultural activities. Hunting is still practised and the glades on Mt. Jang and elsewhere are still maintained in this way, as I will show in chapter i2d. The same regime prevails in the highlands of the Lesser Sunda Islands and large parts of the southern half of Celebes and the Gajo Lands in Sumatra.

The conversion of forest into grassland certainly dates back to ancient time, and it is not surprising that its extension is proportional to the prevailing length and strength of the dry season, so that grasslands are mainly found in Central and East Java, but also for example on Mt. Tjeremai, and are absent or of small extent in the everwet mountains of West Java. One must further consider that a relatively thin population is able to keep enormous areas under a 'fire regime*.

This regime had of course large consequences for the composition of the vegetation, in a global way it had two main effects viz. (i) an immense increase of grasses which in the primary forest were scarce, even in the elfin forest and (ii) a similar increase of all other plant species which had fire-resistant qualities. Therefore in East Java tjemara *(Casuarina,* 8-9) could become an absolutely dominant tree growing into large forest tracts capping mountains; see chapter i2d. Grass and tjemara (its litter as well as the trees themselves) gradually became the big pile feeding the fires. Phot. 40-44.

Such fires do of course not occur *every* year in *each* place, but are recurrent with irregular intervals. Areas are hence subject to fire to degree, varying from one district to another. Extra dry years will of course increase their frequency in all districts.

Also the topography plays an important role, because south and southeast slopes receive rain even in the dry period while the north and northwest slopes on the leeward side of the mountains are the driest places during the dry season; on the latter slopes litter and other matter for the pile gets drier and more inflammable than on the south and southeast slopes. Naturally fire rages primarily upwards on (the drier) ridges and less so down into sheltered moister ravines. The result can easily be imagined: a precise mapping of the area will show the area covered by tjemara forest to have the rough shape of an oblique star, the rays (corresponding to the mountain ridges) being longest at the N. and NW. sides and shortest on the S. and SE. sides.

As said above several factors are involved in the degree of fire. Pyrogenous landscapes, as we are used to call areas subject to a fire regime, show therefore great variation, from mild where fire is rare to severe where it is frequent.

A mild fire regime can lead to a stabilization into a sort of permanent landscape of forest and glades or woodland savanna, a pleasure to visit and a beauty to the eye, as testified by phot. 34, 43 and 69.

Where fires are too frequent the result will be an almost treeless grassland (the *'fire climax*[9]*)* mixed with other herbs capable of surviving fire by having subterranean bulbs, tubers or rootstocks, as grass, or by being annual and capable of producing in a short time seed which survives in the upper soil layer. Phot. 44.

Fires can gain great dimension as shown in phot. 40 & 41.

After the fire regime had once started in the areas subject to a dry season, that is in the entire eastern half of Java—as argued above originally primarily for hunting purpose, dating back to prehistoric time—the surface suffering from it gradually extended at the cost of the steadily shrinking mixed mountain forest. This ultimately led, in conjunction with a steady increase of the population, to the colossal dimension of the surface which the grassland, savanna and tjemara forest occupies today. The process was certainly also speeded up by cattle-breeding and developing agricultural practices.

It need not to be emphasized that such conditions through the centuries had an impoverishing effect on the soil condition, as the soil was no longer enriched with the nutrients of the tree litter, which adds to the difficulty of reafforestation, both by nature itself and by Man.

In a study on reafforestation in Central Java, Altona (1911) pointed out that deforestation has accelerated in the 19th century, in comparing the situation as described by Junghuhn in the forties with that 70 years later. His data on reafforestation, artificial and spontaneous, prove that under fire-protection forest will come back gradually in many places. A proof of this was also given by Ledeboer who protected Mt. Jang from fire during three decades and who photographed the result, see phot. 42 and 43.

The Forestry Service takes safety measures to protect the forests on summits and crests, because these are the most vulnerable and help to regulate the water regime of the lowlands. Burnt lands easily fall a victim to erosion with detrimental effect for the lowland cultivated area. Protection is effected by the cutting of fire corridors and the digging of furrows, to restrict extension of fires.

CHAPTER 11

STRAY NOTES ON THE ANIMALS

A book like this could and should have some information on the fauna of the Javanese mountains, and on the manifold relations between plants and animals of which in this work only notes on pollination and dispersal are mentioned in other chapters. A profound knowledge of these is required for a complete insight in the great living community supported by the mountains. The scope of the present book does not allow for more than a few stray remarks.

The flowers and fruits of the tallest trees are very hard to come by, but sometimes they are found after having been thrown down by monkeys who play in the tree crowns. In the forests on the lower slopes these are mostly small groups *oilutungs (Presbytispyrrhus)* with long black hair (which when young is rusty brown). Higher up the mountains of West Java we find *P. aygula,* with a more silvery coat. Both live on a vegetable diet, amongst others on the flush *(putjuk)* of *Schefflera aromatica,* etc. They certainly contribute to dispersal, but more is done by the luak *(JParadoxurus hermaphrodites,* of the *Viverridae).* Luaks are noisy, nocturnal animals, very agile and excellent climbers, their tail being about half the body's length, measuring about 1 metre altogether. They are often found in the neighbourhood of villages and frequent roofs and attics. They like poultry and coffee beans.

The fat mountain mouse *(Rattus bukit),* common on the summit of many Javanese volcanoes, densely hairy with white belly and long tail with white tip, diligently climbs the shrubs of *Vactinium varingiaefolium* to eat the berries.

The mountain thrush *(Turduspolycephalus)*, also confined to the highest tops if in a great area, feeds mainly on the *Vaccinium* berries and builds its nest from moss in the *Anaphalis* and other low shrubs. Lower in the forest, birds are known to open the stone-hard seeds of *Elaeocarpus.* There are many species, most of them characteristic for altitudinal zones which for the animals agree quite well with those observed in plants. Most birds nest towards the end of the wet season, to breed in the beginning of the dry season, when many plants are also in flower. An illustrated account of the birds of Tjibodas-Gedé was published by Hoogerwerf (1949).

It is curious that the (sedentary) mountain birds may have a pattern of distribution comparable with that of mountain plants: from centres of speciation in the temperate regions outliers stretch far over the tropical mountains. The above-named thrush *(Turdus)* is an example, a kind of finch *(Carduelis estberae)* living on the high volcanoes where it feeds on tjemara and other seeds, is another.

Flying squirrels *(Petaurista)*, *biluk* or *boluk* in Sundanese, *walong kopo* in Javanese, are often found dead or starving on barren summits (e.g. Mt. Sm6ru) and near craters. These animals have the habit of climbing trees and other high objects from where they undertake their gliding flights. It is supposed that this instinct is fatal for them when they keep climbing, even when there are no more trees, over the rocks. Other animals, however, are also known to climb to such places where they die. See Gisius (1930), Van der Veen (1936) and Van den Bosch (1938).

Wild hogs, *tjèlèng (Sus vittatus)* are not rare in mountain forests, where they like to roll in the mud, and to rub themselves against nearby trees. The bark suffers from this, and often cankerous swellings develop. Hogs have a habit of digging, and thus avail themselves of the tuberous rhizomes of *Rhopalocnemis* (5-3). Of greater interest are the deer *(Rusa timorensis russa)* which delighted Junghuhn on his visit to the Jang plateau in 1844. "Thousands and again thousands of deer stay in these elevated plains, and roam before the traveller's wondering gaze in herds of one, two, five hundred, nay, a thousand. Here various groups of this kind lie sprawled and ruminating on the grass, there others moved in dense masses in slow step away below the foliage, while a few old stags, dark brown in colour, and armed with considerable antlers, stepped as leaders in front of the rest.'

About sixty years later, the Ledeboer brothers found that about one hundred had escaped the endless hunting and killing. But thanks to their good care, thousands were thriving again before the war. They discovered that because salt, necessary to deer, is in short supply on the plateau, the deer descended to the coast in great herds and at regular intervals to drink sea water. When the population in the lowlands increased, many deer did not return because being poached on the way. To save the animals the dangerous trip, blocks of salt were deposited on tall poles under a zinc roof. Thus protected from rain, the hygroscopic salt dissolves very slowly in the fog, to drip down the pole in small quantities at a time, available to the deer. The animals keep the tjemara in check, and their dung and grazing do much to keep the turf short (phot. 34 & 43). The barking deer or *kidang (Muntiacus muntjak)* may, like the former, do damage to young sprouts and bark; young trees may be peeled completely (phot. 32).

Even more spectacular are the *badaks (Rhinoceros sundaicus).* We have read how the earliest travellers in the mountains made use of their tunnels. Junghuhn met two rhinoceros on the summit of Mt. Pangrango when he made his first ascent in 1839. Rhinoceros once roamed over almost the entire island but is now confined to a few dozens still living in the protected Nature Reserve Udjon Kulon, the extreme southwestern peninsula of Java.

The *banteng (Bos sundaicus)* of equally wide former distribution, also in the mountains, befell an almost similar fate, but is surviving in a few more reserves.

The mentioned hooved mammals were and are probably responsible for dispersal of the seed of the root parasites *Rafflesia* and *Balanophora,* as discussed in the caption of PL 5-1.

Fine weather on the mountains brings out immense numbers of buzzing bumble-bees. They are harmless unless their nest is disturbed; more annoying are the wasps. The solitary species sting painfully, but far more dangerous are of course the social-living species like *Vespa velutina,* nesting in the bare parts of craters against rocks, and also in the ground. A great number of stings may result in high fever. At Kandangbadak, the 2400 m high saddle between Ged6 and Pangrango, there was such a swarm at times, and parts of the crater of Mts Salak and Patuha were notorious. Running is the chief remedy and the application of ammonia on stings.

The most comprehensive study of the fauna has, of course, been made at Tjibodas, and Dammerman (1945) wrote a well readable brief account of it, from which a paragraph may be quoted. 'A stroll in the evening twilight or dusk is frequently as profitable as an early morning one. As soon as twilight falls the cicadas set up their concerted screaming, which is timed to open and close at the same hour every day. But it is extremely difficult to spot them not only in the semi-dark but even in full daylight. As we try to locate one by its noise, the screaming stops at once and before we realize it the insect has flown away. A very common cicada at this elevation is *Platypleura nobi/is,* about 3 cm in length, the large translucent wings included, which are adorned with brown markings, especially so on the forepart/

'If we have no objection to traversing the forest in the dark, we shall be amazed at the large number of mosquitoes, more so as in the bungalow one can sleep without a mosquito-net. Protected by a strongly scented oil smeared on face and hands, one can walk on undisturbed. The chances of meeting with larger beasts of prey are extreiriely small, although panthers are found here and even have been seen in the neighbourhood of Tjibodas. In fact, an attempt was once made to establish a deer enclosure in the park but the animals were carried off one by one by panthers. The Sundanese even assert that tigers have not altogether disappeared from these regions.'

Now that rhinoceros and banteng do not roam the mountain forest any more, tiger is almost absent and as shy as panther of Man, the forest is as far as animals are concerned perfectly safe for Man by day and night, the more so as vipers are absent. Back from our trip in the high forest we may probably notice that a few land leeches have been picked up on the way and if they have not already dropped off we shall find the blood-gorged creatures still adhering to our legs. They lie in wait on the path and the undergrowth on leaves and twigs constantly groping about for human and animal victims. The nuisance in they cause is often strongly overrated: do not tear them off, a few drops of iodine are sufficient to remove them and sterilize the minute V-shaped incision they make.

CHAPTER 12

THE PLANT FORMATIONS

I. THE PRIMARY FOREST TYPES

Introduction

The fully developed primary or climax forest of the Javanese mountains can roughly be divided into the *high forest* and the *elfin forest.*

The *high forest* is characterized by its strongly mixed nature. The high closed *canopy* or *first storey* is at some 30-40 m height, above which a few (usually widely spaced) species can dome-like *emerge* with their crowns to some 50 (or even 60) m. Below the canopy there are a large number of lower trees which form a more or less distinctly visible *second storey* consisting of medium-sized trees which reach at maturity some 15-20 m height, and below this follows a *third storey* of shrubs and (1-stemmed) miniature trees of 5-10 m height. Through these storeys there are many lianas and epiphytes. On the floor of this very compound forest one finds a *ground layer* of mostly herbaceous plants, but also often patches of litter-covered or bare soil. There are practically no grasses. Light intensity at the forest bottom is very low, about (i-)2-5%.

This structural forest type goes up to some 2000 m altitude, but this may vary with the height of the mountain and with the topography; in the high ranges of Irian it goes easily up to 3000 m. No hard and fast rules can be given as vegetation is a continuum and there is of course always a transition zone. Phot. 1-10.

The *elfin forest* extends above the high forest usually onwards of some 2000 m. It contrasts in missing emergent trees and it has an even upper canopy, while the height of the canopy is about equalling that of the second storey of the high forest, but is composed of fewer species of trees as compared with the high forest. There are also few lianas, both as to species and specimens. Thick-boled trees are absent or extremely scarce, the thinner stems are closer placed and beneath the canopy is a shrub storey, comparable with the third storey of the high forest. This type of forest allows of course far more light on the forest bottom favourable for the growth of grasses, sedges, ferns, mosses, and herbaceous plants. On spurs, ridges and steep slopes it naturally occurs in a dwarfed shrubbery (edaphical) fades because of the prevalence of rock substratum and the consequent scarcity of soil. Phot. 15, 18.

The third main forest type is the *Casuarina* or *tjemara forest* or savanna woodland in eastern Java. This type which has the physiognomy of a coniferous forest by the needle-like twigs superficially resembling needle-like leaves, properly only consists of a pure stand of *Casuarina* (8-9). Phot. 34-39, 42-43.

This latter type is not a primary forest but a pioneer forest following the destruction of the primary forest of both the high and the elfin forest. If fire is kept out and there is no volcanic action it will, when left alone, be eventually replaced by primary forest components while tjemara will be forced to retire to its original marginal position as a pioneer on fresh volcanic ash and debris, earthslides, rock slopes and sandy river banks; see chapter 9. This is of course a very gradual and slow process as tjemara is a distinctly long-lived tree. Moreover, it is unimaginable that this will ever happen, as due to man's activity fires rage over East Java each year and will do so in the future (see Burger, 1930). So this pioneer forest will be perpetuated forever in East Java and the Lesser Sunda Islands.

In the following chapters I will try to give a very brief sketch of the vegetation of the primary high and elfin forest and their biotopes, the secondary and the tjemara forests, followed by short chapters on the vegetation of biotopes which do not carry primary forest because of water (marshes, lakes, swamps) and the sites where volcanism has created other biotopes (lavastreams, lahars, landslides, ash screes, craters, etc.).

a. *The big)) forest*

Various aspects have already been mentioned in earlier chapters, about its regeneration (chapter 9) and its very mixed character which means that most of the hundreds of tree species are represented by rather widely spaced specimens. This is everywhere so in primary tropical rain-forest and detail mappings proving this are for example published by Schulz (i960) in a most excellent analysis of Surinam forest. The unevenly scattered occurrence is obviously a consequence of the spot-wise regeneration. It makes it difficult to give a local subdivision of the forest into forest types comparable to sociations or associations distinguished in temperate countries, as the floristic composition differs so much from place to place.

This is also true on a regional basis. For example in West Java one of the characteristic emergent trees is *rasatnala {Altingia,* 23-4), the other two being *djamudju {Podocarpus imbricatus,* 13-2) and *ki putri (P. neriifolius,* 13-1). But on Mt. Slamat, in Central Java, the latter two are present, but *rasamala* is absent. The same holds for characteristic canopy trees, both *riung anak (Castanopsis acuminatissima) and puspa (Schima,* 5 2-7) being very common in West Java, but on Mt. Slamat *puspa* is absent as its distribution is confined to West Java, like that of *rasamala.* And the same holds for the second storey and the herbaceous plants.

One might be inclined to take *dominance* of certain species as a lead towards distinguishing forest types, but this would be a dangerous procedure as this varies from place to place and is mostly local. We found, for example, distinct dominance of *Podocarpus imbricates* (13-2) in a girdle on Mt. Tjeremai and in other places of *Astronia* (31-1) and on Mt. Slamat a dominance *oiSchefflera rugosa* (3-3) and on Mt. Selo of Ged6 of *Leptospermum* (33-4). Closer research invariably shows that this dominance is due to some disturbing event in the past and will peter out with time to become a mixed stand. It will take a very long time indeed, it must be realized, before this original very mixed character will be regained. The life span of a tree is much longer than that of Man, but the time needed for regaining the mixed climax stand is easily imagined to be very many orders greater.

How mixed this character is and how many species are involved is, for example, shown in the inventarisation by Meijer (1959) of one hectare *(i* acres) of mountain forest in the Tjibodas forest reserve (1500 m, West Java, on Mt. Gedé). He counted 78 species of trees, 40 of shrubs, 30 of climbers, 10 of creepers, 100 of epiphytes, 73 of terrestrial herbs. This makes 333 species of phanerogams and ferns. The whole nature reserve, from 1500 m up to the top, has about 870 species of phanerogams and 150 of ferns. A total of **283** individual trees over 10 cm in diameter were found on that one hectare plot.

It appears from these examples, which could be multiplied manifold, that each species in this *continuum*—as defined by Gleason (1917) and agreed on by Curtis (1959) and Schulz (1960)—has its own private regional range. And whereas it would be useless to define a forest type by presence or absence of one emergent tree or one canopy tree, it appears impossible to make a sociological subdivision. This becomes only possible in forests which are composed of very few species, as is often the case in cold or dry regions, in marshy or saline habitats, in short, where severe or specific conditions are a restriction. Under generous or mild conditions this happens when extreme soil conditions only allow for a restricted number of trees, as in the tropical peat forests of Borneo and the mangrove.

Such restrictive soil factors are not present in the mountain forest; besides, squares comparable to those of 4 sq. metres used for sociology of herbaceous plants in temperate countries on even soil conditions are useless in the tropical forest as these squares should then be proportionally larger with a factor 60 in comparing the height of a herbaceous vegetation averaging half a metre and the tropical forest canopy of 30-40 m, that means that such squares should have a surface of 3600 X 4 sq.m or c. 1 \ hectare. But it is impossible to find homogeneous soil conditions over such an area. Incidentally, I observe that this is, in great detail, not even homogeneous on the 4 sq.m in the temperate countries, where the minutium is simply neglected. Jn the forest it is presented on a very much larger scale and appears visible.

Apart from this it must be realized that with long-lived plants, of which the canopy trees and emergents will attain some 100-300 years in age, the soil conditions may considerably change, at least as to hydrology and topography, during the life-span of these trees.

For the rest, it has been observed in Surinam that even if the soil conditions change over not too large surfaces they need not be reflected in forest composition: a small outcrop of sandstone, limestone, podsol, etc. of a hectare surface remains invisible floristically. This faint reaction on soil differences under the overwhelming forest canopy changes essentially under deforested conditions or in treeless vegetation. One could express this phenomenon in saying that soil differences are blurred under high forest cover, but come sharply into focus in open herbaceous communities. I find this point too much neglected in plant sociology.

Altitude and floristic composition. **With regard to altitudinal** zonation there is also no break in the continuum upwards, each species keeping to its range. Seifriz(i923) gave a rather acceptable picture of the gradual zonation on Mt. Gedé.

At 1000 m already many lowland families do not occur any longer and between 1000 and 2000 m others are only represented by stray species or a special genus, fading away upwards, for example:

Annonaceae	***Myristicaceae***
Apocynaceae	***Palmae***
Araceae	***Papilionaceae***
Asclepiadaceae	***Rhamnaceae***
Burmanniaceae	***Sapindaceae***
Connaraceae	***Thymelaeaceae***
Cucurbitaceae	***Vitaceae***
Euphorbiaceae	***Zingiberaceae***
Menispermaceae	

Other families find themselves in optimal or abundant development in the middle mountain zone, and Junghuhn and Miquel have correctly named this forest zone *Fago-Lauraceous,* because *saninten* (chestnuts), *pasang* (oaks of the genus *Lithocarpus)* and laurels are abundantly represented in species and specimens.

The generous, frostless tropical-montane climate can be compared with the subtropical and part of the warm-temperate climate and this is also reflected roughly in floristic composition by preference or continued abundance of the following plant families:

Balsaminaceae	*Myrtaceae*
Begoniaceae	*Orcbidaceae*
Campanulaceae	*Primulaceae*
Caprifoliaceae	*Ranunculaceae*
Ericaceae	*Rosaceae*
Fagaceae	*Rubiaceae*
Hamamelidaceae	*Schisandraceae*
Juglandaceae	*Symplocaceae*
Lauraceae	*Theaceae*
Magnoliaceae	*Umbelliferae*
Melastomataceae	*Urticaceae*
Myrsinaceae	

Ecological niches. They are partly defined as topographical variants, a swampy place, an outcrop of rock, the deep, waterlogged soil of a stream bottom, a waterfall, with their reflection in the vegetation.

Ravine bottoms are favourable for growth of *Zingiberaceae* (57-2/6), *Elatostema* (56-2), *Saurauia* (15-2), etc.

Waterfalls favour *Elatostema* (56-2), *Pilea* (56-4), mosses (amongst them not seldom *Sphagnum)*, ferns, etc. (phot. 12).

Very steep ridge-sides abound with thickets of some coarse ferns: the genera *Gleichenia, Dicranopteris, Oleandra, Dipteris,* and thickets of *Freycinetia* (40-5).

Microclimate. This differs of course from the bottom up towards the canopy; absence of wind and high air humidity are characteristic. In many places festoons of an aerial moss *(Aerobryum)* hang from branches (phot. 4) and mosses abound on wet, fallen logs and bases of tree trunks (phot. 5). Near waterfalls and on rocks in streams terrestrial mosses may also locally form carpets and upwards of the cloud zone mosses increase.

In certain parts of the forest, mainly due to topography, air humidity seems to be constantly excessive, primarily near the forest floor. This results in an abundance of very small cryptogams (algae, lichens, hepatics and mosses) on leaves which may be densely covered with these epiphyllous organisms. These epiphylls are not especially bound to a 'host* and are frequently found on old leaves, e.g. of gingers but also on leaves of third storey shrubs and miniature trees *(Amaracarpus, Lasianthus,* and the like). Their settling is probably favoured by stagnancy of a film of liquid water on the leaf surface which gives germinated spores time for attachment to the epidermis. This I derive from the fact that their growth often starts in grooved nerves and veins. But hydathodes may also serve for this purpose.

Epiphytic plant life is abundant with mosses, ferns, and orchids and these are also indicative of the everwet climatic conditions and constant high air humidity under and in the canopy (phot. 7-8). They are consequently also found in the 'wet islands' in East Java and I have mentioned several as indicators for everwet climatic conditions: the filmy ferns of the *Hymenophyllaceae, Gleichenia, Nepenthes,* and the majority of *Orchidaceae.* See chapter 4c

This is not to say that *wilting* does not occur on hot days in very local small open spots. I have observed wilting of leaves of *Impatiens, Pilea, Elatostema* and *Amorphophallus,* but the wilting is of very short duration as such spots are often only very temporarily fully exposed to the sun and the plants regain turgescence soon afterwards.

During excessively dry years desiccation may be much more aggressive but I have observed that, even then, drought-sensitive plants as *Agalmyla* and filmy ferns overcome this desiccation, probably by restoring their water balance by absorption of atmospheric water during the night when the relative humidity is even increased in such periods. See fig. 11.

The presence of *drip tips,* characteristic caudate elongation of the leaf-tips (see *Ficus,* 32-1), is sometimes taken as an indicative of an *everwet* climate, but this is certainly not true as they occur also in tropics with seasonal drought, for example *Ficus religiosa* in India, but they do seem to be indicative of a *tropical dimate,* and as such are useful for the palaeontologist. They occur much scattered through the plant kingdom. Furthermore, they are not always constant within the species. And whereas they are only found in a very restricted number of species, and moreover species of the same genus provided with drip tips and those without may occur in exactly the same habitat with congeners without them, I do not attach much importance to them as a special adaptation to environment. It seems to represent continued length growth of the leaf allowed by the tropical climate. Some botanists with a teleological obsession have invented all sorts of theories and inflated drip tip occurrence as one of the great inventions in tropical adaptation, but their theories reflect their ingenuity rather than ecology.

In passing I may remark that teleology is entirely defeated in the tropical rain-forest and with it a great deal of the theory of adaptation. The generous tropical climate allows Nature to produce all sorts of plant forms in which the level of survival value lies lowest, that is, where beyond the primary conditions of germination and early youth in the dark, assimilation and propagation, they may be adorned with all kinds of harmless fancies of structural evolution (S 1969). This has led to the colossal development of forms, often bizarre to our human judgement: from the scaly leaves *oiCasuarina* to the 5 metres long ones of *Amorphophallus titanum,* the minute flowers of *Embelia* to the colossal ones of *Rafflesia arnoldii,* the thread-like stem of *Burmannia* to the towering boles of *rasamala* and the enormous mass of the strangling figs. I see little 'regularity' or line in it as Corner did (1949) in his durian theory or as Went (1971) in suggesting phylogenetic contamination. To me each individual species is a wonder of organic creation each equally bizarre.

Returning to the subject of climate affecting structure, I would like to give attention to the fact that whereas one would likely suppose that in the generous everwet forest climate leaves were not only large but also rather herbaceous and thinnish, the reverse is the case, the majority of trees and shrubs have leathery, often hard leaves. This also holds for the elfin forest and its mossy fades where they are moreover distinctly small tending to be micro-phyllous. In many cases the sclerophyll structure is primarily caused by a very thick cuticle. On breaking the leaves one often hears a sound as in cracking tin-plate. To this common phenomenon of scleromorphous structure in plants bound to a very wet climate little attention has been paid by anatomists and physiologists. Naturally *sclerophyllous* structure is not identical with *xerophilous* capacity (standing drought), as not anatomical but physiological qualities are conclusive for the ecological definition of drought-resistance. As Von Faber has shown (1927) these scleromorphous leaves have a high respiration rate. Furthermore, the leaves of both the high forest and the elfin wood trees can remarkably well stand strong and sudden variations in insolation and air humidity of the daily climatic regime. It does not seem impossible that the development of the very thick cuticle, and maybe other scleromorphous tissue, is due to the leaching effect of the abundant rain-fall which seems to be considerable, according to Frey-Wyssling (1935, 1949), as found for mineral substances of potassium and calcium. The amounts are so large, that this recretion can even be considered as a regular supply of nutrients to the soil. Furthermore he pointed out that of course leaching is greatest for the best soluble substances, especially potassium, and that consequently so many tropical plants accumulate siliceous and calciferous matter in their leaf tissue *(Tectona, Petraea,* etc.). I may add that in addition to this it should be considered that leaves in the tropical rain-forest have mostly a much longer life than those under leaf-shedding temperate conditions. I measured leaves on some pole trees at Tjibodas which remained fully intact for 2-4 years.

Here again is then a nice physio-anatomical problem to be sorted out by the collaboration of an anatomist and a phytochemist in a laboratory in the tropics.

Mycorrhi^a. The usually shallow root system of all trees in the mountain rain-forest is associated with soil fungi, often of the higher mushrooms. They have a most important function, viz. to decay the litter (fallen leaves, twigs, fruits) and transfer their nutrients, of which especially the minerals are important to the tree. One must forget the idea that tropical soils are very rich because they carry magnificent forest. In fact, most tropical soils are proportionally poor, because they are continuously leached by the excess of rain-water by which the dissolved mineral nutrients are washed away. That such high forest, with a huge biomass contained in the wood of the tree frame can be built up is partly done by the root-system sucking up minerals from deeper levels, but to no mean degree by mycorrhizal fungi which catch these substances from the litter and recycle them into the tree. Fortunately Javanese soils are more or less regularly rejuvenated by ejected material from the volcanoes (lahars, lavastreams, ash) providing a fresh supply of mineral substances to come free by weathering of the rock. In Borneo, without volcanoes, soils are consequently much poorer.

Representation of life forms in this book

As many readers will not be familiar with the Latin plant names and one can from the plates of course not always deduce the life form of the depicted plant I will for convenience sake roughly enumerate them as far as necessary. In the complete mountain flora of Java there are of course many more than the ones I have pictured.

Emergents

Altingia (23-4)	*Podocarpus* (13-1/2)

Canopy or first storey trees

Acer (1-8)	*Fagraea* (28-6)
Astronia (31-1)	*Helicia* (42-5)
Bruinsmia(jz-z)	*Schimatjz-i)*
Distylium (23-5)	*Sloanea* (15-4)
Elaeocarpus (15-3)	*Vernonia (iz-6)*
Engelhardia (24-1)	*Weinmannia* (13-7)
Eugenia (H-I)	

Second storey trees

Acronychia (49-1 & 3)	*Orophea* (2-3)
Adinandra(jz-j)	*Pithecellobium* (30-3)
Antidesma (18-5)	*Pyrenariafjys)*
Breynia (18-6)	*Saurauia* (15-2)
Glocbidion (18-7)	*Symplocos ($z-í)*
Kibessia (29-6)	*Talauma* (29-5)
Lindera (26-1)	*Turpinia* (52-1)
Litsea (26-2/3)	

Third storey small trees and shrubs

Ardisia (32-6/8)	*Mycetia* (47-10)
Dichroa (50-3)	*Perrottetia* (8-10)
Geniostoma (28-8)	*Pittosporum* (41-4)
Hydrangea (50-4)	*Polyga/a (41-6)*
Lasiantbus (47-5/8)	*Psychotria* (48-4)
Maesa (33-2)	*Viburnum* (8-3)

Ground layer

There are too many to enumerate and I will below recall these by the herbaceous families to which they largely belong:

Acanthaceae	*Leguminosae*
Amaryllidaeeae	*Melastomataceae*
Araceae	*Orchidaceae*
Balsaminaeeae	*Polygonaceae*
Begoniaceae	*Rubiaceae*
Campanulaeeae	*Scrophulariaceae*
Compositae	*Solanaceae*
Cruciferae	*Umbelliferae*
Cyperaceae	*Ui ticaceae*
Geraniaceae	*Valerianaceae*
Gesneriaceae	*Violaceae*
Labiatae	*Zingiberaceae*

The KCnus *Slmliiluiiilits* (1-4/6) of the *Aeaatlmctar* tie-serves special attention. Many species uftcn **OCCUI grega-riously** in ihi- Javanese mountain forest undergrowth in **complete** dominance (phot. 3, 10). As explained in **the** dpi i'in to PI. t-4 such stands *grtivr* stcudily **for** seven or more **yean to attain a height of** 2-3 m (sometimes more) and come **simultaneously** in 1 lower and then die **off.** This makes a remarkable impression of an 'empty **forest",** but **gregarious** germination follow* **shortly** after and the same **cycle** Marts over again.

Climbing plant*,
herbaceous *(b)* :mil woody *(»•)*

Some of the climbing plants ilini; to the trunk nf the hctst tree, the root-dim burs *(AgatiKjta, Hojii, Sinn, S\mda-Kin.* etc), but other li:m;t> iuru; tree in the air though often close to the trunk. The latter position is often useful for able Sundanesc to climb the often very thick boles of the canopy trees. Phot,).

Aft/ilmyh u-t *(//)*
Aifxia* 1-4 *(w)
Arislokcbia 4-1 *(»)*
Ckmetis \S-v\x (»')
Ctittonopsii 7-j *(h)*
Crawfurdia 20•**I** *(it)*
Creochiton **ji-i** *fa')*
***Cittiirbitaetat* 18-1/4** *(b)*
***PiidnJU* 4-a .i** *(t)*
lilttctigmx 14-19 *>»')*
Eimnjmns 1-9 *fw)*
Ficus 32-2 & 4 *(w)*
S'reycittttia 4c~j *(w)*
Hoy a* 4-5 *(h)
Jasmimm*)j-6 *fm)
Kadsura 19-3 *111')*
Ljteettgit 53-! ***(w)***
Leaietra 8-1/2 *{»)*
Madura 30-7 *(u>)*
Mvrittdit 47-9 *(&}*
Pltctocomia {»•)
***S'a/yjpiii/M* 41 -7** *(//)*
***Rbtwjiiits* 43-7** *(w)*
Rubia 48-5 *(b)*
fivfou spp. PJ. 4) fij
Scbiumdra 1-10, **29-4** f w)
Smiltx Z8-5 ^wj
***Sttpbaria* J3-1 f»J**
Tetralligma 53-) f^
Toiidalip 49-4 ^wj
Tylnplxira 4-6 (^J
Zantixtxyhuis 5 j-i f»J

I Lcmi-cpiphytic plnnts

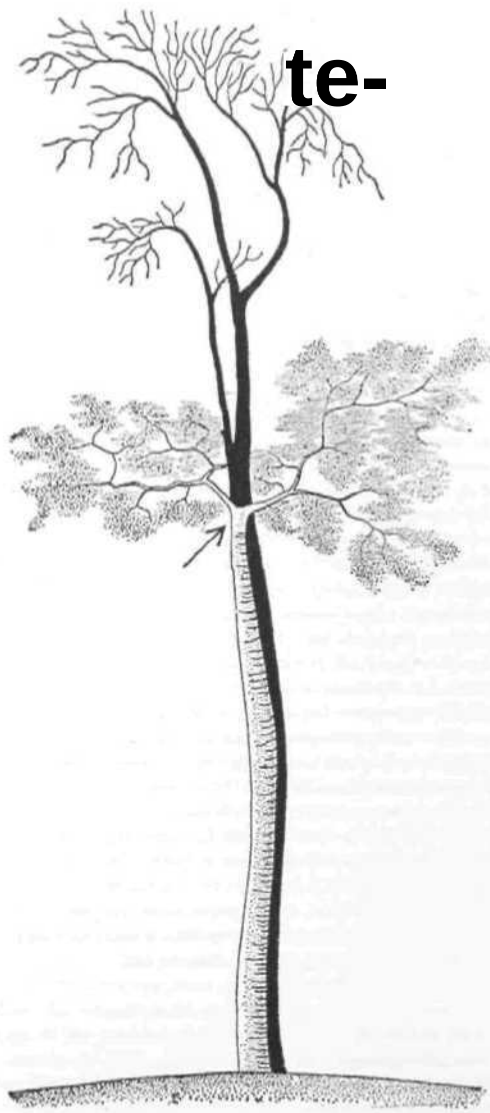
Tins is a peculiar life-fomi in that the seed of those plnnis do not (and **cannot)** germinate on **die foresi Boor,** bur do no in the cmwn or in a branching fork of a tree. There the young plant grows into a shrub and develops n **iota** t"r attachment, But part uf the routs grow down the host-tree and eventually reach the soil. Then mnrt-nutrients become available and bnrh main root and shrub grow vigorously and may remain standing even after the host tree decays. See further the caption to PL ji-) of *W'igl'tij* and fig. 16 (S 1949a).

There arc not many hemi-epiphyte5; the **following** arc examples:

Fagraea (28**-7)**
Ficus spp.
Ilex spicata (2-5)
I *'iitiiniitm* (17-6)
Wightia (51-5)

Epiphytes

Epiphytic plants abound in the rain-forest and trees can be bden with them. Phot. 7-8. In some cases one must even be careful in rmllin.s; at lianas or pitch camp under Such trees as during ruin Storms these masses become



Fin. 16- !!•"«*"*" *ttriKfiuii* i*|s. *sialamlrrt* f(i-j) developed u 1 tree tbtMtkJ un another tree *(PltfoifHrmtim),* cbspinr; the tarter U'ith its ....is. h slatted life u a hcmi-cpiphyiii; ihnib in the fork indicated by the urow (after Kcxirdcra, Pintjur Idjtn, Id*)). The total height *wan* miimurcJ hy **KoOffcjwt** at 4j m. hui 1 think this too hi^h,

satutated with water and very heavy and can come down with wind RUSIS. They consist mainly of mosses, ferns and orchids but there arc also certain herbs and shrubs which !ive normally as epiphytes. Their seed is dispersed by wind, by birds and of some by ants. The roots of the seedlings cling to the bark. !n rate cases they even penetrate the batk as I observed (S 1933) in *Dtniirvtroplx umiielltttta,* a shrub of the *Seittdhftat,* in the forest above Tjibodas. Dust from the air, detritus from fallen parts of plants, sometimes soil brought up by termites or ants, droppings from birds, etc. form the food source of the epiphytes which is also enriched by nitrogen coming down with rain during thunderstorms. According to Roelofsen (1941) this latter source is quite substantial. Especially the very start of the rain, cleaning the sky, brings along the dust and nutrients and the latter are sucked up by the plant surfaces; the pale velamen surrounding the tip of orchid roots may be important in this respect.

On the other hand it must be remembered that the heavy rains in the mountain forest have a constant leaching effect on the epiphytic habitat. But there must be a good balance because they thrive and look vigorous and healthy, notwithstanding the oligotroph habitat.

The accumulation of humus is of course most efficient in the large nest-forming ferns, the largest being the stemless *Asplenium nidus* with a patent'whorl' of many elongate leaves over a metre long. Phot. 3,11. Other ferns may nest in its humus as hyper-epiphytes *(Ophioglossum pendulum, Vittaria* spp.), even *Aeschynanthus* (phot. 11). Very large sound-producing earthworms up to \ m long, *tjatjing sondari,* appropriately named *Perichaeta musica,* live there too.

Several epiphytes climb with rootstocks along trunk and branches, ferns and orchids alike, but also *Aeschynanthus* (21-5/6), *Dischidia* (4-2/4) andi/??* (4-5)- Phot. 5, 11.

Among the orchids pictured on PL 34/39 the epiphytes belong to the genera *Appendicula, Bulbopbyllum, Ceratochilus, Ceratostylis₉ Coelogyne, Cymbidium, Dendrobium, Dendrochilum, Eria₉ Liparis, Oberonia, Pholidota, Pbreatia, Podochilus, Schoenorchis, Taeniophyllum.*

One of the most curious is *Taeniophyllum* (36-14), a genus of which a dozen species occur in Java; the tiny plants are leafless but possess a system of large flat green roots which replace the assimilation of leaves.

Quite a few orchids which are epiphytic in the mountain forest are also (rarely) found on rocks, which I saw in East Java on Mt. Lamongan. Far more abundantly I observed it on Mt. Tèlong in the Gajo Lands of North Sumatra (see also Frey-WyssUng, 1931) where in the treeless lahar summit zone there are the most magnificent orchid rock gardens imaginable. Obviously the very young volcanic rock, poor in nutrient matter, ecologically equals the epiphytic habitat and must be also oligotroph.

Whether the epiphytic orchids descended from lithophytic (rock-confined) ones or the reverse, is an academic question as there have always been rocks and trees alike. It seems rather certain that a fair number of the epiphytes, especially those thread-like hanging species as *Schoenorchis juncifolia* (35-9) are too much specialized to live on rocks and must stem from other tree epiphytes.

Other pictured epiphytes are mostly shrubs, e.g. *Ficus deltoidea* (32-3), a curious plant which is also cultivated as an ornamental plant in Europe and occurs often terrestrial near solfatara and in craters, *Medinilla* (31-3) with its wax-like flowers; and *Peperomia* (41-2). Then there are the *Ericaceae* of which several are usually epiphytic, viz. *Diplycosia*(15-6/7), *Rhododendron*(16-1 /3 & 5) and *Vaccinium lucidum* (17-7). The latter may occur as a terrestrial shrub on ridges and then assumes a curious, erect, broom-like habit quite different from that of the rather irregularly spreading epiphyte. *Rhododendron javanicum* (16-3) regularly occurs terrestrially in craters and on rocks near waterfalls.

Relation of epiphytes with their host tree. Superficially it would seem that any epiphyte has a chance to settle on any branch of any tree in the forest. This does not seem to be true according to Went (1931, 1940), who made a large pioneer study on this subject in the Forest Reserve above Tjibodas. He only found absence of any relation with a few ferns, amongst them the nest-fern, *Asplenium nidus.* He ascribed this to the fact that this fern accumulates its own humus clump largely from its own decaying leaves. Went found two classes of epiphytes, those which grow only on humus-clumps (shrubs, few ferns and some *Bulbophyllums* with pseudotubers) and *bark-epiphytes* (ferns and orchids). Furthermore, he found a distinct relation of the latter to the kind of host tree in that certain epiphytes are distinctly bound to certain host trees in a sort of open air associations. He argued that this was not due to the physical quality or water capacity of the bark or the architecture of the tree crown.

He concluded that it must be the water-soluble chemical substances of the bark causing this phenomenon. He remained in doubt whether this chemical influence was exerted directly on the developed plant or possibly in or shortly after the germination stage via the mycorrhiza. He observed also that on dying branches growth of the epiphyte increased, deducing that the epiphyte indeed extracts nutrient matter from the host.

He mentioned in passing that coffee planters believe that the fern *Pyrrhosia nummulariifolia* frequently webbing coffee twigs with its long and thin rhizomes contributes to the decay of the twigs.

This induced Miss Ruinen (1953) to a further study in which she could show beyond doubt that this is true, and that also certain small orchids exert a similar influence by their long thin roots appressed to the bark of the twigs. This has shed a new light on the nature of the host/epiphyte relation, in which the epiphyte has revealed itself as no longer innocent but as a sort of mild hemi-parasite. She believes this hidden parasitism or *epiphytosis* to go through the symbiotic fungus of the orchid and fern which pierces the bark of the host plant and penetrates into its vessel tissue. It may hold for the tiny-twig epiphytes, but I can hardly believe this to be true for the bulk of the large rainforest epiphytes found on thick branches of trees.

Parasites

Parasites are not uncommon in the tropics. The most obvious ones are found on roots, viz. of the genera *Balanophora(yifz)* and more rarely *Rhopalocnemis{y$).* For some interesting data I refer to the captions of the plates. One small species of *Rafflesia,* not illustrated here, is found up to 1400 m, parasitizing on *Tetrastigma(^y^)* its flowers measure some 15-30 cm diameter, are redbrown with dark red \v:irivcin **the lobes;** ii incurs very rarely in West | a vs. Then there is *AegitKlia* (.J0-4), a magniliccnt plant. ***but*** *y*$_n$rowing largely outside rhc forest in grassland; a related spccEcs, .[r]l. *immbttis*, wjth very short, branched peduncles is a rare forest-dweller, parasitising on **the roots** of various plums, and **amongst** others found on Mt. Salak.

C».rriWfl(i}-j) mostly itturi in Mas! jai.'i, |iiv<l->i[iin:intly on tjemara, but going over on many richer **plains.** Phot, 9,

Then follows a group ot tree parasites which are, in contrast **to** the mentioned pirasires, capable of assimi-Luion and have green stems or green leaves. Therefore, they are often termed *btmi-psrssilsi*, but they arc true parasites and cannot live without sucking a host **plant.**

To til esc Udong in t!ic first |>l:tcc (he *Ijtrantiiattae* which arc represented here by **two** small true mistletoes of the genus *Ker/ia/ifl/a* (jo-;/6); see the captions. On *TtissBiata* also occurs a large mistletoe, *Viscum /iqiiid/imliiirrntlnm* bound to *Hamaraclidmeiic* as a host. The major part of the *LoTdnibtmst* **represented** Wong to the subfamily *Lorentlioi-dtae* u-liieh differ from the true mistletoes in having almost ukravs slu.wy flowers, white, fed, orange, with black and green markings. !'or their interestingbiulugy I refer utthe captions of ***itatrsxttK atvris* (19-1), *Scurnda*** (29-1) and *Daidmphllw* (50-4) and the excellent work of Docters van Leeuwcn (1954); see ilso p, 14I1,

The second family nf hemi-parasires is the *Sonlalateat* to which sand.ihvood belongs. In contrast with the Utter which is a root-parasite, ours is a crown-parasite, *Dtmtre-mjza* (48-7).

The thud family containing hemi-parasitic plants i;. ***StmpMtrMtm*** to which the terrestrial herb ***SepubU*** *frijfdu* (j J-J) belongs which probably parasitizes fin grass **toots.**

Saprophytes

These arc the humicolous terrcstriil plums lacking green substance and depending roc their *(oixl* on decaying matter **though** transfer by fungus threads of myctirrhizal soil fungi. Only tew an? found in the montane zone ind no saprophytk plants arc found above 14)0 m. In addition to the ones pictured, viz. *Biirmaiima* (y-j) and two orchids, *Cytterebis* (34-3) and *Cn/n/a* (J7-4), I found another *Biirmmiiiiam* East Java on Mt. Ijtmongan and at Tjibodas a tiny *Hciaphiiii* of the family *Triuridacau.*

Readers who are interested in the many echlornpbyllous plants of the Archipelago I refer to a key 1 prepared for their identification (S 1934a).

Insectivorous plants

The mnst well-known is of course the pitcher plant, the genus *Ntpaitbts*, of which one species ()3-l) "ccursinthe Javanese mountains. It is strictly bound to an cvenvet climate and occurs in East Java only in the 'wet islands'. Tor particular! see the caption of the d tit wing. Then there is a small *Drosrrti* (14-1*H*); this is not a forest plant but occurs in grassland. Finally there is a terrestrial *Utriailaria* (17-7) which is a true forest-dweller sometimes also found in wins with seepage and near waterfalls.

Succulents

True succulents *An* not occur in the m< mntain forest, but one can dispute whether the pseudobuths of many epiphy-tic orchids *{Bittbopbyltnm, Dtndrohium, Dwdrncbilnnt,* etc.) must not be reckoned to this class, as well as the orchids possessing terete leaves such as *SrlxHtiorcbhjfmcifeha* ($ J -9)* It was e;irlicr remarked lhat these indeed serve as water reserves.

Here 1 should mention the 1 **lecutcenee** 1 >f **wo<** >dy tubers of two epiphytes. Rvcn in the younj; stage *Vacttnuim hiriditm* **(17*7)** forms a woody thickening at rhc stem-base (fig. 17). A similar, rather large woody tuber is found at the stem-base of the santaJacetius epiphyte *Dttidratrepht utsbtl-**i**ata* (S 1933).

Fijf. T7. A young epiphytic specimen of *Vaitimwx tttti/tnm* **(17-7)** in **the** fain-forest on Mt. CJcdi wiih s developed liftnotuber (after Von Fabet. X |).

Gcophytcs

Plants with subterranean rootstoclts, tubers and bulbs are very common in the forest, with the *y.mpbtriutae, Biirmaimiacdit, OrebidaciM, Liliactat, Aractat,* and some other herbaceous families where they arc the rule.

Therophytes

On the uther hand therophytcs, the annual short-lived plants, arc extremely rare *(JJtricitlaria^* 27-7; *Hypericum,* 13-7). Almost all herbaceous plants are perennial by root-stocks.

Si>me biological structures

It might be of interest to point to some peculiar biologi. cal structures.

Buttresses are found at die base of many trees, but usually rti.-fl.ing/* ant of small size, much smaller than those fnund in the mixed lowland rain-forest.

Still roots are of course found in pandans *(Pandanns),* of which two species occur between 1000 and 2000 m, viz. *P. furcates* and *P.janigtt.* The tatter which occurs only {but plentiful) on Mt. Tarub(-Lamongan) possesses ennrmnus thick Stilt roots. Stilt roots occur further often in, mostly smallish, trees *n(Uthoctirp»s (prtiiitg), Ebeccarpnsoxypyrtn. Bttgtnia aaimhatissima, Castampsis snimwudtsima,* and sometimes in palms. They arc also found in cern.n herbaceous plants, viz. some gingers, *Opbhpt>gi>n{z*8-;) **lad** *Piliosantlits* (28-4), and occasionally in *Strobi/ati/Mi.*

A *s/ioif apparatus,* that is, the presence of coloured and mostly enlarged bracts (decoy leaves) or sterile marginal flowers with deviating colour and larger siae than the normal ones, is found in *Mtwain<t'a(48-i),ity<ir,at&a(\o-4),* and *Frgtimtits* (40-O- Such structures contribute to **the** showiness of inflorescences and arc supposed 10 add ***to*** tlidr Attracting pollinating insects, bats, or birds. Experi-ments are still needed tci show that they are really effective towards this purpose, as mentioned in the explanation of PI. 48-1 and 50-4.

Catdiflory, the appearance of flowers and consequently fruit from the old wood of the trunk or from branches *(ratitifiory)* is a rather common phenomenon in the low-land flora: it occurs in some plants in the mountain forest, e.g. in *Ksdsura* (19-)}.[a] sturdy **liana,** and in *Sttiirtmiit* (] j-i) (phot, 6), but is much more rare than in the lowland flora, I further know it from the mountain forest to occur only in *Pittespsmm mmijlvrwa,** species of *Pslyalthia$_t$* some species of *Dysoxybtm* and *Fiats,* e.g. the common *F. ribti,* and *Myrsine* (j*-9)-

St'mgmg hairs arc found in some *Urtitattae, Lepurtia (putus),* t/r/ifd(j)-6) and *Cirardiaig* (; 5-4).

Prickles are of course found in certain *Rttbus* spp. (PL 4j), and further in *Aralia* ()-T), *Zant!x>>glnm* (j 3-1), *Smikx* (1S-1). *Toddalia* (43-4), rattans, *Harmsiopatt&x* (3-1),

Thorns are represented in *Mnclura* (3&-7). *Lttvatigt* (j)-*) and *lihh-ii.aiuis* (14 IM}.

Wuierbttdf is the phenomenon that the tubular calyi of a plant grows and enlarges far in advance of the cotolla (including the sexual organs) and that ir is closed and contains water and slime exuded by glands inside, in **which** the corolla Liter develops. It is found in certain species of *1'crlnnactae, Rignoniaitat* and *Gtmtriactat,* ainongst rhem *Aeutynanthtts* (21-6), **The** ecological advantage of the •waterbud is unclear as these professional forest dwellers are never exposed to desiccation.

In p:i*;in^ 1 may remark that a comparable thing happens in the setting of many ttopicaJ fruits, in which the fruit-wall has often already reached mature size fir in advance of the formation of the mature seed. Plant ex-plorcrs, when collecting fruits, should always check in situ whether they really collect fruit containing ripe seed.

Bud-tfitttritig. **Woody** plants of the mountain forest share with those of the lowland tropical rain-forest that huds .ire 'open', dial is, not surrounded by bud-scales as is **chonc**-reristicfot the deciduous woody plants in subtropical and temperate countries, useful for surviving the winter period. Tltis, on the other ham!, dews not infer that their **gnm** ih could nut gi> suddenly, shoot-wise, with intervals, what we arc used to cull flush-wise growdi *{pntjttk}^* ;ts tor example in *Vscdnium varitigstfottiim* (17-8), *Wi'mmsimia* (t)-7)>etc.

There are exceptions, notably in *Fagaieat, Fraxiiuts,* a few *Sjtgpieou,* »nd *Acer* (i-S), several *Hamtiifitlidaciae, Magttotiiteeae, Tiltatcae* and *Lattrsitat,* which indeed have hud-scales covering axillary and terminal buds. One could speculate whether this is reminiscent of their origin out-side the tropics, somewhere in subtropical or warm-temperate countries where bud-covering scales belong to the survival value complex and that they retained this specialisation when migrating to tropical montane stations where Jeat-shedding was not longer bound to their presence.

L i-.il- shetitling Hi-.-.

The only two truly leaf-shedding trees in the mountain forest I know are *Acer lattrinitm* (1-8), which stands hare only for a very shi >rt lime, and *Wi$Sia(*]-j) which is bare for 2 much longer time (phot. 70}.

Bacterial and algal symbiosis

Besides the bacterial symbiosis, the intimate living together of two organisms, known 10 occur in leguminous plants, a peculiar symbiosis occurs in certain species of a few orher genera of flowering plants. One of these occurs in the high mountain forest, namely *Pawitaindite,* a second-storey trcclet belonging to the family *Rnbiattat.* The bacterial colonies are found in the leaves and can easily be observed in transparent light as dark blotches. The bacteria are harmless to rlic plant and may be of benefit **if** nut **compulsory** for the *Pmttta.* [7]nr the full life histuri ot the symbiosis iti *Ardisia crispti* see Dc Jongh (1938),

Upic :ire runners m **the tfmbio&i cH** :ill **lichens, btu** they may also live together wilh flowering plants. Bluc-grccn algae are found to form colonies in the tissue of ihe leaf-insertions of(7j/wwrvi(i3-i)as mentioned under the caption of the plate. It has been shown that they can assimilate aerial nitrogen, but whether this symbiosis is compulsory for *Gtmittra* is uncertain. For details 1 refer to Baaa Becking (1947).

b. *Tbt tiffin firtst*

Referring to the introduction to this chapter the elfin forest is the primary forest formation above some icoo m.

i-it>. t& An n[tl dwarf ipceimcn of *i'uttinium TiirmgiiitfafiHHt* C17-B) from exported wind-swept debris near the nummif nf Argopuro-Weliran;• <]Ii Mt. JHIUH at 19111 m. Only » nmull part of thcciinrmouA m[it-ay&E?m it dtnnft, X l/j.

Its structure is characterized by only one low canopy of densely set trees with thin, often crooked or tortuous stems and further by the absence of emergent* and lower storeys except a ground layer, and finally a scarcity of lianas. The foliage is small and leathery. It is a distinctly mixed forest, some K-io m high, but composed of fewer species than the high forest. Phot, IT, I£.

In [lie past it has sometimes been called *trieoid* scrub forest or by Docfcrs van I.ecuwcn (1933) *alpiw/iA* forest; **'subfdpine*** would have been a better term, Physiognomical I y its bmsh wooil (' K ru rnmhol x') a ppesran cc a £ rccs somewhat with the gnarled, pr?lc-rrcc *tbaparral* formation in America, but this is only superficial as the clriti tnrcst is a diMiiutly evcrwet [yjic and it is easily destroyed by (ire without capacities of regeneration except for *Aibiqiaxs,* we shall discuss **bdov,** Beards fif grey *Usntd* wave from the branches, sometimes **giving** it an eerie aspccl (phrjt. 19). The people believe that this 'moss' is brought by the wind, hence the name '*tai tjngiti*[1]; because of the resemblance with hair mapica! liair-grnwing powers are ascribed to it. Being wind-borne it is also snld in the market as a medicine against *'maiitk* aN^fff'(natulcnce), an example 01" native medicine due to the doctrine of signature: higher (Towers are supposed to have clearly earmarked the use of plants in (heir features.

I: also resembles some small-leaved forest types in Australia, but again, it is nor growing under any drought conditions, though the small, usually coriaceous leaves might suggest drought resistance. As usual there are exceptions as the leaves of *Am/in* (3-1), *Aibi^ia* (16-4), and *Hchefficm rti$psa* (5-)) and herbs underneath as *LscttKa* (n-j) and *Nasturtium* (11-7) are targe and not sclerophyllous.

On narrow ridges the elfin forest is dwarfed, not because of climatic conditions :is Brown (1319) tried to show but merely because of **the** poor substratum: plants are starved because of the poor rock and little soil, high erosion rate because of the heavy rains and the steep topography, a similar starving :^ artificially practised with the Japanese *btuKzpi* plants. This can easily be checked in the tield because in places where a ridge widens nut and steep topography is replaced by mild sloping with consequently deeper soil, the normal height *h* regained in exactly *tbt same fhristic tompusition.*

Under undisturbed conditions the elfin wood type starts at some 2000 m and would cover the mountains to their summit if volcanism or tire would not interfere. Its components are still found on the summit of Mt. Ardjuno at 3340 m. Where volcanism or fire occur it thins out and depauperates into scattered pioneer specimens or is found only in sheltered places. On fresh deposits of acid ash it usually dwarfs down to 'spalier' habit (phot. 5), 60; fig. it), where dwarf shrubs possess an enormous root system (fig. IR).

Growth under the low temperature conditions and often poor soil is very slow and wood of the thickly set stems very hard, making the cutting of a trail a tiresome task. Consequently, trails remain open a long time and even longer visible *(btJkas),* whether man- or animal-made (the latter by deer or rhino).

liven very small *Vaii'mmm* (17-8) specimens in Java, such as the one figured (tig. iS) are according to Schröter (191B) very old. On similar plants he measured this hy growth rings which he observed in East Java, where they ate ubvitiusly distinguishable on account of the seasonal climate on Mr, Ardjuno-Welirang, and concluded to an ago of z j years.

Doacw van I.eeuwcn provided some data on fire and regeneration of eifin forest on Mt. Merbabu (1913) and on Mt. l.awu (192;), and observed this un Mt. Gcdc (1933}. He correctly stated that after a thorough fire the treclcts are ail dead; after a mild fire sprouts may appear from old stumps. Elfin forest can withstand to some degree being covered with fresh acid ash as t observed r>n the rim nf Mt. Tjcrcmai in *Vaccinium* stands (phut. 65) where partly killed trees sprouted. Whether regencratiim was fully resumed afterwards I could ant check. It is certain that **•a least *Rladsdendroii rtlusnm{\ 6-fi)* and *Vate'minw varitigiac-ftiliitm*** (17-8) show a high resistance against the sulphuric acids of enter conditions.

On wind-swept slopes elfin forest also dwarfs and appears to be dipped.

Burning the elfin forest results in an increase of grasses which were already in the ground layer and finally results in grass-covered slopes and knolls (phot. iS, 16, *7, 44)>

There is one species, however, which profits from fire, hut nor by a suckcring capacity, viz. *ktmlandinpn gimmig, Albizja lophtmlba* (16-4). This remarkable tree is, in **iharp** contrast to the cither elfin **wood** trees, distinctly short-lived and generally starts decaying when some 10 years did. At that time it is also heavily affected and galled by a rust fungus (see the plate). Its large seed is hard-shdled and consequently germinates very slowly, as in many *Acacias,* because the thin sced-coar is impervious to water. **This** seed abides its turn and remains latent in tlie litter. **However,** if **I** ground tire sweeps through the forest in an extra dry period, its seed-coat is scorched and cracks, enabling water to reach the embryo and germination soon follows in great profusion. As many seeds are affected simultaneously, a thicket of a pure *Albisga* stand grows up, as thick as hairs upon a dog (phot, 53). The Javanese who use fhe immature pods as a popular vegetable **lake** advantage of this capacity by using a primitive method of 'fire-agriculture'and the practice is quite effective- Man **ignites,** and reaps later; Nature in between does the rest, thanks to the rttmultnneous ^crmirtation of the storched seedy. When an earlier stand of some 8 years old docs not produce enough pods the Javanese intentionally set fire tu it to perpetuate this food source. Large stands of it I saw on Mts Slamat and Sukct, but they occur locally common in many places in Central and East Java.

The main trees and shrubs of rhc elfin fnrest amongst many others arc the following:

Albizia (26-4)	*Mjrica* (31-j)
Aslrania {$i-i)	***Mjrsint(i2.-*))***
***Camellia* (H"4)**	***Permit/tia* (8-10)**
Cypboloplmstjyi)	*Photinia* (44-5)
Daphniphyllum (19-3)	***Pittosperutu* (41-4)**
Eurya (52 5)	***Ptityesma* (;o-5)**
***Ficla dcitoidta* {) 2 -})**	***Rhododendron* (16-G)**
***Grmtistoma* (18-8)**	*Schefflera* (3-3)
lies	*Symplocos* (52-4)
***Ltptesperimm* (33-4)**	***Turpinia^i-t)***
Ulsta (16-3}	***Vacs'm'mm* {17-8)**
Mek stoma (3 t-6)	*Weinmannia* (13-7)

Among these *Vauinfam, Ijptosptrmam, Myrsiiu* or *Schtffltrs* may locally occur more common than others or even become dominant. Tilis often OCCUR due to sdection of resistance against crater gases where I *'iifdmunt varia-giaifaliiim, Rhododendron rttMOD** **and *Myrsbie* prove must** resistant. For reafforestation of highland grass slopes *Myrica* has sometimes been used in Central Java,

On sharp exposed ridges and spurs the elfin forest may weil descend bdow IOOO and go down to some IJOO m, as one can easily observe on Mt. Geger Bin tang and other smallpeaksabovcPuntjskPassf^G. Ltmo, G. Tclaga, etc.). Characteristic herbs in this formation at that altitude are: ***Cerybai* (36-6, 37-2), *Senerittt* (31-9), *Argpsltutn/a immtanum* (46-6) and .'I. *iiiii/lsr/im* (46-7), *Po/jga/a vtnetma* ssp. *piildira*** (41-)), *Nertera* (48-1), *Impalieus javensis* (6-4), and many orchids.

At still lower altitude, oursidc Java, a similar physiognomy of elfin wood is observed even below 1000 m, on isolated peaks in rhc Sourh China Sea, as for example on some of the Lingga Is., Mt. Maros in Banka and Mt. Ranai in the Naruna Is., of which the granite summits reach 700 and 1000 m respectively, and also in Bawcan I. in the Java Sea (650 m). They acr in thtir way as one-eyed kings and this dwarfed forest is due to equal steepness of terrain, exposure and lower cloud level over the sea (fig. 9). It is consequently also known as 'cloud forest', but this is an ambiguous term. It would thus appear nn elevation effect connected with the height of the mountains, *a* telescoping effect (fig. 19). However, it must be emphasized that the

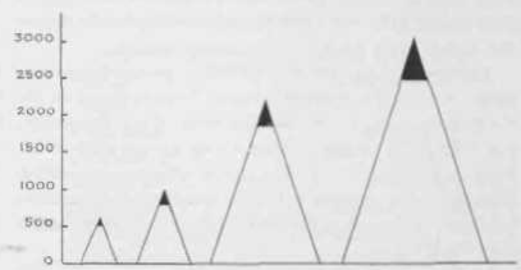


Fig. 19. Telcscopins effect by 1M33 devotion *nn* ihc mrcurrcnec of mossy furcst. from left 10 right on Mt. Tinggi (llawcin). Mt Raiui (Nsrunn Is.), Mt. Silak, wd Mt. PangranK" in *Wai* Jm, Alti. uiik-5 in metres.

similarity ends with the physiognomy, as the botanical composition of the dwarfed forest below 1000 m is entirely different from thai of the high mountains and that both the woody nnd herbaceous plants of the high summits are nor allured to low altitude by the one-eyed kings.

Tit mossy fucks of the elfin forest

Trees in the high mountain forest always carry moss, and especially the hanging moss garlands of *Atrtbryum* from twigs are enncpicuous (phot. 4). But in the cloud belt the soil and forest may be carpeted with mosses, mostly liverworts; rocks and fallen logs, twigs and branches, alive and dead, all may be thickly felted with .t greenish or brownish fur of moss up to some 2-j m above the ground. Above that level twigs carry lianging lichens of]>eard-moss ***{Usnea).***

This mass development of moss rarely occurs in high forest but is mostly found in elfin forest which is then termed *mossforest*'(phot. 16). Physiognomically it has an eerie aspect and the lack of sounds, save a rare bird's cry, add to this.

In my experience the floristic composition of this forest is not changed by the moss development, and not different from that of the elfin forest. Therefore I accept this type as a minor ecological variant of the elfin forest because of its overall aspect. Several mountains are called after it G. Lumut or G. Belumut, in Celebes, Malaya, etc.

On the ridges the two are transient, as narrow crests clad with crooked elfin forest continue as higher mossy forest in wider depressions of the ridge, the depressions (as well as passes) being more liable to stagnant dampness and fog than exposed crests. The mass occurrence of moss is doubtless bound to the local cloud belt (see chapter 4) and this varies on the sea, the plains and the high mountains. There is hence a telescoping effect homologous to the one for the elfin forest (fig. 19). On isolated small peaks in the ocean it occurs at much lower altitude than on the high mountains in the interior: on Mt. Tinggi (Bawean I.) at 550 m, Mt. Maros (Banka) at 650 m, on Mt. Ranai (Natuna Is.), Mt. Salhutu (Ambon) and Lingga Peak at some 800 m, but in Java on Mt. Salak (West Java) at c. 1800 m and Mt. Pangrango at 2500 m.

In Malaya, where mountains are much lower than in Java mossy forest is found on isolated small peaks, but on the higher Main Range only at higher altitude.

Topography and soil may prohibit the development of moss forest, as for example no moss forest is found on Mt. Ged6 proper, the volcanic-active twin of Mt. Pangrango, but is found in profusion on the long-extinct cone of Mt. Pangrango. This is, I believe, due to different atmospheric conditions, the presence of the big crater regularly emitting sulphuric gases and to the rocky, young substratum under the elfin forest.

In areas with a distinct dry seasonal climate (as in East Timor) no moss forest in the mountains is found, the only sign of the cloud zone being the occurrence of *Usnea* beards on eucalypts and *Podocarpus imbricata.*

After rain the moss forest is soaked with water, but also mere fog can be condensed to water when filtering through the thick moss cover (see chapter 4).

Rarely one may also find peat moss *(Sphagnum)* in the moss forest on the ridges; it is recorded from Mt. Ungaran and I have seen it on the spurs of Mt. Patuha. Very rarely there is only a thick moss carpet on the ground and hardly on the stems and branches, as I saw below one of the peaks of Mt. Salak and on Mt. Suket. *Nertera* (48-2), *Corybas* (36-6, 37-2) and C//r/V///*n* (27-7) favour such moss-covered ridge ground.

The very heavy development of moss to several metres above the soil as observed on Mt. Pangrango and several other peaks in Priangan is restricted to West Java, with an intermediate position on Mt. Ungaran and Mt. Dorowati (above Punten) in drier Central and East Java. On other peaks there is a distinct moss development, but more restricted to the soil and trunk bases.

It is clear that normally fire will never occur in moss forest, but if its occurrence locally depends on stowage rain it may happen that in the dry season of an exceptional year with severe drought even the moss forest is drying out. The pile is then enormously increased by the amount of moss and a really destructive fire can follow. Brass described such a case from the Papuan mountains.

II. THE SECONDARY FOREST AND OTHER VEGETATION TYPES

c. *The mixed thickets and secondary forest*

In chapter 9 on the subject of succession, weeds and aliens, the reader has become, I hope, familar with the terms used. He will have learned that the forest belt below 2000 m has seriously suffered from the activity of Man through devastation and deforestation, the making of fields, clearings, humas and estate cultivation. In chapter 10 on the influence of fire it has been explained that especially in the parts of Java which have for ages been subject to a fire-regime also above 2000 m primary vegetation had to give way to secondary growths which led to an explosive expansion of fire-resistant plants, grasses and tjemara.

What I will do under this heading is to make some remarks on certain important plants in the regrowth and succession in the everwet parts, as the grass-tjemara vegetation deserves a separate treatment.

As said before there is a perplexing variety of situations as succession means only a *structural sequence* in height and increasing floristic complexity of stands, but no fixed succession by fixed species succeeding each other; this occurs at random and locally. Besides, during succession interference of Man continues and successions are interrupted, degraded, deviated, etc.

Below 2000 m altitude

Thickets (struweel, Dutch) which reach some 2-4 m height will be formed in abandoned fields, grassland etc. by mainly two aggressive alien plants, *salijara (Lantana)* and *Id rinju (Eupatorium inulifolium),* both capable of suppressing the shade-intolerant grass. In their shade seedlings of weed trees can grow up, but also seedlings of primary forest trees if such seed trees are in the vicinity. If clearing is done by way of clean felling for huma or gogo, geophytes of the forest remain in the soil and after abandoning such places sometimes large growths of tall native *Zingiberaceae* (57-2/6), of which the rhizomes were spared, may grow up (phot. 24).

Shortly before the war two other aggressive *Eupatoriums* have been introduced from tropical America and have invaded secondary growth in SE. Asia, spreading over Sumatra and Java. The first is a white-flowered not too high species which multiplies enormously, *E. adenophorum.* The other one is much coarser with mauve or violet heads and is as suffocating as *ki rinju: E. odoratum.*

There has been much discussion about the benefit of thickets of *Lantana* and the *Eupatoriums* for the soil as predecessors of the returning forest and for reafforestation. I believe it is beyond dispute that they contribute to soil conservation, hamper erosion and enrich the soil with their litter. But it may be costly to remove them before reafforestation.

If such thickets are liable to regularly burning a fire-regime will of course easily lead to grassland with herbs and *Pteridium,* and below 2000 m it ends in wastes with absolute predominance of the well-known *alang-alang* or *lalang (Imperata)* with its characteristic white, spike-like panicles. Alang[2] has at some 20-30 cm below the soil surface a thick net of rather coarse, white rhizomes and is ineradicable. As every aggressor it has its weaknesses: it cannot stand water-logged soil, it is shade-intolerant and it can be killed by constant cutting which exhausts the rhizomes which then rot away, but that is a costly procedure.

In moister places wild sugarcane, *glagab, kasb* in Sundanese *(Saccharum spontaneum),* grows in high masses in ravines.

In thickets as well as in secondary forest vines may come in (phot. 24), *Mikania* of the *Compositae9* furthermore several *Cucurbitaceae* and *Convolvulaceae* and *Passiflorafoetida,* forming garlands and webbing, but not suffocating plants and trees to the degree they sometimes do in the lowland where they may form the so-called 'sagging vegetation* or 'botanical blankets'.

Secondary forest. There are a rather restricted number of weed trees in the mountains and they belong mostly to four families, viz. *Euphorbiaceae, Moraceae, Ulmaceae* and *Urticaeeae.* I mention:

Breynia microphylla (18-6)
Cyathea (tree ferns)
Debregeasia longifolia (56-1)
Ficusfistulosa
grossularioides
padana
Homalanthus populneus
Litsea cubeba (26-2)
Macaranga rhi^inoides
tanarius
Mallotus paniculatus
Maoutia diversifolia
Melochia umbellata
Mussaenda frondosa (48-1)
Pipturus argenteus
Trema orientalis
Vernonia arborea (12-6)
Villebrunea rubescens
Wendlandia glabrata

Each of these can occur commonly but some may be predominant, especially *Trema, kurai* in Sundanese and *anggrung* in Javanese. Also tree ferns may occur abundantly and form small groves. Phot. 22 shows an example how such a secondary forest may look in an abandoned tea plantation at c. 1200 m, *with Eupatorium* as the lowest stand (2-3 m high), overtopped by tree ferns and these in turn by the fast growing *Trema.* The *Eupatorium* which came first is already thinning out as it is shade-intolerant.

Special mention deserve the wildernesses formed by the scrambling/creeping ferns of *Gleichenia* and *Dicranopteris, akar resam* in Malay, *paku andam, p. pajung* in Sundanese, *pakisandam* in Javanese. In nature they form impenetrable thickets on talus and landslides and they keep this role in an aggressive way in waste or disturbed places (phot. 28).

Another very stiff high fern with large, bilobed leaves is *Dipteris conjugata* which may form stands on very steep slopes and crests in untouched forest, often together with a fourth stiffish fern, *Oleandra,* and *Freycinetia* (40-5).

Backer & Van Slooten (1924) classed the plant growth on steep places as *kremnophytes9* not applying this to the proper natural vegetation but to that of earthwalls and talus, which are also invaded by the *resam* ferns. Talus offer bare soil, not rarely with seepage, but rather sterile and this is for nomad weeds, native and foreign, an invitation to pioneer in a random assortment. They seldom can thoroughly settle as the substratum is unstable (phot. 21).

Above 2000 m altitude

Destruction and succession in the elfin-wood zone due to volcanism will be treated under later headings.

Fires caused by Man cause an easy shift to grassland or pyrogenous savanna and there are in this zone only two aggressive secondary forest trees, both native. The ecology of the first, *kemlandingan gunung{Albi%ia9* 26-4), has already been discussed on p. 43a; it is only of very local dominance. The second, *tjemara (Casuarina junghuhniana,* 8-9), forms a dominant forest stand and will be separately treated in the next chapter.

Of the assortment of secondary forest pioneers (phot. 23) of which several occur also at lower altitude I mention:

Anaphalis viscida (10-2)
Astronia (31-1)
Buddleja (30-1)
Cypholophus (5 5-1)
Dodonaea (49-5)
Engelhardia (24-1)
Harmsiopanax (3-2)
Homalanthus giganteus (19-5)
Lespede^a (27-2)
Ligustrum (30-8)
Myrica esculenta
javanica (32-5)
Parasponia
Pittosporum (41-4)
Trema orientalis
Vernonia arborea (12-6)
Viburnum coriaceum (8-3)
Weinmannia (13-7)
Wendlandia (48-6)

Here again I must mention that in addition the obnoxious *resam* or *paku andam* ferns *(Gleichenia)* may locally form dense thickets.

Otherwise most of the listed plants are not very aggressive, which is partly caused by slower growth at this altitude. Also on summits cleared and ravaged for placing triangulation pillars secondary vegetation grows only slowly.

d. *The tjemara forest*

In East Java, from Mt. Lawu eastwards, all high mountains are, above 1400 m altitude, partly capped by forest of tjemara, *Casuarina junghuhniana* (8-9). Its total extent I estimate at several hundreds of thousands hectares.

It is of coniferous physiognomy by young trees having a conical crown (phot. 34), by the occurrence of needle-like branches which droop as a whole, and by cone-like fruit-catkins. However, it has no affinity whatsoever to the conifers and the superficial resemblance is merely due to similar habit.

The tjemara forest has a great charm of its own, in sunshine with its carpet of flowers (phot. 37) as well as on gloomy days when fog pervades it. The 'needle'-layer muffles the sound of footsteps, the main sound in the forest being the continuous rustling of the wind through the drooping twiglets which make a great impression on travellers.

It is dominated by this single species which resembles the tjemara from the beach which is, however, an other species *(C. equisetifolia)*. The mountain tjemara has much coarser twigs and is dioecious, with male and female trees; the first are very conspicuous in anthesis because then the tree has a brown hue from the catkins, at the end of the twigs, out of which dangle the anthers. The long drooping twiglets are capable of condensing fog which often is formed at this altitude in the cloud-zone (Braak, 1920; S 1935b) and this dripping water comes in addition to the rainfall.

The tjemara forest can appear in several stages of development cq. degradation, from a few scattered trees in grass-steppe to scattered stands in savanna woodland type and dense closed forest. Compare phot. 34-44.

Undergrowth in full-grown tjemara forest always contains many native grasses, *Microlaena* (22-9), *Streblochaete* (22-15), *Hierochloe* (22-16), *Brachypodium* (22-6), etc. (S 1940a) but hardly ever alang alang which is scarce at this altitude.

In old tjemara forest there are many interesting herbaceous mountain plants to observe, *Compositae, Labiatae,* too many to list. Some of them are very beautiful, *zsLespede!(a* (27-2), *Pimpinellajavana* (54-3) (phot. 37), *Thalictrum* (43-6), *Boenninghausenia* (49-2), *Vernonia* (9-10), *Wedelia* (9-11), etc. Two ferns, *Pteridium aquilinum* and *Pteris wallichiana^* are frequent, and still more frequent, sometimes forming stands, are *Anaphalis viscida* (10-2), *Elsholt^ia pubescens* (24-6) (phot. 34) and *Euphorbia javanica* (19-4). Some species are extremely rare: I found here for example on Mt. Ardjuno a new species of *Plectranthus* and the first record of *Parietaria* (5 5-5).

Looking overhead one may not infrequently observe that old tjemara trees may carry loads of epiphytic plants, ferns and orchids, *Peperomia* etc. (S 193 5b). Phot. 3 5. Junghuhn noted their absence, but this may vary from place to place, the dampest places having more than those exposed to dry wind, and old trees having more than young ones. A beautiful *Dendrobium, D. Jacobsonii* (39-2) is (hitherto) even known only as a tjemara epiphyte.

Here and there some vines come up, *Tetrastigma, Cayratia, Smi lax, Polygonum chinense* (41-7) often provided with beautifully coloured rust galls, and *Melothria* (18-4). Phot. 38.

In the crowns there are sometimes large clumps of a parasitic mistletoe, *Scurrula montana* (29-2) which is almost confined to tjemara. Another frequent crown parasite of tjemara is *Cuscuta reflexa* (13-3) which may in places come down as a rolling blanket (phot. 9), e.g. on Mt. Tengger.

At higher altitudes, 2500-3000 m, on the ridges, tjemara dwarfs and eventually becomes an untidy shrub (phot. 20).

The *autecology* of tjemara is exactly known; it matches that of *tusam*, the North Sumatran pine *(Pinus merkusii)* and is exemplary of the life-cycle of a fire-resistant, long-lived nomad species, with which definition the reader is now familiar after having read chapters 9 & 10.

Its germination is bound to light and contact of seed with mineral soil or ash; it proceeds rapidly and growth is fast. Eventually trees can reach enormous size, with a trunk to 1 \ m diameter and a height of some 45 m. Phot. 35-36.

The needle-like twigs are shed and may form a dense litter below the trees prohibiting its germination, and consequently spontaneous regeneration. As a professional fire-resistant plant tjemara forms its own pile: its litter composed of the thin branchlets together with larger fallen branches shedded beneath the crown. On slopes this pile is accumulating against the upward base of the trees. The litter and grass are very inflammable during the dry season (July to September).

The full-grown forest can easily stand a ground fire raging through it because mature tjemara has a thick bark which gets only scorched. Looking upward a slope one does not see the black stem-bases, but looking downward all trees appear to have a scorched base, because of the accumulated litter upwards of the trunk base having burned higherandlonger. If, however, trees have (growth-) cracks the fire will also burn into the trunk base which may become hollow (Docters van Leeuwen, 1925). This may in not too old forest cause the tree to burst into flames which may lead to a real forest fire. Phot. 40 and 41.

Thus all the tjemara forest in East Java is under fire-regime, fire, as Burger (1936) argued, due to Man, and in but very exceptional cases to volcanic action. Fires occur regularly every year, more serious in dry years. On a single mountain, for example Mt. Ardjuno, on the average some 4000 ha are annually burnt (Burger, 1930), not necessarily in the same place. As mentioned before the tjemara forest extends to the lowest altitude on ridges and less so in valleys; furthermore it extends wider and to lower altitude on the climatically drier leeward N. and NW. slopes in connection with the direction of the dry monsoon winds. These factors cause it to occur in an obliquely star-shaped area on each mountain resembling the shape of a filled anemogram for wind, the rays corresponding with the ridges where fire and hence development of tjemara forest goes lower down than in the moister ravines between the ridges.

The *regeneration capacity* of tjemara is fabulous. Completely burnt trees can sprout from latent buds under the scorched bark. It also sprouts from damaged superficial roots and most young trees in old tjemara forest are root sprouts, not seedlings. It has been observed in Timor that these roots can sprout long after the tree itself has completely gonel

Naturally if fire occurs in the same place with very short intervals even tjemara will succumb. Phot. 44 shows such a situation where the tjemara forest is doomed and will be replaced by grassland. There are all kinds of stages between grassland, savanna woodland and high forest. Phot. 34

gives a picture how beautiful the landscape can then be, with large glades and tjemara savanna on Mt. Jang. The Ledeboer brothers, who in 1902 found the forests badly damaged by fires caused by deer poachers, protected them and photographs 42 and 43 show the same place with an interval of 30 years protection resulting into a dense stand on the same hill.

But how is it, the reader will request, that the glades have persisted under fire-protection with no pioneer stands coming up? Tjemara is a profuse seed producer and the small nuts provided with a narrow wing must have been mass-like strewn over the glades. As we observed on Mt. Jang seedlings can be found in plenty, but suit the palate of deer which keep the turf short-clipped.

Naturally tjemara shows also high resistance against being buried by ash after volcanic eruptions and J. Th. Bik accompanying Reinwardt on a tour on Mt. Idjèn observed, 23rd Dec. 1821, that the 'winter scene' of white ash from the 1817 eruption still covering the buried forest was only broken by sprouting tjemara.

Succession. As usual with invaders tjemara has its weaknesses: it cannot regenerate from seed under its own canopy without fire, it is shade-intolerant. To persist, fire is necessary to conceal both weaknesses. Ground fires keep the forest clean of all leafy plants coming up in it.

If fully protected from fire the stands may grow old, even a century or more, but they are doomed to be replaced eventually by the mixed leafy climax forest dominated by oaks and laurels, after having passed a succession. Above Bermi on Mt. Jang both types occurred side by side and offered a good place for study.

For the succession the same trees and shrubs which are listed in the preceding chapter for the zone above 2000 m come in as pioneers. Phot. 39. The most important ones being in particular *Dodonaea* (49-5), *Engelhardia* (24-1), *Homalanthus giganteus* (19-5), *Vernonia arborea* (12-6), and *Weinmannia* (13-7). As soon as old tjemara trees die, they enter the openings. Some climbing *Rubus* and *Melothria* (18-4) are among the first, but shrubs and trees will soon follow, as can be well studied on the Jang and Idjfen plateaux. Phot. 38.

During this succession it will be simultaneously possible that primary forest trees enter, provided that there are seed trees in the vicinity. They will in their turn gradually replace the secondary leafy pioneers which prepared the ground.

The attentive reader will have by now understood that the time period needed for such replacements and shifts of vegetation cannot be computed by decades, but are very gradual processes occupying many centuries, nay, thousands of years. An agriculturist works and thinks in terms of years, a forester in terms of several decades, a vegetatiographer has to extend his time-scale to centuries and even niillenia for understanding vegetation and gaining knowledge which is important for decisions on land-use problems.

If it is true that tjemara cannot maintain itself as a forest and the area it occupies today is due to deforestation by Man, *where did tjemara then belong in Nature before?* The answer to it can be found today: it invades fresh soil of landslides and mudstreams, it pioneers on lavastreams and on the ash screes of volcanoes. Phot. 53 & 54. It occurs in all Lesser Sunda Is., including Sumba and Timor which are not volcanic. In these islands it accumulates in thick fringes on river-banks and in gravelbeds and can then descend to fairly low altitude, much lower than ever is the case in Java.

Tjemara behaves in Java in strict accordance with the elevation effect (chapter 6). It occurs on Mts Lawu, Wilis, Ardjuno, Kawi-Butak, Tengger/Sméru, Jang, Raung and Idjfen/Merapi, between 1400 and 3100 m, on mountains which attain at least 2550m altitude, hence with an effect of 1150 m, about the same as that of *Albi^ia.* Phot. 40 is taken of Mt. Panderman, with summit height of 2037 m, but this is a parasite cone of Mt. Kawi. The effectiveness of the rule is that it does not occur on Mt. Kelud (1800 m) due west of Mt. Kawi.

The tjemara forest has served as a refuge and sanctuary for hermits in early Hindu and Modjopait times and ruins are still found in it (with terraces) on Mt. Lawu, described by Junghuhn (Bunten Tjfcto), the summit of Mt. Ardjuno, and Mt. Argopuro on the Jang Plateau. On the crest of Mt. Dorowati, above Punten we found a single old tjemara marking an old grave.

Tjemara is another example to demonstrate that response (so-called adaptation) to climate cannot be 'read[9] from scleromorphous structure or leaf reduction. The most primitive members of this genus even probably originated in the everwet Malesian-Melanesian tropics.

e. *Plants of mountain marshes, lakes, and waterfalls*

The flora in these habitats is rich and interesting. Lakes and marshes are nearly always found in former crater sites which are dish-shaped and often circumvallate. Phot. 13, 69. After volcanic activity stopped the lakes gradually silted up and were reduced to shallow lakes. In case of a weak place in the surrounding rim giving way, drainage by a streamlet followed, either leaving a marsh or a marshy valley; sometimes it remained a dry hollow. Lakes may also be formed when lavastreams, lahars, or landslips shut off a valley or depression. Lakes in active craters have as a rule no phanerogam vegetation as this cannot stand more than a little sulphur and certainly no acid dissolved in the water, nor strong heat. Kawah Idjfen with its lake of sulphuric acid is famous for its desolation. Slightly better accommodation for plants give Kawah Putih on Mt. Patuha, and Telaga Bodas, but no marsh flora is to be found on their shores. If volcanic activity subsides and the poisonous substances disappear, marsh plants step in. A flat shore is much more inviting than a steep one, and in the former case the lake will tend to become marshy land and eventually dry land.

The finest upland marsh and lake flora in Java is found on Mt. Diēng, where all stages can be compared: Telaga Balékambang almost filled up, Telaga Warna and Telaga

Pengilon with distinct floating mats (quitting bogs) of *Sphagnum* and *Maibatrma,* Tekga Mcidada with floating mats and advanced islets of *Seirjau mucroiusltis* (14-17) but too deep to be eventually filled with peat, Tekga l)rmi;u •with dominance of *Acorns (ilriiigs),* a medicinal uoid which is nni indigenous in Java, Tegal Pangon.™ with *Cnfrx plnnritii{\.\-f)* forming massive stubs 75 cm high am) JO cm diameter in a *Wirpus mncrmatm* (14-17) stand, [he stubs acting as tiny islets giving opportunity tor many other plants to settle.

The production of detritus 15 mainly due to *Sphagnum, Cypemttse* (PI. 14), some grasses (important arc *f'tiukiim rcfiens* and *Lttrtia be.vaniira,* neither of them indigenous), /sarttf(t4-i/s),.Xj™(j7-l)(fig, 20}, andZJV/ofW»n(ii)-i/2). Tloaiing plants are *PolntitageM oilimdmt* (41 -1*1), P. Moiigiu* and *P. iiiiiinitiiiiis.* There is often a beginning of pent formation, below nr abuve the water level; in the latter process. *Sphagnum* cushions play an important part.

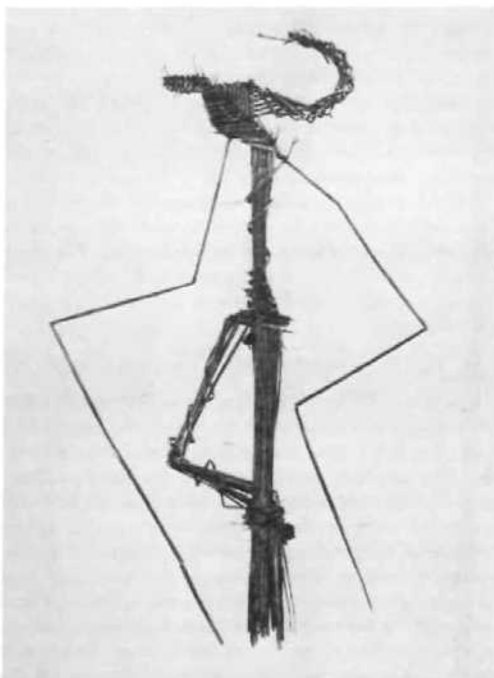


Fig. 10. On the plateau (if Ml. Dieng, Central **Javo,** it **2**ma ni, **an**-jang rigures WCTC plaited fmm rhc ftiwtr stalks *n(Xjrii itipriuif* var. *irtxHxoMt!* (i7-i). which were nffcrcd niar the Hindu shrines (BUnncnicijcr, Jin. 1917). *X* iA(.

The Dicng Plateau is in addition tr> its botanical richness a charming place. At the time Junghuhn visited it he described it as almost entirely forested with the lakes and marshes largely surrounded by forest. And so it must probably have been in 1 lindu rimes when the shrines were built, now mostly swamped at the base, near Telaga Balikflmbiing. Much has changed since that time and hardly any forest is left unfortunately except fur a small grove on the summit of G, Prahu, the highest elevation at some Ij6| m. Potato and cabbage fields, grassland and pastures have replaced the forest of ere.

Very En* murshes could also be found on Mt. t'atuha, iind perhaps stilt can, as far as they have not been drained. The large Telaip i'atengan itself had only a shore vegeta-rion blM there are a fair number uf marshes of different composition representing various stages from nligotropb to entroph wattrs to compart-: Ramja Tjibi>das, R. Tjipa-daruiim, R. Tjiwidij, R. Ups, R. Willini, R, Bali and Situ A Rid in, all situated between 1700 and 1000 m.

There are also a numhtr of excclleni mountain marshes around Pengnlungan and Talun in Prian^an, one of the richest being Rantj;) Gcd* neat Kcrtasati wltete the rare *Stddtyt* (ij-fi) and *R/ynciojpermum* (11-7) occurred. They possihly are now, by natural silting op, gradually over-whelmed by the high forest, *2.* menace to the light-loving marsh herbs.

On Mt. Papandajan larger lakes and marshes arc absent, but the marshy valley of the Tji I'arugpug, the brook, draining Tcgal Aloon Aloon is rich in tnarsh plants (the only locality of *Point/Ufa palypbyila.* 44-6) and so is the interesting Tegal Primula on Mt. Ipis (phot. 15).

Easl J;iv;i bas also several fine mountain nurshes and lakes, e.g. near the Smeru homestead, Ranu Pani. R. Reyulo, Rawa Dringu. On Mt. Jang the finest is Taman hlidup above EJermi; surprising is the moment whcn> coming out of the high forest, one stands before the iake where ducks swim and deer roam by the torcst tringe in the background, When the sun sets, magnincent light is cast upon ibe high tjerrara-covcrcd slopes. It is one of the finest camping-jites I know. In its forest border is the only locality d^ *CJethra jjvanica* (8-11). But Mt. fang has several other intcrestm^ marshes and Jakes on its east side too. portunatcly Mt. Gcd£ has also a mountain mirsh at Tji-lieureum which largely consists *ui Pfjragmitei karka* with *Gimncra* (i)-i) (phot. 14); there is a smaller one in the vicinity, Rawa Gajonggong (S 1941b), with about i ni depth uf *Sphagmm* peat, *Xyris* (J7-1), and *Jnrtciis* (14-)). Here is also the only locality in Java of *Cartx gratffeanti* {Un-

characteristic tnarsh plants depicted in this book are:

Came taptllaaa (14-8)	*I Itltoeharis Itlraqitttra* ('4-'])
graeffeana (14-9)	*Juncus cjjiisus* (14-3)
***jiickjaiia* (14-})**	*prismtstixarpw* (24-1)
BMOWtofl (14-j)	***Ofxasttbi iiiM/iki!* (54"2)**
nubigtna (14-1)	*Ptirocfx/it? eemmimis* (17-4)
pbaeota (14-7)	*Potamotyton ncttmdrus* (4.-ii)
Cypenis flptiidus (14-10)	*Rbf/lcJiespura r/igosa* (i4-"f)
mihmsptrinits (14-14)	*Seirpus /liii/nm* (14-ifi)
Brmaiihn browxiitimm (19-z)	***IKIK mill III!* (14-17)**
so/ly/mnm(\g-i)	^frw *taptrtsis* (57-1)
Fimbrijlylii (Bnsanf/i'tmn (14-n)	
Cttliitm mblrifidaiff (47-* St 4)	

Wattrfath are not rare between 1000 and iooo m. They are generaIly surrounded by forest, and their flora is **not** a very characteristic one. At Tjibeureum, above Tjibi>dss (Mt. Gcdc) a marsh is found at the base of the fall. The rocky wails where the water comes down MC nearly always overgrown by an almost pure vegetation of *EkMterna* (s J-J) and ***Pita*** (56-4), plan" with juicy **green** stems. The leaves drip continuously from the spray which breaks the sun beams into wonderful rainbow colours. Phot. 12.

The perpendicular rocks behind the waterfall, wet from trickling water, are slimy with algae and around them arc mosses. In the less steep part of the rock-walls mosses grow in great profusion and among them *Spi>ngtitt#).*

Waterfalls are openings in the forest and as such serve forthc settling of epiphytic plants which become terrestrial on the rocks, such *as* for example several *Orcbidactae* ;md *Riwdodetidrnnjtivtaiiatm* (i6-}). Ferns, also tree terns, always grow in profusion neat falls.

Seeds and fruits from the higher zones are transported downward by the running water of the stream and often come to rest among the debris below the fall where they sometimes can grow at their lowest localities thanks to the cimlness of such sites, for example *Potygmum pitbeiiim* (41-10).

f. *Grasslands mid f/tldf!, sloons andsand JIJS*

As explained in chapters 9 & 10 virtually all mountain grassland came into being after forest destruction, mainly by fire. This painful process took s very long span of time; judging from reports by early explorers ii must have become accelerated in the beginning of the former century. We have also seen that grasslands easiest originate in Central and East Java which are subject to a dry season and furthermore that very large expanses (if gr.i^hml run originate with a very sparse population density or even none as ovec 2000 m there exist no villages in Java. It has finally been shuwn that natural reafforestation is a very slow process mostly starting from the forest borders.

Naturally the grass species were always present but they were in the primeval State in rather scant quantity in the undergrowth rif the elfin forest, in rocky places, along bn.ioks and on swamp margins and furthermore near places disturbed by volcanic action, landslides, etc, where there was suflkient light.

All the grass species of the mountain meadows are indigenous and many of them occur all over the island. On PL 21 a number of the most important are depicted. Nearly all arc easily rccogniitablc by their habit, if one also cares to **look** at aspect and structure of the spikelets and presence or absence of awns. The composition of the grasslands is rather different from place to place and is worthy of further sociological study. Former land use, soil and climatic **condition!** (exposure and altitude) on the one hand and preferences of the grasses 00 the other contribute to differences in composition. I.edeboer toid us that when he started fire-protection on the glides of Mt. Jang they were mainly covered by *a/iing along (Impetata)* which afterwards almost disappeared in favour of *Petiiiiu-lum aloptturoiiiti (ii-})* which I assume is to be ascribed riiiher to increasing population of deer than to the absence of file. Phot. 43, On Mt. Idjin (1000-1)00 m) it is mainly die awrse species of *Tbtmtda. Sacchanim spoiiiantum igk^ih},* and *Cjmfopogut nardw* which form high grass thickets. Near the Smcru homestead *Attdropojtp't vardits. Mitresttgitim alia/urn* and *Petmistlum* {II-}) are most frequent. The *ttgah* (properly meaning 'plain' and the same as a glade, in Javanese *savabmi)* of Mi, Papandajan have also a different grassland composition (phot, ij-28): T. Aloon Aloon largely *Slgrnitisinfirma* (ii-sj with local stands of *hltlktotrkhoni^z-i)* and *Fritw-a*(22.II),T. Mamik with much digging of *tjiiiiig* (pigs) had **much *Mimltmt*** (22-9}, on T. Pandjang *Btwbjpodixm* (22-6) and *Htiiclo-iric))im{ii-i)* vtere very common but there was also*Imptta-ta*, T. Bunjrhrung had almost exclusively *Deytttxfa anstralb* (22-7) in beautiful tussocks with waving drooping panicles. On the slopes of Mt. Tjeremai *Drfeiixia* (21-7) and *Hitrach-fot (it-16)* occur in musses, the latter scenting the air with cumarin,

The grasslands arc enlivened by many herbs, too many to mention all separately. They never occur so massed and colourful as for example in ilic European or Himalayan Alps, but are still a most interesting assemblage, largely belonging **to** the same genera, for example:

Afrs/sama	*Polenlitk*
Akhtmilla	*Primula*
Cartx	*Rammcuhu*
Fti/na	*Riibns*
Gentiana	*Siittictda*
Geranium	*Seirptts*
Habcsaria	*StHttUarin*
Ufrmiaium	*Stmcims*
Hyprriatm	*Swtrtia*
?Mffff!t	*Tbalislrum*
ijparii	*Valeriana*
l.yiimatbia	*Viola*
Malaxis	*Wahlenbergia*
Pimpinttta	

There arc aiso genera which do not occur in Kurope but are peculiar 10 SE. Asia and still others are representative of the 'Australian clement' as *Nirtrra* (48-1), *Sfyplrtlia* (tj-j)and the orchids *Tbrfywitra* G4-7), *Caladsnia* ()4-i), *Mitrelii* (jfK?) andCfirpfeM()6.6, 57-2).

The occurrence of herbs in the grassland is very miied and proportionally sparse and there are nnly few which may form pure stands of any dimension, for example *Ehbeltqts* **pbtttmt** (14-6) on Mt. Jang and *Euphorbia jsvenied*(xjh4) on Mt. Ardjuno and some nthcr places. On Mt. Papandajan legal Bungbrung (phot. :g) is chiiractcr-ized by a massed occurrence of } m high *Poly^ntim jmnini-Utiini* (41-9). from the native name of which the tegal derives its name. Two shrubs mny do the same, vh. *Ltspt-*^0(27-2) onMt. Ardjuno and *Annpi^i/isiiisi-ida(jo-i)nn* Mt. Ardjuno and even more so on Mt. Jang. In a tare case I observed a sparse low stand of the shrubby *Hypericum* (23-6) on Mt. Jang.

Sand seas and aloons

Sand seas {*dasar* in Javanese) and Aloons (West Java) are shallowly hollow or flat dry crater floors or floors of calderas (as on Mt. Tengger and Idj&n) filled with sterile volcanic sand (particles of obsidian glass) and lapilli. The substratum (one can hardly speak of 'soil') is very pervious and, though after heavy rain they may be flooded for a few hours (phot. 45), water is soon drained away. These plateau-lands are rather sheltered against wind being surrounded by a rim of several hundred metres high and peaks on this rim.

In the entire Tengger complex (phot. 45-50, 52) there is one tiny oasis, a small permanent spring at the base of the Widodarfen cone (adjoint to Bromo-Butak), but as soon as its brook reaches the Sandsea it is choked. This spring is the only locality of *Epilobium cinereum* in Java. Sand seas have a subterranean drainage; the water reappears in springs in often considerable quantity at the foot of the mountain, often near the sea, from Mt. Tengger amongst others on the north coast.

Apart from the higher rainfall, the desolate flatness and sandy surface of the Dasar, with ripple marks and moving dunes, are suggestive of a desert or steppe: in the daytime hot, with the ascending air in strong motion, entailing strong evaporation; during the night very strong eradiation and therefore little clouding, with regular hoar frost on the ground, causing daily extremes in temperature to be large. An *Agave* would look here by no means out of place.

In the morning the ascending air above the Dasar sometimes shows whirlwinds hundreds of metres high; it also causes clouds on the outward slopes to overflow the rim downwards into it, a so-called cloud-fall, an engaging spectacle which can well be observed across the rim at Ngadisari (phot. 49).

One can find sand seas in various stages of age and development. In some situations, as for example the big Sandsea or Dasar of Mt. Tengger (phot. 45-47, 50, 52), there regularly is a fresh supply of ejected material from the active Bromo crater and it is consequently bare of vegetation. But on the southern end of its crescent, in the direction of Ider Ider, where the floor is shielded from Bromo ejecta by the Widodar&n cone, the Sandsea has a steadily higher and denser vegetation. This part is no longer called *Dasar* but named *Rudjak;* it carries a rank pioneer herb vegetation of completely random composition (phot. 48). Around the Dasar is a zone where vegetation is scarce on moving sand and where small dunes are formed (S 193 5b). Sand binders on such dunes are several: *Deyeuxia* (22-7), *Pennisetum* (22-3), *Festuca* (22-12), *Carex baccans(iyi)9Imperata, Polygonum cbinense* (41-7), *P.plebeium* (41-10), and also *Stjphelia{\y^* a miniature shrub, capable of withstanding being buried by sand. Phot. 50, 52.

Smaller sand seas are for example found on Mt. Merapi (Idjfcn) which has four shallow cup-shaped ones, but their bottoms are almost bare of vegetation, the sloping margin being marked with a fringe of the shrub-like Javanese edelweiss {*Anaphalisjavanica,* 10-1). Why the bottoms are almost bare I cannot tell. A similar situation is obviously found on the summit of Mts Sumbing and Sindoro in Central Java (Docters van Leeuwen, 1930) where there are several, all with a sparse covering of grass, *Agrostis* (22-5), *Deyeuxia* (22-7) and *Festuca* (22-12), on Sumbing mixed with mosses *(Racomitrium),* lichens and small appressed rosettes *oiGnaphaliumjaponicum {10-j).* On Mt. Lawu there are also small sand seas which are sparsely set with the tussock grass *Festuca nubigena* (22-12) (phot. 31).

On Mt. Ged6 there is a very large crescent-shaped aloon between the ancient craterwall G. Gemuruh and the new one of Mt. Gedé proper at an altitude of 2700-2650 m. This large valley, some 4 km long, is drained by a brooklet; the valley bottom is more grassy, the sloping parts covered with a huge stand of *Anaphalis javanica* (10-1) (phot. 30). On the summit of Mt. Pangrango the situation is similar but in mini format. It is also drained by a brooklet.

Why is it that they remain so sterile and bare? Well, no hard and fast rules can be given. We must keep in mind that revegetation on fresh volcanic material goes very slow at these altitudes. Rudjak distinctly showed that there the process is possible at c. 2000 m, and Dasar is free from vegetation because it is regularly covered with fresh volcanic ash. The other sand seas lie all higher, at 2800-3200 m. They are of different age and the Ged£ aloon must be very much older than the tiny Merapi-Idjèn sand seas. Still, the Gedd aloon seems not to have changed in aspect, since Junghuhn described it more than a century ago, but for a locally increased stand of *Anaphalis* on the slope by reason of fire. Obviously weathering of, and soil formation from, the acid volcanic debris goes extremely slow while heavy rainfall and porosity of the debris promote the leaching process. It is in my opinion the poor soil conditions prohibiting them to become forested apart from the growth of the shrubby *Anaphalis* (10-1) which has less demands as to soil.

Anaphalis is a most interesting plant and I gave copious notes on its ecology in the caption of the plate. I may add that here is another instance where you cannot tell at all the water balance of a plant from its morphology, because notwithstanding the so-called protection against evaporation by its densely velvet coat it wilts extremely soon after being picked.

It is sometimes argued that frost would prohibit growth of elfin forest in these hollows. Though frost indeed occurs during the dry months of the year I cannot share this opinion. Also on the gentle *Anapbalis-cowered* frostless slopes neither *Myrica* nor *Vacdnium* settles. Where there is some water, as on Pangrango and Gedé, vegetation is more advanced than on Sumbing, Sindoro and Merapi (Idjfen). The glades and tegals show a still better vegetation but their soil is of infinite better quality, having been deposited in water and being fine-grained. And as shown above the tegals would have been under forest if there had boonnn fire. If a regal is swampy Like the hottom ▷f Tegal Primula near Mt. Papandajan or the tega] on G. Djampit on Ml. Idjin iI is in this way unable **to** cany forest.

Sufficiently drained tegals arc destined to disappear when protected against (ire, Rantja Gedi near Kerrosflri was on the verge of being suffocated. Once under forest frost will no longer occur as the eradiation surface is then elevated up in the air. Such level closed plateau forests are plenty between Tegal Mariuk and T. Fandjang. In ascending Mr. Suket I also observed distinct dry hollows which were completely forested. I-injilly I have never seen frost damage to the *Vacdmum, Myrka* and *Myrsha* trees. And I strongly believe that frost is not the primary cause of rhe origin and even not for the maintenance of the glades, though ad mitred ly luw temperatures wil! of course slow down regrowth, but that is an other matter.

g, *Craitrs and solfatara, futmirolis, mttdwtlis, hot springs ami'drat// valleys*

In chapter 3 the reader has been sufficiently introduced into the dynamics ofvolcanism and the terminology of the aspects of it, virile and senile, so that we can confine out attention here Co its influence on the vegetation.

In Java active craters *(kawoh* in Javanese) are almost all situated above zoco tn altitude, the exceptions being Mt. Kelud at **tljom** and Mt. l.amongan at 160c m.

In West Java some l.irge solfatara fields are found in BantcflonMr. Pulasaiiat 1 joomandMt.Karang at ljoom, andonMt. Salak at tjoo m (phut.)8). In Priangan in the Garut area there areo,uite a number between 1600-1900 m belonging to Mts Gimtur, Papandajan, Galunggung and Patuhn: KawaKaraha, K. Kiamis, K.Tjiwidej, K. Tjihuni, the must well-known being K. Kamodjang and K. Manuk (cf. Tflvcme, 1926). Phot. 59,

Also in East Java there are many solfatara fields *an* the active volcanoes; one tif the best known is that on Mt. Ardjuno-Wclirang (phot. 61) where from **old** time sulphur ('welirang') is won; along the nld trails in the tjemarn forest one frequently meets people carrying heavy loads 1II ., ilhl pieces [if sulphur in kr.uul|;;u;- **(bukeU) down**-slope.

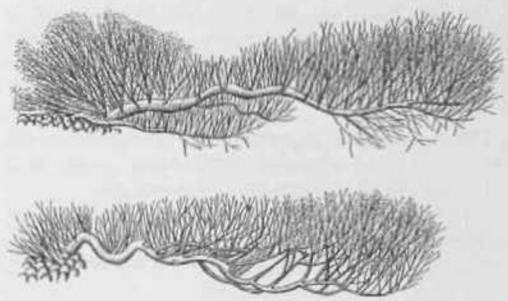
In the crater fields the 'soil' is as a rule rocky, pervious, sterile and acid, exposed and devoid erf any organic matter, a set of conditions extremely adverse to plant life. In addition the atmosphere is perpetually polluted with poisonous gases, from jmsivclls, mudwells, and st'ilfatsica which cmil sulphur, Milphur-di oxide (SOj) and mostly also hydrogcn-sulfidc (HjS, causing a stench like that of rotten eggs); sometimes also small quantities of chlorine (ClJjCC), NO, etc. In the vicinity the eyes are prickled and young sprouts damaged.

The high acidity near **soliaBUB** also effects the soil which is leached **to** a kaolin-like sriff clay. Small streams coming from craters are very acid by sulphuric and sulphur acid. But plants are sometimes unexpectedly tolerant and I found in N. Sumatra *Xyrii (37-1)* standing an acidiu W low as 2.9 in such a stream, where also blue-green algae were abundant.

Finally, in craters the soil may be heated by the magma underneath.

For all the poisons emanating from a so I fata ta, its wi irking remains very local; apparently just out of the crater area a strong dilution begins, and perfect mountain fotesi approaches closely the kingdom of death. Our nose is very sensitive to sulphuric gases and in moist weather and proper wind direction a crater can be smelled ai a fcilumcter distance, bur there the concentration is too low and the time of subjection too short to inflict any damage to the vegetation.

Von I'aber (1927), who made a study of the ecology, found that though the pioneers are more or less scleromorphous they show a rather strong evaporation and have extremely long superficial root systems (sec fig. 18) on which a cork layer is developed.



Pitt- It. ProHiiic fame of shrubs in ihe Papandijan enter, **Wat** Java, *ax* ZDOO m, capped through ihe combined action ▷f wind and aulphuicous gases from toifeiam suppoicd *in* be on the left side, the slira\n some I m l(niK, Above *VaKinium* i-afnT^r/s/mmfiy-B), h e W *Rhtnhd/n,1rM rtuuum* [I **fit.),** *X* t/m. Loves and Ilinrcis not dm wn.

Tliose closest to the soifatara get a very much dwarfed and prostrnte ('Spalier') habit, appear clipped, and become in this way often oblique towards the leeward side. Phot. 60 and fig. 11 (S 193 s a).

Growth is extremely slow and Such dwarfs (fig, 18) are sometimes dozens of years old.

Naturally, if there are erosion gullies, such pioneers arc especially found there where they find both water and protection from wind and ga.scs, as can easily lie observed on Mt. **Bromo** (Mt. Tcngger). Compare Phot. 47 and j;>

As told in chapter j active craters are of course very dynamic and vents come and go. If extinction occurs in part of a crnrer pioneer vegetation sets in, as shown in the crater of Mt. Cede (phot. j6), which eventually may develop into *tjaittigi { Vaitimitm)* elfin forest. But a new vent nuy destroy what was buiit up, as shown by the destruction caused by Kawah Baru in Papandajan crater (phot. 61).

No species of flowering plants is especially adapted to these conditions or grows there under its optimal conditions: those which are found tolerate crater conditions rather than enjoy them. There are only few of them and in approaching a crater the flora steadily becomes poorer, vegetation thinner and specimens smaller. Phot. 58, 59.

Not far from the crater even *Myrica* (32-5), *Gaultheria* (17-1/3), *Albi^ia* (26-4), *Myrsine* (32-9), *Diane/la* (28-2), *Ficus deltoidea* (32-3), *Gahnia* (14-12), and *Rhododendron javanicum* (16-3) cannot stand these conditions and fade away.

The last remaining plants are *Vactinium varingiaefolium* (17-8), *Rhododendron retusum* (16-6) and the fern *Selliguea feei (phot.* 57), sometimes accompanied by some mosses.

Certain cryptogams go still further and bluegreen algae can be found in hot acid water where flowering plants cannot grow any more.

Because of the oligotroph open habitat, shrubs as *Ficus deltoidea* (32-3) and *Rhododendron javanicum* (16-3), which are usually epiphytic, occur in crater terrain as terrestrial plants, but the epiphytic orchids and ferns do not respond in this way.

On large rocks and very stony high ridges of crater-walls vegetation may be extremely scarce and sometimes only consists of large cushions of the moss *Racomitrium lanuginosum* (phot. 20) which is in dry condition snow-white.

One might expect the existence of certain plants which have in the past evolved into species bound to the crater habitat. However, without exception they also occur on non-volcanic soils, even the most crater-resistant species: *Rhododendron retusum* (16-6) is almost confined to volcanoes, but I have found it also on the Losir massif (Gajo Lands, Sumatra) on non-volcanic mountains.

Mudwells, hot springs andfumaroles

In senile solfatara fields and near hot mudwells the vegetation is not very different from that sketched above, the influence of the sulphur compounds is weaker, permitting a closer approach of the forest vegetation. But due to the poor soil it is dwarfed to thickets of elfin forest habit. This can be well studied for instance on Mt. Salak and Kawah Kamodjang where one can observe *Gahnia javanica* (14-12), *Ficus deltoidea* (32-3), the ferns *Gleichenia, Histiopteris incisa, Blechnum capense,* and *Myrsine* (32-9). The immediate vicinity of the wells is of course rich in slimy bluegreen algae.

Hot springs occur mostly in similar places as mudwells and are found on vestiges of magma extrusions and lava-streams. The water emitted is not seldom rich in calcium bicarbonate and sinter-terraces are consequently often deposited. Also here slimy bluegreen algae and liverworts are very common, as e.g. observed halfway Tjibeureum and Kandangbadak on Mt. Ged6. They frequently smell feebly of sulphur gases, but to such a low degree that special crater plants are not present. The water may be saline and at Tarogong (near Garut) *Scirpus littoralis* is found at 800 m; in other places *Bacopa monnieri, Pluchea indica, Enicostema byssopifolium* occur very locally, all of them characteristic coastal halophytes.

Fumaroles have similar features as the two biotypes mentioned above. But if found at high altitude outside the old crater areas they appear to be of particular interest, as I have described (S 1935, S 1936) from 3100 m on Mt. Kembar, one of the summits of Mt. Ardjuno-Welirang and from Mt. Agung in Bali (S 1936) at the same altitude. These small spots I have termed tropical montane *'open air hothouses'*. The soil and air in the immediate vicinity of fumaroles remain moist and warm all the year round, by day and by night. They may form 5 o m high steam blowers on cold cloudy days, and as the wind direction changes they circle round (phot. 59). In the muddy, warm vicinity some seed and spore plants are found, which otherwise occur only at a much lower altitude in the tropical lowland and hills. These plants show a remarkable dwarfing (phot. 63), with dense branching and contracted internodes, hence tending towards the forming of cushions. One might assume this to be a reaction to the abnormally high altitude, to the high insolation, etc. But this explanation is not valid, as true mountain plants (as *Dichrocephala chrysanthemifolia,* 11-2) also become dwarfs. Other factors must be responsible and it would be interesting to imitate this in experiments, a nice subject for plant physiologists.

The question how these lowland plants reach this peculiar biotope is more easy to explain. Profuse droppings of deer show that these also take advantage of the warm places, at night and during bleak weather. Passing men do the same (as we did). Also Junghuhn had once pitched his tent near fumaroles (on Mt. Merapi), but told that he soon shifted his camp site because of the excessive wetness. I have assumed that these two agencies, deer and man, are responsible for carrying diaspores of the lowland seed plants attached to hoofs and footwear, that is, epizoic dispersal. The following seed plants were found at 3100 m: *Lindernia Crustacea^* normal highest record 1450 m, *Hedyotis herbacea,* ditto 1450 m, *Emilia sonchifolia,* ditto 2000 m. They are all common lowland plants. The latter species and some ferns may have reached the spot by wind dispersal. In Bali another 9 species of seed plants occur in an exactly similar situation. The annual mass pilgrimage to this sacred summit must add to the dispersal of sawah plants.

The altitudinal gap between the highest normal record and that near the fumaroles amounts to between 1000 and 1900 m.

Van der Veen found several lowland plants near hot springs and fumaroles at 2000 and 2400 m on Mt. Rindjani in Lombok (S 1936). I may add that the same phenomenon is described from high latitudes (Alaska, Canada, New Zealand) where also some plants are found near fumaroles or hot springs far beyond their normal range.

Death valleys

Gas-wells may also occur outside the crater and solfatara fields, sometimes in the forest, and their products may be poisonous to man and animals. Often this is the scentless carbon-dioxide, -monoxide, etc. escaping or collecting near the ground, there where small animals have to breathe. For this reason, personnel of the Volcanological Survey take a chicken or a dog with them when such places must be visited. The animals faint from the gas before man is in danger. If the valley is dish-shaped, the gas collects and may reach a higher level so as to become dangerous to man. Vegetation in such suffocating valleys is not possible, and caution is necessary in such ravines with bare bottom, even if no corpses or skeletons of suffocated animals are seen. In Java, the Volcanological Survey has put up warning signs, but gas-wells may suddenly change place. On Mt. Papandajan a visit to Kawah Nangklok—unless under guidance—is dissuaded.

h. *Lavastreams, ash screes and labars*

The mineral material ejected by volcanoes, building up their cone during eruption phases, consists of two kinds: lava solidifying into rock, and loose material (ash and lapilli of various size) deposited on summit and slopes of the cones forming what is here called ash screes.

Lavastreams

Lavastreams or -flows slowly roll down slopes from their vent, sometimes covering very large areas as phot. 71 of Mt. Guntur shows. They solidify with a very rough surface, full of fissures and hollows and we suppose that, even when taking up some earth and vegetation during their bulldozing descent, that they consist of sterile rock. Eventually they may be covered by flows from later eruptions, but it also happens that these consist of ash; furthermore new lavastreams seeking a way will mostly be deposited next to older ones. There is thus usually a lapse of time before superimposition, during which weathering of the lava sets in.

As experience shows, this is a very slow process. Weathered products are washed into the fissures by rain and it will take thousands of years, even under everwet tropical rain-forest conditions, before the surface is sufficiently disintegrated to any depth to carry a closed forest. On road talus I observed such intervals in the Canary Is. where superimposed basalt lavastreams alternate with earth layers.

The large flow on Mt. Guntur, now 132 years old, is still visible as a huge black 'boot'. Kerkhoven (1898) described its sparse vegetation 50 years after the eruption period, Van der Pijl (1939) after a century, with a review of the literature.

One might expect that colonization might have to start with cryptogams preparing the ground for higher organisms, and Treub (1888) even speculated that the sequence of the regrowth would reflect the supposed evolutionary sequence of the plant kingdom. However, this idea was too good to be true: all plants alike, algae, mosses, ferns and flowering plants are obviously capable of early and independent settling on lavastreams provided that there is sufficient water. They settle first in cracks and fissures where this can be found and from where their seed is washed down. De Voogd (1940) confirmed this random settling on the fresh lava of Mt. Batur in Bali.

Naturally the nomad plants, accustomed to pioneering and indifferent to soil, settle first. There is no competition and the way is free for all.

Where do thy come from? This is easy to answer: just from the vicinity of the lavaflow, as within a few dozen metres distance of a lavastream vegetation remains undisturbed. Van der Pijl also mentioned a spot spared by the lava, similar to the kepukas of Hawaii, such nuclei serving as sources for revegetation.

Naturally the substratum is not rich and specimens on young lavastreams are usually of meagre stature and the vegetation can be best defined as a sparse shrubbery, even after a hundred years. On Mt. Guntur even the much older lavaflows round the 'Boot' carry sparse vegetation: *Schefflera rigida* with *Arundinella setosa* dominating at c. 800 m in a grass-steppe, *Wendlandia densiflora* (48-6) taking the lead at 1050 m, the best developed forest in the cloud zone at 1450-1500 m, *Myricajavanica* (32-5) at 1600 m, and sparse low *Ericaceae* higher up. The 'Boot', then 100 years old, has still a much poorer vegetation in a similar sequence, but is still largely black and bare.

As usual several otherwise epiphytic plants are found terrestrial, orchids, ferns, *Ficus deltoidea* (32-3).

A good description of the vegetation on older lavastreams in East Java, so-called redj&ngans on Mt. Idj&n (phot. 70), almost flat at some 1000-1100 m altitude, was given by Schröter (1928). I added some records in 1940 (S 1949a: 217). This is low brushwood in which small trees of tjemara (8-9), *Harmsiopanax* (3-2), *Wightia* (51-5), and some *Dodonaea* (49-5) are the main woody plants, with grass and herbs underneath. In places *Wightia* forms a dominant woodland, 8-10 m high, the trunks with thick corky bark. In August the (deciduous) bare tree produces its magnificent purple flowers in great profusion together with the flush on twigs which still bear the woody dehisced capsules, a gorgeous sight. See for its interesting habit and ecology the paragraph on hemi-epiphytes on p. 3 8a and fig. 16.

The most interesting study on the progress of recolonization of lavastreams in Indonesia has been written by De Voogd (1940), who compared the vegetation on flows of different age in the Batur caldera in Bali.

Ash screes

The term 'ash' must be taken in the volcanological sense as small and large, rather coarse particles of obsidian glass grains varying from sand to gravel and even larger lapilli interspersed with rocks, mainly produced by ash eruptions.

In Java these screes are in well developed form only found on the higher active volcanic summit cones, viz. on Mts Slamat and Merapi in Central Java, Sm£ru (phot. 5 3) and Raung in East Java; outside Java on Mt. Kerintji in Central Sumatra, Mt Agung in Bali, and Rindjani. in Lombok. The physical soil conditions are like those of sand seas, pervious, barren and sterile, with the difference that because of the steepness of the slopes the loose dry material is in constant motion, especially after rains which not rarely cause avalanches. It is clear what the result is: poor growth of crippled pioneers of the mountain zone with enormous root systems, trying to find moistness and to maintain a foothold. Naturally grasses are among this desert-like vegetation, some *Carex baccans* (i 5-1), *Ericaceae** *Polygonum chinense* (41-7), *Anaphalis* (10-1), *Myrica* (32-5), etc. and also ferns, as *Histiopteris.*

A singular feature is the forest limit at the base of the ash scree of Mt. Sm£ru where tjemara forest goes up highest, maintaining itself on the ridges between the erosion gullies, but is constantly battered by ash- and stone-slides (phot. 54).

On active volcanoes the scree has no chance to be completely covered by elfin forest which would be the climax, but plants pioneer and in local places sheltered from soil movement some vegetation is possible, though always remaining stunted because of the sterile substratum where plant growth is anyway slow because of the high altitude.

If volcanoes become completely extinct, however, as happened with Mt. Pangrango aeons ago, the climax will be gained. The beautiful cone-shaped Pangrango must in the far past have been such an ash scree extending from some 2500-3000 m. From Tjibodas one easily observes some places of a lighter green colour which do not carry forest. These appeared to consist of huge dense thickets of several species of the scrambling fern genus *Gleichenia (paku andam)* on later earthslides; similar *Gleichenia* thickets are described from Mt. Kerintji by Jacobs, obviously due to the same cause.

A miniature ash scree under moist climatic conditions is found on Mt. Lamongan at much lower altitude (1400-1600 m). Phot. 64. It is most instructive for study of the transition of pioneer growth into natural very mixed secondary forest; it consists of mostly stunted specimens of early flowering and fruiting species, with many ferns and orchids. The rather fine-grained moving ash buries the vegetation and this organic material allows for growth of mushrooms. My detailed internal report on its vegetation (1938) ought to be published some time.

Labars

Mudstreams *(lahar, besuk* in Javanese) occur all over Java; the most conspicuous ones start from mountains with ash screes. They originate when material on the screes has accumulated and is set loose by heavy rainfall; volcanic earthquakes may also start these 'liquid earthslides'. If water from summit lakes is thrown out during eruptions the lahars will be hot.

Tremendous masses of ash are deposited on the summit zones of volcanoes after heavy eruptions as shown by phot. 66, a desolate view of such a happening in the summit zone of Mt. Kelud. After heavy rains these loads of ash slide down gullies and may thunder down. Vissering (1910) has vividly described and illustrated such phenomena.

Avalanching lahars have a tremendous force and speed, and may run down mountains to almost sea-level, destroying anything in their way. Phot. 68. When coming to rest they look like sinuous dikes of sterile, mostly dark, sand interspersed with rocks and gravel, the big blocks lying on top as if floating. Many of those can be observed south of Mts Raung and Sméru; big ones are known from Mt. Merapi and especially Mt. Kelud. Phot. 68.

Colonization on lahars is more rapid than on the unstable screes, though in steeper parts they are also rather unstable because of their unconsolidated structure. The material of which they consist is finer-grained, partly weathered and disintegrates more rapidly. Sometimes organic material is also incorporated in the lahar.

They share qualities adverse to plant growth with screes and craters, in being extremely pervious and their surface being exposed to the baking sun. As they run from the mountain to the lowland they are invaded by different plants at different altitudes: in the lowland often by*glagah* and *widuri.*

In East Java, at higher altitude, tjemara invades lahars in great quantity leading to pure stands, in a similar way as *tusam (Pinus)* does in the Gajo Lands on the huge lahars of Bur ni Tfelong. Pioneer trees, once established, provide seed for later generations, so that different age classes are represented. But many other plants, notably those mentioned as pioneers and secondary forest species in chapters 8 & 9, all with shade-intolerant germination, invade the bare soil of the lahar. Re-establishment of forest is here of course infinitely more rapid than on the lavaflows.

A most excellent detailed account of the colonization on the huge Lahar Badak of Mt. Kelud, dating from 1919, was given by Clason (1935). He found here as dominant pioneers the ulmaceous secondary forest trees *anggrung (Trema orientalis)* and *anggris (Parasponia parviflora)* which are very similar in habit and ecology.

In *Parasponia* the stipules appear to be free, while they are connate in *Trema. Parasponia* grows to some 15 m, but *Trema* finally attains greater height. Clason observed to his surprise Vast areas purely covered with *Parasponia* of almost the same age as if they had been sown on a large scale shortly after the eruption.' However, he found plants one year old which already fruited abundantly, concluding that the stand might have been derived from early pioneers and zapidly dispersed by birds which are fond of their fruit. *Trema* appeared to have lichens on the bark. Many other species joined the *Trema-Parasponia* stands, notably an understorey of tree ferns and a mixture of smaller shrubs. A third, still lower storey was formed by *glagah,* with patchy abundance of *ki rinju* and *Lantana,* and mixed with a considerable number of herbs and ferns. The situation was thus not vastly different from very rapid regrowth in abandoned plantations (phot. 22): a rich 3-layered young secondary forest in about 15 years. Van der Veen had a similar experience of rapid regrowth on Mt. Kelud after the recent eruption of 1966 (phot. 67).

CHAPTER 13

DIFFERENCES BETWEEN WEST AND EAST JAVA

In an overall aspect one can say that the difference between the flora of West and East Java must be ascribed to the difference in climate, everwet conditions in West Java allowing for a richer flora than a seasonal climate in the eastern part. As everwet conditions are only locally found in East Java (in the Vet islands', see chapter 4) it follows that there less rain-forest species occur.

One might think that this would be compensated by an excess of drought loving species in East Java, but as fig. 5 shows the northern part of West Java (Krawang, Indramaju) has a distinct prolongation westwards of the seasonal climate, so that West Java gets there a fair share of seasonal species.

These two aspects are well reflected in the statistics of the Java flora made by Mrs. Schippers-Lammertse (1965).

Orchidaceae are characteristic for an everwet climate: in West Java 607 species occur, in Central Java 291, in East Java 234. A similar decrease is found in *Rubiaceae* where the figures are 177: 110: 93.

In families which are best represented in seasonal climates the situation is different: in grasses the figures are 134: 134: 161 and in *Compositae* 72 : 68 : 74.

The totals for the whole flora of Java from west to east are 3882 : 2851: 2717 and the excess of West Java is mainly due to the greater amount of rain-forest plants in that part.

I have made no such statistics for the mountain flora, but assume that these will be similar; this is to a fair degree due to the occurrence of many species on Mt. Papandajan which were before 1930 only known from East Java, or at least not west of Mt. Diëng.

As to landscape, land use and crops there is, of course, both in the lowland and in the mountains a great difference between East and West Java because of the difference in climate, generalizing: in the East much open grassland and *Acacia* woodland savanna, teak forest and sugarcane cultivation in the lowland, large-scale cultivation of maize in the hills and preponderance of coffee estates, the mountain-forest characterized by tjemara forest. In the West preponderance of rice-fields in the lowlands, tea and cinchona estates in the mountains which are clad with mixed rain-forest.

CHAPTER 14

COMMONNESS AND RARITY IN MOUNTAIN PLANTS

Some words must be said about this subject as the concept 'rare' is an ambiguous term in botany, but I was faced with it when listing the species which should be depicted.

There is a great variety in rareness. *Primula* (42-4) is certainly a rare plant; in Java it is only known from four mountains, but on three of them, Mts Pangrango, Papandajan and Jang it grows in profusion in suitable localities, on Mt. Sumbing it occurs only locally. Tjemara (8-9) is a leading forest tree in East Java, but does not occur west of Mt. Lawu. *Drosera peltata* (14-18) is common in the grassy plains of the large Idjèn caldera, but is sporadically found elsewhere, and so are the remarkable *Wightia* (51-5), the Javanese ash *Fraxinus griffithii* and the araliad *Pentapanax elegans.* Locally abundant, these plants are in general restricted or very rare.

Notwithstanding extensive field work by others and myself it has appeared that quite a few species are still only known from one mountain though I made plenty of efforts to find them elsewhere. I have made an approximately complete list of them to bring them to the attention of professional Indonesian botanists as well as of amateurs; we know by experience that the latter not seldom happen to find rare things.

I have divided the plants into three lists, for West, • Central and East Java respectively, and I have marked the species which are assumed thusfar to be *endemic* in Java (that is: found nowhere else in the world) with an *asterisk.*

WEST JAVA

Bulbopbyllum sulcatum	Salak
Carex capillacea (14-8)	Papandajan
graeffeana (14-9)	Ged<§
lateralis	Papandajan
oedorrampha	Papandajan
feres	Papandajan
**CeratostyIis simplex*	Ged*
Chamabainia cuspidata	Patuha
Corybas carinatus (36-6)	Salak
* *mucronatus* (3 7-2)	Ged£
* *vinosus*	Salak
Cryptostylis acutata	Salak
conspicua	Burangrang
**Dendrophthoe magna* (30-4)	Ged6
Eriapunctata	Salak
**Eugenia ampliflora*	Galunggung
Galium asperifolium	Papandajan
**Garnotia fragilis*	Burangrang
Haloragis micrantha (23-2)	Papandajan

Hypericum beccarii	Papandajan
**Lasiantbus tomentosus*	Salak
**L,iparis bilobulata*	Gedé
* *wightiana*	Pangentjongan
**Malaxis sagittata*	Ged6
Medinilla verrucosa	Salak
**Microstegium steenisii*	Papandajan
**Microtatorchis papillosa*	Ardjasari
* *steenisii*	Papandajan
**Nastus elegantissimus*	Pfengalfengan
**Oberonia subligaculifera*	Tirtasari
Ormosia penangensis	Gedé
**Pachycentria varingiaefolia*	Gedé
Platanthera blumii	Gedé
Potentilla polyphylla (44-6)	Papandajan
**Silvorcbis colorata*	P&ngal&ngan
Sophora wightii	Patuha
Stachys oblongifolia (2 5 -6)	P&ngal6ngan
**Taeniopbyllum tenerrimum*	Kartamana
Vactinium bancanum	Patuha

The list comprises 39 species. All are herbaceous with the exception of 6, viz. *Dendrophthoe, Lasianthus, Medinilla, Ormosia, Sophora,* and *Vaccinium, Ormosia* being the only real tree among them.

There are 17 orchids.

Finally there are 18 endemic species, of which 13 are orchids. Most of these endemics have been collected only once and it is not unlikely that they will be found in future in other islands and appear not to be truly endemic.

CENTRAL JAVA

**Bulbophyllum distans*	Wilis
* *truncatum*	Slamat
**Cyrtandra elbertii*	Lawu
**Eugenia discopbora*	Wilis
Zanthoxylum avicennae	Wilis

There are 5 species in all, 4 of which are endemic including 2 orchids. *Zanthoxylum* is a shrub, *Eugenia* a tree.

EAST JAVA

Begonia latiniata	Tengger
**Bulbopbyllum ardjunense*	Ardjuno
* *refractum*	Ardjuno
Car ex breviculmis	Jang
Carpesium cernuum (10-3)	Tengger
**Clethrajavanica* (8-11)	Jang
Elatine ambigua	Jang
Epilobium cinereum	Tengger
**Gaultberia solitaria*	Ardjuno
Gentiana cephalodes	Idjfen
Geranium homeanum (20-7)	Tengger
Hoplismenus undulatifolius	Sméru
Hyparrhenia filipendula	Idjfcn
Lespede^ajuncea	Idjfen
**Melastoma vpllingeri*	Tengger
Parietaria debilis (55-5)	Ardjuno
**PIectrantbus petraeus* (30-2)	Idjfen
* *steenisii*	Ardjuno
Rumex brownii	Tengger
nepalensis	Jang
Sagina macrocarpa (8-5)	Jang
Stellariavestita(%-%)	Tengger
Tylophora adnata	Tengger
Wahlenbergia hookeri	Idj&n

The list contains 24 species. All are herbaceous, 3 excepted, viz. *Clethra, Gaultheria* and *Melastoma,* all shrubs. There are only 2 orchids. There are 7 endemic species of which 2 are orchids.

The inventory shows that there is a total of 39 + 5 + 24 = 68 species only known from one mountain. Among them are 6 + 2 + 3 = 11 woody plants of which 9 are shrubs.

Orchidaceae take a preponderant position and count 17 + 2 + 2 = 21 species, one third of the total. They are all rain-forest dwellers.

Two fifth of the total is endemic, as follows: 18 + 4 + 7 = 29 species. Among these again the orchids have more than 50%, viz. 13 + 2 + 2 = 1 7 species.

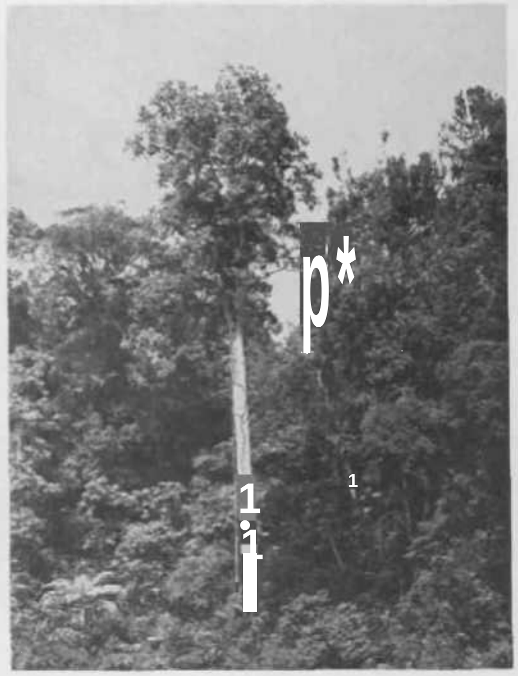
Discounting the orchids, West and East Java are about in balance, Central Java being infinitely poorer in species confined to one mountain only.

Which mountains are richest in having these records? The sequence from west to east is as follows:—West Java: Salak 7, Gedé 9, Burangrang 2, Patuha 3, Pèngalfengan c.s. 7, Papandajan 9, Galunggung 1.—Central Java: Slamat 1, Lawu 1, Wilis 3.—East Java: Ardjuno 5, Tengger-Sm6ru 9, Jang 5, Idjfen 5.

The reader will be curious to know *where the non-endemic species occur outside Java.* This is very different. Some of these species occur further only in the Lesser Sunda Islands or in Sumatra (as for example *Hypericum beccarii),* but others occupy very large ranges and the occurrence in Java means only a marginal extension. For example, *Haloragis micrantha* (23-2) has an enormous range as shown in fig. 22, from North Japan to New Zealand. *Micro tis unifolia* (39-7) has a similar range (fig. 24), and *Parietaria debilis* (55-5) occurs even much wider, over North America and Asia to Australia. Some other species are mainly southern, in Australia, and for them Java is their northernmost extension as is the case in *Rumex brownii* (40-7), and *Epilobium cinereum* which range from New Zealand as far as East Java.

Are the data trustworthy? I must confess that I have my doubts about the permanence of the list, though feeling certain that these plants will all prove to remain definitely rare. I base these doubts on many plants which before 1930 were only known from one mountain but which appeared later to occur in other places, for example *Disperis* (38-3) and *Stigmatodactylus* (39-5), tiny orchids requiring a sharp eye to find them. The riches of Papandajan are due to the intensive research of its large and certainly

1. The hi(?h miicd rtin-forest. ML licdc, 1200 tn (Kramer, May *V124'/.*



2. *Aliisgk txnt/ti (mMM/Jn;* **23-4),** the msisiie **anmgent,** 45 m mil, on forest border 'I^itHtdfls; forc^n>und 4 rhiiikct, 145(1 m (Docters van Leeuwen).

3. The high forcti aJu^iiicLt wirh liunu; above (bo lunc cpiphy-Ik nisi fecm *{/itplttuiM aidia),* bclrm- underfjtowih of *StnbiiaMltti* liiboda,. 1500 m (Van Stecni*).

4. **Fesooni** of moncj of ihc jicnut *Armlnyum,* Tjibodai, 1500 m **(Vin** Sttenij).

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16. Mossy forest, of the type as found on Mt. Pangrango at 2700 m (Van Steenis).

17. Vegetation | a brook in grassland: the Fern 1'iiru uvil-lichiana and Primula prolifera (... Selonjeng, Mt. ... 2200 m (Van Steenis).

18. Shatp-cut ftittsi luirJvf ••('MV. *Ulitarpm amUtm,* sutilnti pyK.K«i.jui nnwlimi ofrl.c mf.-,,r.^ /v«WJ (22-12) u-ith bractco uul S|)mc burned Ihnabitl* .)f rcgtncnilinK *Ltthuarfm.* South Mr. Kiui-Buiik, 2!SUfl n (Areiu. April 11)16).

19. Thick old tree of *Myrsine* (32-9), loaden with *Usnea* on Argopuro summit of Mt. Jang, 3000 m (Van Steenis).

30. StDBf rid({c -if Data I wtmnil aith mow-white mod cmhions nf *Rtnmtnmtt lamftncnm* ind dwarfed, Imik ipccimtns (if tjenmra. Mi .\rdjunri. 3100 m (Aicrti),

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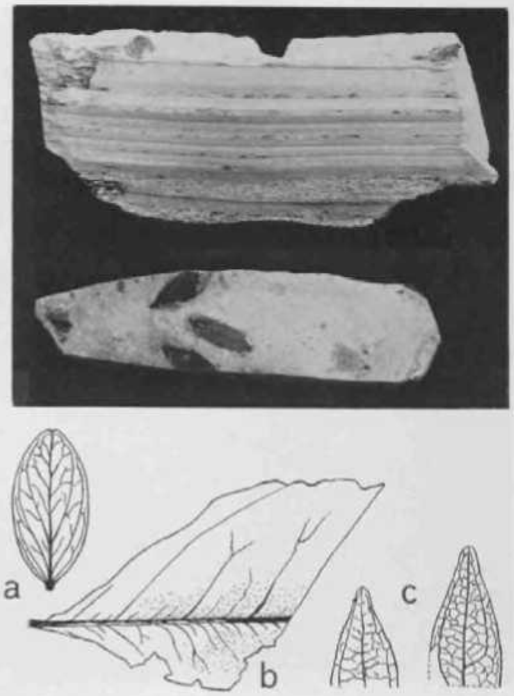
24. \ denv: **thfcka of** hr^L |**ii**n^rrs **doroSopod tftn** nik-.^ration: background **KMne** trc« left u'ebbL-d in by vines. \. SlunuiL$_T$ 1600 m (Van Steenis).

25. Tegal Primula, G. Ipis, Mt. Papandajan, 2235 m, after rain (Docters van Leeuwen).



29. Fossil* fr<mi TC^KI A^iw.in Ahmn luff^ above, tuff taltc4 vertical sect L'HI, **Inwci** ^^'.^il **tetvetj** i. idntriitcd H I . 1 *',ittiainw.*

26. Tegal Indians. **Mfc** Papimlainn. mcanJciiiiK brouk with cillery «rul>. 2040 m (Van **Smnb).**

27. The large Tegal \l,,,,n Ai. ..in. 2StW m. Mi. *ftp*andajan (Japing).

28. Te ^l Bun^ru^ , Mi. Papandajan, n 3-4 in hi^h rhickn iif *Gliitlxma* and (41-9). 23<K) m (Vim Stccnit),

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31. S»vahMi(nJ5Sock Rranland) of Feristr* mi&itfmt on silwd up old CUtetfWce?] sumjuuJcJ by clfm forest "f IJthoearpHi and F 'accinium. Mt. Lawu, 3200 in (Dnctct* vm LCCUVLCTI)H

32. Barking deer or muntjak are fond of the fleshy bark p>r>-ijuiij» trees, in this case *Engelhardia*. Mt. Jang, 2100 m (V HI Siccnis).

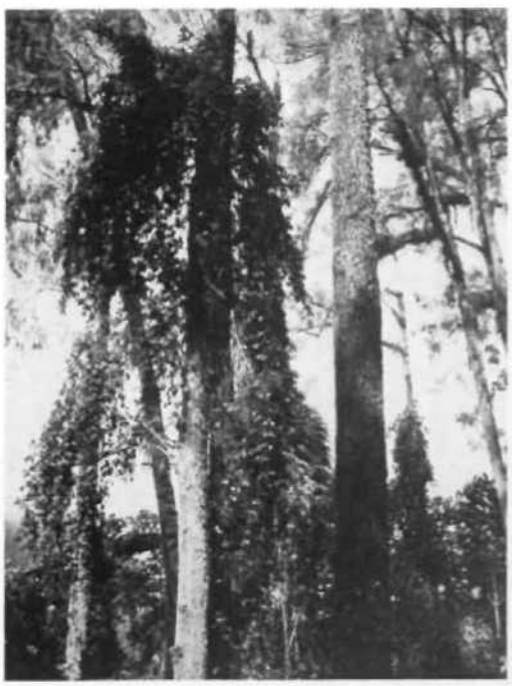
33- I'lcmr 1| ?unr >>ld rliickcr of *Aihj^ia* (26-4) on rfdgfl I< <. Sukct ^liljviij i:i L|f[n:^a forest with -^nrcbcd black ttcmi fmm big Fiic tn Oct. 1938, lurur dcsd; nmihfoonu tbrfw in fissure* of charcoaled bark (Van Steenis, 1940).

34. Woodland savanna oftfenm |G»«iK/H|I*N 8-9), glades with large thickets of 2 m high *Elsholtzia pubescens* (24-6). Mt. Jang, 2000 m (Van Steenis).

3S. T*Htjanutt with kadi sEepfphirtti Cnwaa.£»nt,aidildt). Mr. Ardiun... 2500 m (V H I Siecnit).

36. **Gxtmp** rii irct* **qpronji fan H*- nem-bue bl** a decayed ricmara. Mt. Jo 111; 221 Kim f\»n Slccnis).

3". **'Thc** firh **berbKeoai andugfuwilj** tn ricmara foreKi ⊳L-T. ftwpi*//«..'iir«»j f J+-J). Ml. TCIIKMCI, 2«W in (De Voogd).



IS. ULmWnj; pii in rs of Vitisi **id** C—***Mtmtm* gnnring die** iemara forest. Mi. Wicn, IWOn (\»n Sictnit) ""

39 I «-ift ircm invade i|emnra {.««!• *tl*twle*il>K,* (l')-5). I fnrs- (12-6), *thdowj* (49-S). cic. Mt. idjtn. 1600m (Van siren is).

-W. Hn-.li fire on Mi Puukibun (ibovc PuJjuii) taken Ttum hotel "Klein ZvitKrl»n<l", 6 Oct. l'MO (M. Sig«).

41. The **tnc fire as in ph"r. 40, jr ni^lit; lln- niyss and bush fire lt evcti. the flifcs trc ljeman ircc» mi fire (M. Sigg)

42. C U t «nd hill '. i •. .| J o M t J[J11]^ p l W l {i.itcpi fi..m '!*.'['. 121), in IVUJ, rhf ^tawliinil unevtn with much alani: iliin)i, the hill partly dcfimircd bcciuse <•(ftcurrcm fir™ of humen. 2W» m (Lcdcbncr).

43. The M a c ptaea oflci Ha pimcdSO. in !'J32. lhc lull carrying denw ticnuri fot«r, yrMj conipoiiii,,,, m n n. hubnced, without ingaLins. but i n h • ruismrc .,f *rutin* Knuiet (hinujfh Kiazing of d«f (txdebner).

44. Bven tjcmara **cannot** «rmd **too** frcrcjucm fires. **G. Ttmbak** on 1J|cn Pljitcau, 1400 m (V*n Stccnh).

45. G. Btomo oa Mt Ttaggce with ash eruptiun, f<>rc^f>und rhc extinct (r. Hai<pk, down bvlniv ihc SanJsea, with a small stream after heavy showers.

4fr. **Vlnr** OO Mt "li-n^er nrnliJcra, from Mt I'ciiatiJjain **VOtUhw»*l*l CCOttS** cililicf rihbcil Gr, JJ:i(H-k 1^-hinJ it rlip hrcifltl CP. Vl idodarèn, in ihc background *the* cone of Mr **Smdm.** i^ft of Batuk is the Dasar (SanJsca)«fhc base of (i, Bromo of which the sharp rim left of the cluud is iust visible (WcU»nborn).

47. The **eomptmt)** banco Sandsta flJasar) ai I he li«t ..I (. Bromo (Mt. Tc"(yt=t). ih* '!"P[C] ••""S "<winn gull Is u-ith It™ *Vaccinium*; extreme ri,hr **tWaa of** ortfaa **G.** Ha"*. 2W0 m (\«n Betithcm J i)

48. **Further .out* in the Sudm. P«i of * e** « « • « «« ™ffc«nR fn.ro the Btomu **cnujtiora: UH** B'«" **pW**<" "r "»«Wj wltn lu^ hrrhi (hd« the introduced F«»«»>"*) ud ^=m»« »'<««ilw«l ™ the •liipes, 2000 m (P. r "-----1-1

49. Cloudfall over the rini n["Th i-.i.k:i •! k .. I ;Tengger, cod July 1935, .1! 7.30 **i.tn. (Vui Benthsra** lutiin^).

5ft Ouncs on ihe **mugftl of** IIIL **Dan** (alani: uliiiig. Gmx *afftim «tc), cushions ≼f *Stfpbtlui* (li-5). 20W m (Outin),

SI, Burned ctfln scrub (in **Tsgxl** AlfMin **Aloon** nn Mt. PapUl dajan in uhichircc ferns *iCyiAibraicnlamlnitia)* pnivc **to** lijicfirc-tesi* tance. 1500 m **(Via** St«nj»),

52. [\ T lijii. wuidhlou n pjirL> Hif rFic DJUI, Runic ^n ises having **a foothold, VU. Tenggv, 20<HI m £Je»wieO»**

M. After an LTiipii.iT] uf MI. SEMLMI in **191B ub Bttd Upffil** iivnbrichfd dnwn as n dry Inhur, stripping ihc tjemaru Trees of branched, the indomitable *W'tlcs* maintaining fnf>thold DO ridges and **Hpiii**ut]*tiy, aft-A*in frtmi the m KJCA. 323D m f A**rdMlJ**.

53. **Thfl** hu>;c scree of Mt. Smcni {in crupti' *ta)* 00 = lit south side of the summir {367? m>, rhc **ijeoin forest "craping** up* **bO WRtt** 1350 m and ma **iti**ling iisdf *t*n* the ridges; foreground *Lithocarpus* *tt* w O-JJland. **it** some 25-00 m_H

55. A mutt or less stabiliwd scree ofvatcufc :iih ibon kjiwiih Idie'n m-itb pmstrsie itiruiB nf I *afiimnu lAuag* **cmrion** K«"i": '>n t»p * raiiiJ cin.l w«»d «f 'i'mira »nd /1/AI^FU. 2000 m (Van St.-,

57. The **cnwculuui**. . . .n *\tlhim,i* ***(mi* tnd nckt WTOSd** niih lichenj which i.hxinislv **do** no! i–irc sb<iui iulptiur<iui> tt«c»: some pUci >> ph.™ V.

5(1 A miict place in Gedé crater lvith Piliru<' * « * " •" ' •"•'•"'••"• -'|'-'1: -""I 1»V'W;>(riuht); (wtiind. **the uidoin** columnii (if the lain-stream strata; ihf hitilurtist i.i ftuni **Von** Hmttl Hccpon. 2WM m (Otmeri vrn Ixcuwcn).

•W. Solfihu* Held of Mr. Salak, L200 m. in foeground the fern *Hkthmm oritnttihr* Note rhtw: i-id nil? of intact hl^h fnrert behind M fringe ^pf du-Kffnli fbtcM (Vifi 5teaib)<

ML-HCII blovftfl (EtilWUolot] iii k»wiih kamodjang above Garut; tlOU dn^e pfaximitj <»f inrucT Ebmt. J<00 in {I L Overbeck).

60. Oblige dwt I J| .Li|Isl. UWaniSIi I *i\£tlfHUt»* 111 L',ip.LISU I|-IU crater; beneath it the fem *Hiiti&fitfrit ituitn.* 2000 nt (\dji Steenis).

61. Elfin forest in Papandajan crater destroyed by the new vent "Kawah Baru", a large field of blackish persisting skeletons. 2000 m (Japing).

62. The barren siic i>f r!,c IntRc S"If«aia -n d» KMUI side of Mi. Wclinuw (Mt. Aldjooo) where sulphur is won. 3075m (Ri™.-pke).

63. The pcculnr (tariffing of plum^ oeu fiunatokn Mt hijrh &l-tfaxk fk't'e rhc nonntl, cjgfti dw Jwsirfrii seme), *Ihptii* t lovlcnd plant *iliihrwffrfiiilti* a ^uSfllpinL' apedo, <*. Kctnhur 1 (Mi ArJituv i|, J100 m (Vin SiccnisJ.

64. The unstable tones of Much volcanic ash on Mt. Lamongan, 1400 m, with pioneer herbs, builics and trees h .nth.jl5 HI form a rltluml sera l' fiircst "(Vin «"-"«»

65. Itifm btm ul t onMSn) md Agnta butieJ hy acid ns^ on »«"tiem crircr rim (if Mt. Tjcrcmai; small red iprtmii spne»r C hire iiemu. 3250 m (Vui S t i)

66. The J cv >]ET t: sum mi *i* zone' of Mt, KcluiJ, alter rhc <k'\:ivrniiri|L' cruptifjuii of 1919, atl fitrc&(dtstroytil *and* completely covered *by* i rhkr: layer nf sanJy **volcinic** ash.

67. New vegetatiori **eocnfaij** up near the lake **of** Mr. Kclud (20511 mj after ihc catusrruphr of April **1966; shmbfl** 11[' *Priraffmtia frnm/tora, Anaphalis* nd alang alang; wjch **two** guJtki of **the Voh notogk*] Survey,** S<rpt. 1971 (R, vm dct Veen).

68, Coffee plantation with stlJe tm doviuiwltil **ttlOngt** ami tiuritil under n nnnliirram (tahar) «f Mr. KcluJ (Ainu).

69. The beautiful Jind [WUCtful lake Baflu **Kmabolo,** i NaHHc HtlisrvB litmicd nn the nrmlk i; hase of Mt. Sméru, at 2400 m. Grassland ind purt ijemara (*(mat* **(D**urtm van Leeuwen).

70. Spa me prowrb f»i NM luTFi^trciini!i (redjènfgans) on Idjèn Plateau, ripihi *JFigJfth* (S1-SJ hare **wilh** j»»J>, left *i-i<tr#tiiQp<tttits'* **^-2) vkfa apical ponldot of flower? liiH)** m (Roepke).

72. The low sugarloaf andesite peaks as volcanic ruins near Leuwikidang (Madjalèngka) (C.O. van der Plas).

7L The huge system of lavastreams on the norrh iidc of Mr Gtincur^ the youngest being "The Biwn'\ dating fiuni 1840, older unes in various ng.

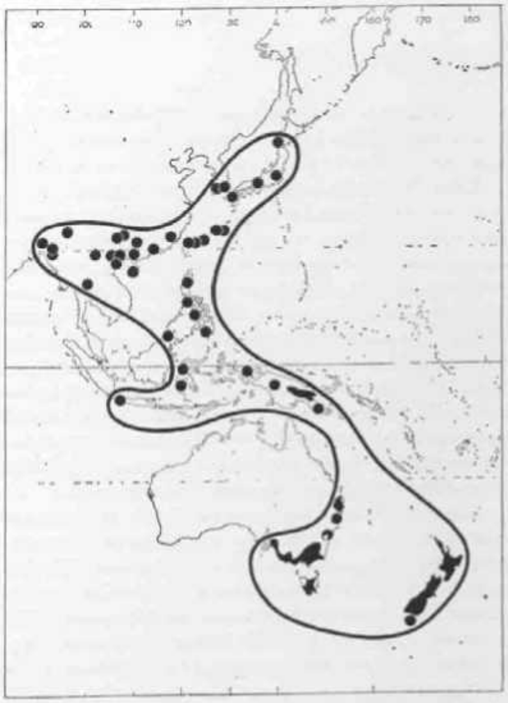


Fig. it. Disrrihutiun *oi* rhc micmihcmi **apccics** *Haforugii micrantha* Uj-J): **in JAVO** 'rtily **found on Ut. L'apandajan ai icjo-lfo** m.

rich highlands, but I expect that if more of such simihr terrains on Mrs Wajang, Windu, Tilu, Talun, and others in the vicinity of PcngalenganaCe subjected in detailed field work, several of the listed species will also be found to occur there. Similarly from the Gcmuruh ridge of Mi. Ciedd looking eastwards we have observed certain spots, as eyes in the forested eiist slope nf Mt. Gcdi, which must be highland swamps or teg[a1s]* We cnuld **not** find them located un maps; they have obviously estaped **topogXBptv** e(S and are botanicnlly unknown. It is extremely diJficult to go with » 'botanical comb' through the mountain for*st.

Still, it is most peculiar that sucli a showy plitnt as *Poletititla pofyphylU,* winch could hardly escape a **botanist** in the field was never found elsewhere and I know it only from ; individual well-developed plants close together. No explanation or even suggestion can lie given of this rarity. Neither can 1 account fur *Gtmlthtria solilttria, GtMiami eepbalodei,* and *Epilobittm c'mtnum* which are all three known from nne en I lection, but which I did not succeed to recollect myself in the indicated places.

There are of course an additional number nt similarly rare plants which have only been found in 2 or 3 localities. I cannot enumerate these. Both for my own satisfaction and to stimulate my younger colleagues I have depicted several rarities to draw attention to them, o.g. *Disptris* (}8-j), *SligmattidBetylut* (J9-1). *Peritttiria* (JJ-?). *Certx capillacea* (14-8), *C. graeffeana* {14-9), *HoUmxis(iyi), Stigma* (8-5), *Stachys* (25-6), *Rhynchospermum* (11-7) and some others.

I should add that hunting for rarities should not exclude to pay attention to other species as well, because many certainly possess a range which is wider than cited under the captions in this book; many new records can still be expected. Esiwcially a better inventory should be made of the rttin-forest species in the Vet isbnds' in I iast |ava, for trees, ordiids and the like, as we have insufficient pubiished information on them (Docowati, Lamongan, S. Smiru, S. Raung, and S. Idjin).

Wlurt le kok for rtirt plants is difficult to say, but one should go off the trails, that is one thing. Another is that one should make himself as familiar with the species **U possible** even if one does not know the scientific name, ili! facilitates spotting other localities. Open marshlands, marshy meadows, brooklets are often rewarding and places on the slopes below the summits, not on them.

When la &foe plant hmlimt, is more or less answered in the c 11:1 pic r on flo we ring periodicity. For grasses the period of end April to early June is the best one and this is valid for many other herbaceous planrs of the open lands as well. But the short dry spell in January is often also rewarding (if it comesl). And many rain-forest plants have their (lowering period in the rainy season. So, trust your luck. A good herbarium and well-developed field knowledge- result from the accumulation of many unsatisfactory trips, old Hooker **laid** And this is true, it goes bit by hit.

A few species were in the past considered a great rarity, notably the find tif a European waterplant *Eiisma njtani* in **Tdaga** Bdekambang on Mi. Uicng. [mention this, because we invented a curious method (S 19)6) to prove that this was based on some eiT.ir. It was done by means of 'tracers' for which we used the microscopic diaioms attached to this waierpknt; the composition of this microflora proved that the specimen must have come from Europe. It was inadvertently brought from there with rough old drying paper to which they adhered. Two European *Curicis* were confused in a simihr way.

CHAPTER 15

VARIABILITY IN MOUNTAIN PLANTS

Each species of plants consists of a great number of individual specimens *{flat population)* which are scattered over its distributional area, its 'range', extending in both horizontal and altitudinal direction. The individual specimens of each population are not all identical, there are variations.

These are partly a reflection of environmental variation: plants growing in the shade have a ranker habit, larger leaves, often larger flowers, etc. than those in exposed sites and such phenotypic variation is not inherited, only the capacity to react in this way is.

Other variations, however, are hereditary and they maintain the deviating characters irrelevant of the environment.

Usually it is not difficult to distinguish between these two types of variation.

Among the hereditary variations there are again two types; this is apparent if we consider the geographical distribution of the variation.

Some variations are found in a rather random pattern, e.g. a white-flowered form in an otherwise red-flowered population. We call them *varieties.* Such specimens originate from occasional, *local rate* Mendelian combinations.

In other cases, however, the variation is of *regional* occurrence. For example in continental Asia specimens of *Primula* (42-4) are all heterostylous, but those of Sumatra and Java are homostylous. The species is therefore split into two replacing races, the continental Asian and Malesian ones. This can only be understood if we assume that this splitting of the population into two parts has happened in its distributional history. In other words, in studying such a range something is revealed about its genesis. Such replacing races we distinguish botanically as *subspecies.* They are important enough to be recognized as they may provide arguments for former migration of a species.

They occur not rarely among mountain plants and I refer to the captions under *Impatiens* (6-5/6), *Schima* (52-7) (Bloembergen, 1952), *Primula* (42-4) and *Sanicula* (54-5) as examples, and for altitudinal races to *Symplocos* (5 2-4). Not rarely such races distinguish themselves, besides by their differentiating morphological characters, also in their ecological preference, as for example in *Impatiens* (6-5/6) of which ssp. *nematoceras* is bound to a seasonal climate while the 'normal* race of *Impatiens platypetala* grows in an everwet climate.

The process of forming *races,* raciation, proceeds also on a still finer local scale in mountain plants, as we must realize that their populations are broken up, as in islands, because there are no such huge mountain systems to allow them to be or remain continuous. And this isolation on distant summit areas leads to interbreeding, resulting into a greater local homogeneity on one summit or mountain complex. For example, the local populations of *Primula* (42-4) on Mt. Jang and Mt. Gedé are not exactly the same and this is hereditary, but that on Mt. Papandajan is more or less intermediate and as the differences are very small we do not deem it useful to provide these local mini-races with a subspecific name. But from their existence we may derive the important conclusion that obviously dispersal of seed or fruit from one mountain to an other—and that must be effected by some agency through the air (wind or birds)—is absent or is at least clearly extremely rare. If that were not so the homogeneity would have been easily upset by continuous interchange of racial characters of the local races which would have contaminated each other.

How old the racial formation is, is difficult to tell and will differ from case to case, but it would appear that geographical raciation will proceed infinitely more slow than local altitudinal race-forming, as in the latter case no big dispersal obstacles must be overcome. An example of a local subalpine race is that of *Symplocos cochinchinensis* ssp. *sessifolia* (52-4) which is clearly a local derivative of the montane species.

To the botanist raciation may be a challenge if he pays more attention to different than to common features of plants and if he does not consider geographical distribution as an important check for his evaluation, in that usually good species show overlapping in their ranges where they prove their independence. If he does not follow these golden rules of synthesis, he will easily regard the races as representing species, especially in mountain plants which are by their isolation eo ipso sharply separated. This has unfortunately often happened and so the number of so-called species in mountain plants has been enormously inflated, e.g. *inBerberis, Mabonia9Pleiocraterium9 Ranunculus^* etc.

Finally a word about *hybridisation* of mountain plants. Up till now few data point to frequent occurrence of hybridization in mountain plants, though in quite a few cases distinctly allied species are found in the same place *(Aeschynantbus, Lonicera, Lasianthus, Lysimacbia, Galium9* etc.). The observation by Docters van Leeuwen of frequent self-compatibility among Javanese mountain plants may partly explain this scarcity of hybrids. I have in two genera alluded to possible hybridization and refer to the captions under *Impatiens radicans* (6-7) and *Argostemma montanum* (46-6). None is really studied and evidence is only meagre and based on superficial field observation.

CHAPTER 16

DISPERSAL AND DISTRIBUTION

Propagation is JI universal property of Life, dissemination is another one: all plants and animals lend to increase their area of distribution (their rawjf) through dispersing [licit offspring through their means of dispersal *(diaspow)*, seed, fruit, etc. They have done so in past ages, from which their present range is the result.

in trying t> get an idea how and when [he present ranges came inro being, we will have tti consider the dynamics of the environment where they had to live in the past, *Geology* tells us tli.it this **wa]** nor static but in *slow* (secular) but constant change, land emerged or subsided, mountains came up and others eroded to decay, aad also climLcs **cony** have undergone changes. Even ihc level of the ocean was not constant as, during the Glacial Period, not so long ago, that is, according to the geological time scale, Sumatra, Malaya, Borneo and Java formed one vast subcomi nent, unbroken by intervening seas.

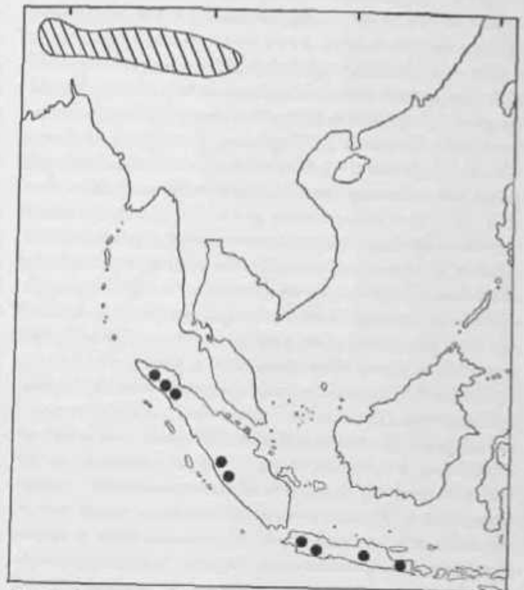


Fig. 23. Range map of the subalpine *Primula prolifera* (42-4), localities indicated by dots; disjunct from a large shaded area in the Sino-Himalayan tract.

Now let us luf>k at the plants in the lickl: there we see that there is always some distance between specimens (if the same species, partly a matter of chance where a seed germinated, and partly due to the fact Lhat suitable places where itcangmw arc also spaced. We suppose that such spacing* can Iw overcome by the means of dispersal a plant has, i.e. by the dispersal qualities of his own djasporcs and agencies which can transport them (wind, animols, water, sea) to a new station where rhey are capable to germinate and settle. This normal or 'short-distance dispersal' occurs ot course in a random direction, although sea currents, constant winds and track ways of animais may give 'direction' ro it. Here we meet the first essential difficulty when trying to visualize how dispersal works lor mountain plants; */low far ii the reach of this shurt-dteUma disptrsali* We must realize chat mountain plants need mountains *to* live on 2nd hive to jump from one mountain to an other. And even more us we have learned in chapter 6: these mountains must often have a certain height. But **neb high** mountains are at present sometimes widely separated, its appears for example from the plotting of tlie distribution of *Primula* (41-4) (fig. 13) where the distances between the nearest stations in Java run into several hundreds of km, in Sumatra 500-600 km, but between N. Sumatra and the main area in the Himalayan tracts over 3000 *km.*

A similar feature shows the map ot *Hn/oragis (i$-i)* (fig. *xi)* where the Javanese locality on Mr. Papandajan lies at ijoo km distance from Mt Bonthain, Celebes, the neatest locality. Many other Javanese mountain plants show a similar or even larger gap because they are abseni from Sumatra, e.g. *Cartx mibistfiui* (14-t), *Rumix* ***IHpekiuil,*** *Staebjt Dbhitgifeiia (if-6). Listplmrliia jaeanka* (I$M), cte., in which the gap is some 3500 km, that is of continental **size:** we call such gap *Mgimtthns,* In Burope it would mean distances such as fn.ni **London M BakaMW** or fr.»m Gotcborg (o Rome. From map 21 can also be seen that disjunction, occur it, many places of [H at«, wmetimes over

...ie terrestrial ... hid ge s *Micro* ... the ant™ of .pctbtion h in Awtt.ii.vwT4 spicicT'i™ 6™n"d- ' *PJti* "ceur in N™ ?«.|nnd. In Mjinjj 111(! nrjnl,wltd ^ j , ' one species occurs ... alpine grassland, *M.* ... ranges throug... ...alia and New Zealand.

large stretches of sea, between Tasmania and New Zealand. Also the map of the orchid *Microtis* (39-7) (fig. 24) is instructive.

The explanation of these disjunctions have puzzled many minds and there are mainly two theories, the relict theory and the instant theory.

The *relict theory* considers that present ranges have in the past undergone and behaved according to the physiographic changes of the earth crust, that is in distribution of land and sea, mountain formation, peneplainisation, etc. These changes must sometimes have been favourable but in other intervals unfavourable, in colourful succession. And it is likely that unfavourable physiographic changes have sometimes had such dimensions that gaps appeared in erstwhile continuous ranges which could then no longer be filled through the means of dispersal.

The *instant theory* holds that such gaps were never filled but have been bridged by a single unique, admittedly rare occurrence, or so-called *long-distance dispersal.*

The latter theory has been strongly advocated by Guppy, an American naturalist who about the turn of the century was engaged in studying means of dispersal, especially of coastal plants by sea-currents. Nowadays some American botanists studying Pacific island floras perpetuate Guppy's idea. And in the rash and hurried world of today instant processes fall into line with the modern trend: instant gardens in Japan, instant towns in the U.S.A., instant transport by jumbojets, instant elevation of underdeveloped countries, and instant coffee everywhere.

Both theories lack necessary factual data for proof. Fossil data are completely inadequate to prove former occurrence and extinction in the disjunctions, as geologists are unable to provide biology with an atlas how the world looked like in the past fifty million years. And nobody can predict the destiny of a seed.

So we have to rely on other ways to approach the problem, which hinges in no mean degree on the probability of effective long-distance dispersal, that is, not only the mechanical means of transport but also including effective establishment following.

What does the Javanese mountain flora tell us about dispersal!

There are mainly three ways to attack the problem, viz. (i) the comparative study of the characters of the diaspores (seed and fruit), and their correlation to ranges, (ii) study of the carriers responsible for dispersal, (iii) what do experiments tell.

As to the first point it appears that the mountain plants have various devices which may be held potentially effective for dispersal, *Nertera* (48-2), *Myrica* (32-5), *Vaccinium* (17-5/8) possess berries which are or may be eaten by birds, *Sanicula* (54-5) has hooked fruit and *Myriactis* (12-4) has sticky achenes which may adhere to feathers of birds, most *Compositae* and *Valeriana* (56-6) have plumed achenes, orchids have dust-fine seed, both suitable for dispersal by wind. Especially the last category looks very obvious though we must keep in mind that the plume only works as a parachute in dry air, folding up in case of humidity. We observe to our surprise that distinctly wind-dispersed plants as *Valeriana* which is common all over Java and grows in profusion on the Tengger and Idjfen plateaux does not occur in Bali or any other of the Lesser Sunda Islands, although the distance between Idj&n and the high Balinese mountains is hardly 100 km and their ecology and flora a replica of those in East Java. Conversely, if wind would be that effective, the strong southeast monsoon blowing continuously for many months each year from Australia should have light work in carrying plenty of diaspores of many Australian species to the Lesser Sunda Islands and East Java. As it is, however, these islands have a distinctly Javanese mountain flora, poorer in species but without Australian compensation. Among them Timor, the nearest to Australia at c. 500 km, is even the richest in Javanese species. So one wonders about the degree of effectiveness of plumes and other means of wind dispersal.

Then we consider dispersal by birds. Most of the factual data on dispersal of Javanese mountain plants by birds we owe to Docters van Leeuwen (1925a, 1930a), who incorporated in his large work on Mt. Pangrango (1933) also the observations by his son Hans (1929) gained on Mts Sumbing and Sindoro. Of 20 species field observations and data on stomach contents are recorded. Mountain thrushes and fruit pigeons feed on *Vaccinium^ Eurya, Pbotinia, Mjrsine, Gaultheria, Rubus, Schefflera rugosa,* etc., forest fowl and partridges on *Carex baccans.* Furthermore it is clear that of berried plants as *Vaccinium9 Myrica,* etc. the seed passes the intestines in viable condition as shown by germination experiments; local dispersal seems proved. However, he is sceptical about dispersal from one mountain to an other, as the seed of fleshy fruit is rarely kept in the intestines of a bird for more than half an hour, in the case of *Loranthaceae* even only a few minutes. Furthermore, he stated that the fruit and seed eating birds are sedentary as is agreed by ornithologists, and confirmed personally to me by Stresemann. That also is the reason that they are racially differentiated over the mountains; they do not move from one mountain to an other.

Migrating birds such as snipes from Manchuria and Japan are observed to land first on the coasts of the South China Sea lowlands and work themselves slowly into the Malesian mountains. They do not appear to carry diaspores of any East Asian plants; besides, such birds preen themselves carefully before their setting out on long journeys. For the rest, die raciation among mountain plants is an exact replica of that in mountain birds. This again raises our doubt about the role birds can play in long-distance dispersal by feeding on fruit or carrying diaspores on their feathers or feet.

Another approach towards the problem of dispersal is by comparing *diaspore spectra* of plants of the same range. For this we divide the species into three or more dispersal classes, those which have devices for wind dispersal (either plumes or wings or dust-fine seed as orchids), those for animal dispersal (either edible or adhesive) and those which have no devices and are too large to be suitable for wind dispersal (e.g. *Euphorbia,* acorns *oiQuercus).*

One would then suppose that going up a mountain the first two categories would increase in number and the third would decrease. But in his analysis of the mountain flora of Mt. Kinabalu in N. Borneo (4100 m) Stapf, who introduced this method of analytical statistics, found to his surprise that the reverse is true: in the summit zone potentially animal-dispersed plants were nil, potentially wind-dispersed counted 26%, but 74% of the species possessed diaspores without device. Docters van Leeuwen (1933) made such statistics of the plants of Mt. Pangrango and concluded that of the 15 2 species he treated, 5 8 were potentially animal-dispersed, 42 by wind (including small-seeded ones), and 52 had no special device.

A similar procedure can be followed in comparing range maps of plants with different potential diaspore devices. It has been found that genera and species of all three categories can show exactly matching ranges and, what is more important, they also grow together. Thus it becomes clear that homologous ranges have come into being synchronously, that is they have through the ages slowly travelled together, irrespective of their different dispersal mechanisms. This is also found in the conformity of two major distribution patterns in the Javanese mountain flora, as will be discussed in the next chapter: the patterns are not random as should follow from the instant theory.

It is interesting to add that Guppy, a firm believer in large-scale oversea migration was baffled by the endemic inland plants of Hawaii and their being often confined to one island only. It led him to suppose that the agencies which once carried the seeds of these plant groups to Hawaii had stopped their traffic long ago. Skottsberg found this hard to believe and was tempted to ask if these agencies ever have been so very effective, concluding that Guppy's suggestion is rather a declaration than an explanation.

I may add here also that I have always been surprised why those who take to some magic way of long-distance dispersal over some thousands of kilometres omit to view the corollary this assumption involves, namely the question why not the same plant with such assumed immense carrier capacity is then not found in greater profusion at shorter distance from the source area where it came from, as probability logarithmically increases with shorter distance. This may be a useless question for isolated islands in the vastness of an ocean. But this question is imminent for dispersal of a continental or archipelagic flora as that of Southeast Asia and Malesia and a mountain flora which has a similar archipelagic character. It would be simply silly to accept *Euphorbia javanica* (19-4), and many dozens of other species with a similar distribution pattern but all without any dispersal device, to have jumped from Ceylon or the Himalayas to East Java, but not to have been capable to settle closer by somewhere in Tenasserim, Malaya or Sumatra. The root of the redundant way of hypothesizing by the 'diffusionists' is that they insufficiently realize that the present plant cover is the result of a very long evolution, a very complicated historical process and that a tip of the veil it is covered by can be lifted only by very careful plant-geographical analysis, not by instant assumptions and discarding of the past.

Reach of short-distance dispersal(S 1962). It remains to be considered to make a rough estimate of die reach of normal dispersal, a thing which is difficult to ascertain.

The discussion of the elevation effect (chapter 6) has shown that normal dispersal from one mountain to an other cannot be very wide and is at least very infrequent. The recolonization of Krakatau has often been quoted in favour of instant dispersal and it is true that most of its inland flora has newly arrived and increases; curiously epiphytic orchids, however, with their dust-fine seed lag far behind and naturally the arrivals belong with rare exceptions to the nomad species of the secondary forest.

Distances from source areas range in the case of Krakatau from 25 to 50 km. This figure must then fall within the dispersal range. For greater distances we have no similar example to guide us. Skottsberg found between two of the Juan Fernandez Is. near Chile, of equal origin and age, 15 o km apart, distinct differences in flora, but found a very great difference between these florulas and the flora of Chile at 575 km. This is also about the distance (700 km) between the very different rain-forest floras of North Queensland and Papua. Figures of similar magnitude are gained if we compare the flora of Timor and North Australia, territories which are ecologically well comparable, but possess a very different flora and lie as the crow flies 500 km apart. Compare in contrast with this the southern savanna plains of South New Guinea and of Cape York Peninsula which show a very similar flora, but observe that the distance oversea is only 150 km, with Thursday Island halfway Papua. So it seems that some 500 km will be the absolute ceiling even for very rare occasional dispersal, irrespective of means of dispersal of land plants, some 100-200 km probably a practical ceiling for most species.

And this relates to *effective settling* after dispersal. The establishment of a self-supporting, self-perpetuating life community is effected by mass immigration, of both individuals and species. One or a few individuals do not make a population; if they can maintain themselves at all, they do not spread, as many introductions by Teysmann on Mt. Pangrango have shown, where *Rumex alpinus* after 90 years still continuously produces fruit without any extension of the few square metres occupied by the species. The more individuals of slightly different genetical make-up, the more vigour a population has. This finding of experimental taxonomy is in itself an argument against success of incidental long-distance dispersal.

This gains weight especially in the case of dioecious plant species, where seeds of two kinds, for the female and the male plants must be dispersed simultaneously and must by random dispersal come so close to each other that cross-pollination can follow to guarantee progeny. One might suppose that they would show differences in range with plants possessing bisexual flowers, but this is not the case. A mountain genus as *Coprosma* (46-8) (with berries) which is dioecious has an almost homologous range in Malesia with that of the umbelliferous genus *Trachymene* with bisexual flowers, which is without any special dispersal device on its fairly large mericarps.

My own dissemination experiments with Javanese mountain plants point in the same direction. I have sown fresh seed of the *Stachys* (25-6) from Tjibitung in great quantity in (even) likely favourable places on Mt. Papandajan, scattering the nuts on the surface as would happen in nature, but without success. I have done the same, a matchbox full of seed, with *Primula* (42-4) on Mt. Gedé from nearby Mt. Pangrango. Though a rainy week followed nothing came from it. Docters van Leeuwen did similar experiments, which he did not mention in his book, fearing being blamed for contamination of Nature. He confessed to me later that his experience agreed with mine. It is another thing if entire plants are transplanted with a clod as he did with a Sumatran *Imp a Hens* and *Anemone sumatrana* in the deep forest soil near Tjibodas. These plants survived but did not spread; anyway they had a good start. This is ecology, not dispersal, but it is still informative on the great difference between simple means of transport and effective dispersal.

Returning to our problem offered by a large percentage of plants which show a homologous distribution as *Primula* of fig. 23 it has now become clear that the large disjunction between the Himalayas and North Sumatra, or the still bigger one between the Himalayas and Java, can never be explained by direct, instant dispersal, neither can the occurrence of the eastern species in Java, for example *Haloragis* (23-2) in fig. 22 and *Microtis*(39-7) in fig. 24.

The age of mountain plants

Not long ago geologists have found that the huge granite dome of Mt. Kinabalu in North Borneo (4100 m) is of young origin, some 9 (± 2) million years old. And it was concluded that its high mountain flora should then consequently also be young, even younger.

This is a fallacy. All botanists know that it carries a complicated mountain flora composed of several elements, Holarctic, SE. Asian and Antarctic.

To prove this we must try to follow the fate of a cold loving (microtherm) plant migrating across the tropics over the mountains. Let us assume that it has established itself on a range. This range has from the start of its uprising been subject to constant abrasian by erosion but that process was counteracted by more rapid elevation, as for example in the Himalayas and the Papuan Alps which still rise in spite of the process of erosion. When the rising of the range comes to a standstill, however, final decay sets in in the usual slow but steady (secular) way Nature works. Then the microtherm plants gradually become threatened by extinction when the height of the range nears the minimum altitude required by these plants.

During their life on the range the microtherms have tried to disperse to other mountains within dispersal reach. If this happened new stations were gained and the microtherms perpetuated life there. If there were no such adjacent mountains the microtherms were doomed to get extinct.

Now it so happens that decay of ranges is often accompanied by uprising of others in adjacent parts of the earth crust where new anticlines are formed and so the doomed plants may get, during the period of their decaying homeland, a new chance.

Such a thing surely happened in New Guinea where the ancient range along the northcoast, of which the low Cycloop Mountains form part, is largely a decayed one no longer having sufficient height to carry mountain plants. But these must have dispersed to the new Main Range which is of more recent date as proved by fossil Pliocene shells on their lofty summits.

This must also have happened in Borneo of which the mountain frame has been decayed by erosion with only a few remaining remote peaks above 2500 m. But I have been able to show (S 1964) that a few so-called endemic Kinabalu plants are still witness of their former grandeur. And the same relict occurrence has been found by Smythies for Borneo Kinabalu birds.

I suppose that in a former geological period there must have been a Malaya with lofty mountains to carry a flora such as is now found on the high peaks of the Gajo Lands in North Sumatra, of which the occurrence of the sedge *Oreobolus* is a last vestige.

The conclusion is that in many places mountain plants are older than the mountains on which they grow at present (S 1967a). In their hazardous insular life above the clouds many perished, but others could survive at new tropical mountain stations. Of many these footholds are scarce and give only a scrappy picture of their former distribution.

A case as that of *Haloragis micrantha,* of which fig. 22 shows its bi-hemispherical range with still a miraculously large number of intermediary stations in the tropics, is quite exceptional, in *Microtis* (fig. 24) this is already less well expressed. In most bi-hemispherical ranges of microtherm genera and species, however, the number of tropical stations is very small, three, two, one, and not seldom even none. In the last case we call these ranges 'bipolar'. This does not mean that the plants concerned occur only near the poles, but merely indicates that the range of a microtherm plant consists of two parts, one in the cool parts of the southern and one in those of the northern hemisphere. Considered in the light of their precarious life on temporary fragments of the former transtropical mountain bridge, their present scarcity or absence on tropical mountains is not at all surprising. Though the number of such bihemispheric or bipolar microtherm genera and species is very small in proportion to the entire flora (S 1971), they are plant-geographically fascinating, as they bear testimony of an unparallelled history of ancient mountain systems.

The transfer of mountain plants from a decaying one to a newcomer must also have happened on the Javanese volcanoes. In chapter 3 I have indicated that several ancient large ones have completely fallen into ruins (fig. 4 and phot. 72) and their mountain flora must (at least in part) have been taken over by new ones.

CHAPTER 17

THE COMPOSITION, DERIVATION AND ORIGIN OF THE JAVANESE MOUNTAIN FLORA

The composition of a flora is usually expressed by the percentages of presentation of the elements, *autochthonous* and allochthonous or foreign, *peregrine.*

Under the *autochthonous* element we understand those families and genera of plants which have, as far as we can ascertain, lived in a given country, and have evolved in great profusion. For example, *Dipterocarpaceae,* to which belong *keruwing, papahlar* (Sund.), *klalar(Jav.)*$_9$ *tengkawang*> *rasak, kapur, mengarawan, meranti,* etc., are characteristic for the autochthone element in Indonesia and this is proved by their fossil remains. And so are for example the genera *Eugenia (djambu)* and /^//.r, of which many hundreds of species occur in the forests. The autochthonous element consists of course not only of lowland plants but also includes an autochthonous mountain flora. There are *djambus* growing in the mountains. Of *Symplocos* (52-4), *ki seriawan, djirak,* several species occur in the mountains in profusion. The majority of the mountain species of such autochthonous genera we must assume to have evolved in situ, they are the children of the Indonesian botanical cradle, an ancient important tropical matrix.

The former paragraph on dispersal started with the statement that dispersal is a universal trend in the dynamics of the plant world leading to migration. So it is not surprising that the autochthonous element, the base flora, was enriched in past geological ages by successful foreign plant groups and this happened of course both in the lowland and in the mountain flora.

Thus *Eucalyptus* is a characteristic genus of the Australian element. In Australia some 400 species are known to occur in immense quantity: a few are found in New Guinea and two in the Lesser Sunda Islands; these are supposed to have migrated in the past from the large Australian cradle or centre of this genus, wandering northwards and northwestwards into Indonesia where they found a place among the flora and in the vegetation formed by the autochthonous element. In Indonesia they have no relatives or ancestors in the autochthonous matrix; they did not remain alienated but were generously received and are incorporated in perfect harmony. In East Java plants derived from Asia and from Australia adorn the undergrowth together with autochthonous-Malesian herbs, a happy family together under the 'umbrella' of the Australian *Casuarina*$_9$ a botanical 'warga negara\ They migrated from far on their own account, probably very long before the advent of Man, ages ago. In the flora of Indonesia *Eucalyptus* is hence a representative of a peregrine, foreign, vi2. the Australian element.

Also from the Asian continent such migrations took place and as an example I mention *tusam*$_y$ or Sumatran pine tree, *Pinus merkusii,* which belongs to a large genus developed with many species over the entire northern hemisphere. This pine occurs also in montane continental SE. Asia, but has taken occasion to extend its range as far as Central Sumatra. It is therefore a foreigner, in the Indonesian tropics representative of the Asian element, as the Sino-Himalayan region in SE. Asia must have been the source area from which the Sumatran pine started on its migration in the dim past.

What is the representation of peregrine plant groups in the Javanese mountain flora?

We become especially interested in these peregrine groups, the assimilated foreign genera, because they may provide information, by vestigal traces in their present ranges, on the pathway(s) which they have followed.

It is obvious that we will never find these pathways still intact, as in the former paragraph we have just discussed that in the course of the ages the earth crust has undergone immense changes, with mountains coming up and being eroded to almost nil; furthermore many plants must have succumbed by the crumbling of their lofty abode. The peregrine genera which succeeded in the mountains must have come via mountain systems as their cradles are situated in the extra-tropical colder countries or mountains, the Himalayas, and the Australian Alps. They must have used a cool lofty passage across the steaming equatorial regions. Their way cannot have been a continuous march to Tipperary, but very slow and gradual and often interrupted for long periods, until the situation became again favourable for going on. Unseen in action, unbelievable in effect, slow but steady, unimpaired, as all secular processes in Nature are.

For our further reasoning we have to single out reliable evidence. For these bits of evidence we could choose the species. But as we have seen, they may form other species on their way, which appear then of local occurrence and thus obliterate the essence of a genus migrating along a pathway. So it is better to take the genus as a unit for our analysis.

Here again we must be cautious as we have to single out those genera which really need a cool or cold climate and consequently must have needed mountains to be capable to extend their range.

Thus we must review the ecology of each individual genus. In doing this, it appears that there are not simply two categories of genera, one with *megatherm* ecology, comprising heat-loving species and one *micro therm,* confined to cold-loving species, but a great number which are *eurytherm* by possessing species of both kinds, some loving cold, others heat. We have observed this already in the above-mentioned genus *Symplocos,* which has lowland, montane and subalpine species.

The tropics are a test to reveal the ecological amplitude of the basic genome potential of a genus, quite a mouthful, because in the tropics a genus is challenged by both conditions, heat and cold, in the equatorial and montane stations respectively and tempted to enter both.

It may be a surprise to botanists acquainted with northern floras only, to learn that genera which they would have supposed to be of clear temperate ecology, have produced species which have taken to grow, or even are confined to equatorial climatic conditions, sometimes even at sea-level, as for example *Vactinium bracteatum* on the coral islets in the Java Sea. *Acer, Ajuga,* some *Carex* spp., ***Cladium, Daphne, Euonymus, Goody era, Ilex, Lactuca, Liparis, Ma/axis, Platanthera, Polygala, Quercus, Rub us, Satureia, Scutellaria, Spiranthes, Styphelia, Utricularia, Vaccinium* are** all eurytherm genera with species capable to grow in the equatorial zone as well as in the mountains.

This review shows that caution is justified when selecting reliable bits of evidence and that we have to restrict ourselves to microtherm genera which have proved to stand the ecological temperature test in the tropics and were not capable to produce lowland species, in short, genera of which all species are found in tropical countries only on the mountains.

As a condition I have chosen genera of which no species is found below iooo metres altitude. They need mountains which are at least 2300 m high, a figure emanated from our discussion on the elevation effect in chapter 6.

The reader will question: *how do you know that these **temperate genera which now grow in the tropical high mountains have always had this ecology?*** **The answer is that we cannot** guarantee this for the full 100%, but that it is experience which tells us that not only morphological characters are very conservative, as shown by the fossil evidence, but that also ecological behaviour, to temperature in particular, can be a characteristic deeply rooted in the hereditary qualities. It has also proved to be constant in the past, as fossils show, and the narrower their tolerance the better they can serve as guide fossils: reef-forming corals and *Dipterocarpaceae* for an equatorial climate, mammoth, *Primula* and *Betula* for a temperate climate. Paleontology is built in this respect on the fidelity to temperature of carefully chosen groups which, as Seward said, can be used as the thermometers of the past.

In the following two lists I have enumerated these temperate genera as represented in the Javanese mountain flora under their families, because this gives more information about the composition.

Some of these truly microtherm genera cannot be placed with certainty in a source category, as they range too wide in the world, without a distinct centre, which makes the derivation of the Javanese species uncertain; sometimes it seems as if some species of such a genus has come from Asia and another from Australia, as for example the 'Asian' *Rumex nepalensis* in East Java together with the 'Australian' *Rumex brownii* (40-7); a similar thing is found **in *Gaultheria, Juncus, Ranunculus,* etc.**

These excluded microtherm genera are the following:

ERICACEAE: *Gaultheria* (17-1/4)—GRAMINEAE: *Coelachne* (22-4), *Danthonia* (22-11), *Deyeuxia* (22-7), *Festuca* (22-12 & 14), *Hierochloe* (22-16)—JUNCACEAE: *Juncus* (24-2/3)—LABIATAE: *Plectranthus* (25-2 & 4, 30-2)—LORANTHACEAE: *Korthalsella* (30-5/6)—POLYGONACEAE: *Rumex* (40-7)—RANUNCULACEAE: *Ranunculus* (43-3/5)—SCROPHULARIACEAE: *Veronica* (51-4)—URTICACEAE: *Urtica* (55-6).

1. Asian peregrine temperate genera or subgenera, or sections preceded by §

ACTINIDIACEAE: *Actinidia*—ARALIACEAE: *Pentapanax*—BALANOPHORACEAE : *Rhopalocnemis(yi)*—BERBERIDACEAE : *Berberis* (7-2), *Mahonia* (7-1)—BUXACEAE: *Sarcococca* (7-4)—CAMPANULACEAE : *Codonopsis* (7- 5)—CAPRIFOLI ACEAE : *Lonicera* (8-1/2)—CARYOPHYLLACEAE: *Cerastium* (8-4), *Sagina* **(8-5), *Stellaria(S-6/j)*—COMPOSITAE: *Anaphalis{10-1 fz* & 6 & 9), *Carpesium* (10-3), *Centratherum* (n-i), *Dichrocephala* (11-2), *Ethulia* (11-3), *Lactuca* § *Prenanthes* (11-5), *Lagenophora,Myriactis(iz-4), Rhyn'chospermum* (11-7), *Sonchus(iz-))*** —CRUCIFERAE: *Cardamine* (13-5/6)—CYPERACEAE: *Carex* **§ *Acutae* (14-5 & 7), *C.* § *Elongatae* (14-4), *C.* § *Hymenocblaenae (14-6), C. %Multiflorae* (14-1), *C.* § *Polystachyae* (14-2, 15-1), *C.* § *Primocarex* (14-8), *Scirpus* § *Monostachyae* (14-16)** —EUPHORBIACEAE: *Euphorbia* § *Esulae* (19-4)—GENTIANACEAE: *Crawfurdia* (20-1), *Gentiana* (20-2), *Swertia* (20-3/5)—**GRAMINEAE: *Agrostis* (22-5), *Brachypodium* (22-6), *Bromus* (22-8), *Helictotrichon* (22-2), *Muehlenbergia* (22-10), *Streblo*-***chaete* (22-15), *Tripogon* (22-13)—HALORAGIDACEAE: *Haloragis* (23-2), *Laurembergia* (23-3)—HAMAMELIDACEAE : *Distylium* (23-5)—HYPERICACEAE: *Hypericum* § *Norysca* (23-6)—LABIATAE: *Elsholt^ia* (24-6), *Melissa*(25-5), *Stachys*(25-6)—LEGUMINOSAE: *Dumasia* (26-7), *Euchresta* (27-1), *Lespede^a* (27-2/3), *Parochetus* (27-4), *Shuteria* (27-5)—LILIACEAE: *Disporum* (27-8)—MELASTOMATACEAE: *Sarcopyramis* (31-7)—MYRICACEAE: *Myrica* (32-5)—OLEACEAE: *Fraxinus*—ORCHIDACEAE: *Disperis* (38-3), *Herminium* (37-5), *Stigmato*-***dactylus* (39-5)—POLYGONACEAE: *Polygonum* § *Aconogonon*** (41-9)—PRIMULACEAE: *Lysimachia* (42-2), *Primula* (42-4)—RANUNCULACEAE: *Thalictrum*{43-6)—RHAMNACEAE: *Rhamnus* (43-7)—ROSACEAE: *Agrimonia* (44-1), *Alchemilla* (44-2), ***Neillia* (44-4), *Photinia* (44-5), *Potentilla* (44-3 & 6/7), *Rubus* § *Alpestres* (45-1), -fi. § *Chamaebatus* (46-1), *R.* § *Ideanthii*** (45-5), *R.* § *Lineatii* (45-4), *R.* § *Pirifolii* (45-6)—RUBIA**CEAE: *Allaeophania* (46-2), *Galium* (47-1/4), *Neanotis* (46-**3/4)—RUTACEAE: *Boenninghausenia* (49-2), *Toddalia* (49-4)—SAXIFRAGACEAE: *Astilbe* (50-2), *Hydrangea* (50-4)—SCHISANDRACEAE: *Schisandra* (2-10, 29-4)—STERCULIACEAE: *Reevesia*—UMBELLIFERAE: *Pimpinella* (54-3/4), *Sanicula* (54-**5)—URTICACEAE: *Chamabainia, Droguetia, Girardinia* (5 5-4)** —VALERIANACEAE: *Valeriana* (56-6)—VIOLACEAE: *Viola* (56-7/10).

2. Australian peregrine temperate genera

CAMPANULACEAE: *Lobelia* § *Pratia* (7-8/9), *Wahlenbergia* (7-10)—COMPOSITAE: *Senecio* c§ *Erechtites*9 (12-2)—CONIFERAE: *Podocarpus* § *Dacrycarpus* (13-2)—DROSERACEAE: *Drosera* § *Polypeltis* **(14-18)**—GERANIACEAE: *Geranium* (20-6/7)—GRAMINEAE: *Microlaeana* (22-9)—HALORAGACEAE: *Gunnera* (23-1)—MYRTACEAE: *Leptospermum* (33-4)—ONAGRACEAE: *Epilobium*—ORCHIDACEAE: *Caladenia* (34-2), *Mfcnth* (J9-7), *Tklywitra* (J4-7)—RUBIACEAE: *Cvprostna* (46-8}, *Ntriira* (48-2).

In comparing these two lists it appears that the Asian element is infinitely richer, being represented by a total of 90 genera ccj, sections which are herbaceous except 6 tree genera, 7 of shrubs and 6 of wmdy climbers, while rhe Australian clement is represented by 15 genera, among which 1 tree genera, and 1 of shrubs.

This would point to a. far better road of access from the Asian continent to Java than from Australia. And this is reflected in the present physiography, with a long distance from Timor to the mountains of New Guinea and Australia.

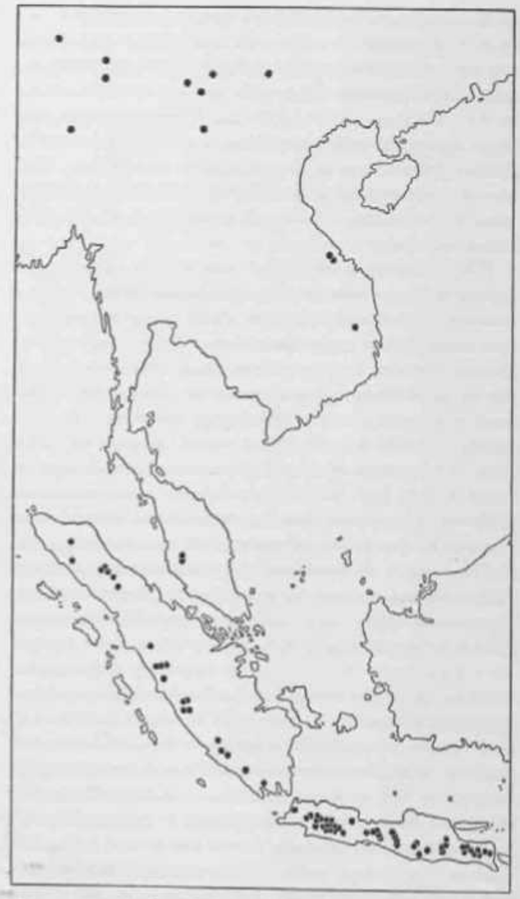
Though the present configuration of the pathway from Java to the continents! SE. Asian mountains in northern Burma (Khasya Mills), which is the likely source area, is rather intact, it must have been much mure flourishing in former time before the abrasive penepiainisatiun of Tenasserim, Lower Burma and Thailand and Malay* towards Sumatra. Mf>st mountain plants show here a considerable gap in Their area, some 1400 km wide, simply because the present mountain ranges are nut sufficiently high any longer. In Sumatra the situation is better because the huge Barisan range is interspersed with many high **volcanoes** and in South Sumatra there are several volcanic ruins of once **lofty** summits. In Bantcn casrwards to Mt. Salak [here are now only some small mountains, but formerly there have been huge volcanoes which must have **been** responsible for the extensive Bantam tuff strata which buried and destroyed the once high forests of camphor trees—with the fossil wood of which now roads are paved—which were the home nf hippopotamus, antelopes and ancestors of modem elephant. Prom Mt. Salak and Gede eastwards there is an almost unbroken series of volcanoes and interspersed between the present high peaks are many decayed **volcanoes** of ere.

Not all species occur on all mountains and this i regard *it* a reflection of the vicissitudes of time in the sketched reconstruction, A scattered occurrence is of course **the** likely situation ii" otic has absorbed the visualization of how dispersal must have worked in the dynamic world of mountain summits as pictured in the foregoing chapter.

The montane mountain plants had, of course, better chances 10 remain in an intact area than the subalpinc ones, **U they** could maintain themselves longest; liigh peaks were scarcer, of smaller surface and of shorter duration than lower altitudes which covered larger areas and lasted longer.

To illustrate this a map was made (fig. ij) of *Samnih* ***mrepHa*** ssp. ***%l«t**** (14-i) •" SE.Asia, **Makya,** Sumatra and Java. *SMUMIH* is a light-intolerant forest plant which occurs between (600-S 00-) 1000 up to jooo m. It shows very lirtlc elevation effect and is found on mountains **which** peaks need sometimes not to be higher than c. 1300 m.

If we compare this with the map of *Primula* (41-4) in fig. I) there is a striking difference in density of localities. This is easily explained: *Primula* occurs from iOjo (o JIJO



I ivr 2)- The Ji K-.ititu-s in Went Mslcsla of the mewunc to subalpine *Stixiflifa rttroptitn* ss]i. *titi/n* (54-5) which show much lets gaps in the r-tn^.c ihnTi *Primula* in lig. 2).

m altitude and is a shade-intolerant plant of open localities. It shows a distinct elevation effect and is only found on mountains of at least 1650 m altitude. Though there are at present in Java several intervening mountains of ih.n altitude and higher with suitable localities (Tjcrcmai, Slamat, Dieng, Lawu, AtiJjuno and Smfni) which could fill the gaps, it <h>cs not occur on these mountains. Tliis is naturally a secret of Nature, of the past, and we einnm account for it, but it becomes sttmcwhnt understandable in the light of what 1 h.-ive just said.

There remains another interesting point to discuss, viz. the occurrence of severaJ species from the same source area along the same route or track which do not occur in Java, for example *Anrmtmt stmiatram* which ranges from continental SE. Asia tlurougli Vhitaya all the way down to Mt. Tanggamus in the Lampong Districts of South Sumatra and so do a composite of the genus *Airtifiitrj,* and .ithcrs. Both arc light-intolerant furest plants, and this may throw light on their slower progress, 1 have ,»n another occasion already remarked (S 1964) that prnlwlily the open high mountain routes with their patches of bare soil can serve for more rapid crossing as compared with the forest, which would also explain the **tow** number of trees in [lie assortment derived from the Asian source area, and be in agreement **with** the relative scarcity of them in ihc densely forested mountains of Borneo and Malaya. This would mean a curious para.Net with the traveiling of Man who also chooses the ridges, as crossing the forest is laborious work.

Il"IKH did ihc peregrine clemtills tome in? For this we tnusl of course think in terms of the geological time-scale, that is in millions uf years, a remark which gives dimension to our thoughts but nr> mure. A very difficult question to answer. But we can make some botanical assumptions, the most obvious being to speculate that, it' the immigration were *very* ancient and ihe species of the peregrine elements really old relicts, one would suppose sufficient time and opportunity for their evolutionary change, in **Other** words they mould have liecome more and more dirlcrtnt from the original source species, would have changed into, <ir produced new species, or even new genera.

The tatter is distinctly not the ease and the experience is thai ihc majority are the same specie* as growing in the source area. They have sometimes got diftbrtnl species names, **because** the botanists who descrilwd them worked on a local basis. But as soon as thorough revisions arc made in which the material from Asia and Java is correlated, it appears that the migration usually did not lead [o new species. Admitted]v\ specimens irom Sum;vi.i md Java do sometimes show a different racial facjes, but this happens as well in their continuous contincnrii **nets, By exception** *fleclrattlbm pttraem* (jo-i), *P. jcysmanvii* (i)-4) and *P. sttinifii*, *PirrrpineJla javtvui* (J4-3) and *Aijdphtilis maxima* (10-9) seem to be endemic species, but in each case they have a closely allied continental SB. Asian (vicarious) sister species supposed to helong to the same ancestry.

The situation leads, however, to the view that the migration was probably not very o)d and maybe tuok place in the Pliocene or Upper Miocene epoch.

Among the few representatives of the Australian clement individuality is proportionally better represented as *Tbelyruitru*, *Ctiprssma* and *Ertchtittt* all have distinct species. Also *Casnarinaj>mgimhm<in<i* is of eastern affinity and we can add to this *Stypbtlia jammiea.* They all occur also in the Lesser Surtda Islands. In these islands arc also *Drimjs piperiia*, an ancient clement of eastern ancestry, *Lobtlia* (§ *Praliii) bartieensis, Tmcbymene actri/o/ia, Dittris fryaita, Dttmm gltKbidiaius*, and on Mt. Tatamajiau in Portuguese Timor t found the New Cuinean and Ceram highland grass *Desthampiia kiossii* and the Australian i;rass *Dichclaclmt ram.*

In passing 1 remark that on the whole, however, the mountain flora of the Lesser Sunda Islands is an uninterrupted continuation of (hat of Fast Java but somewhat poorer.

In fig. 16 I hive given a very rough, and very tentative, presentation how these two pathways could likely have run, mainly to fix attention to the direction but by no means to any detail.

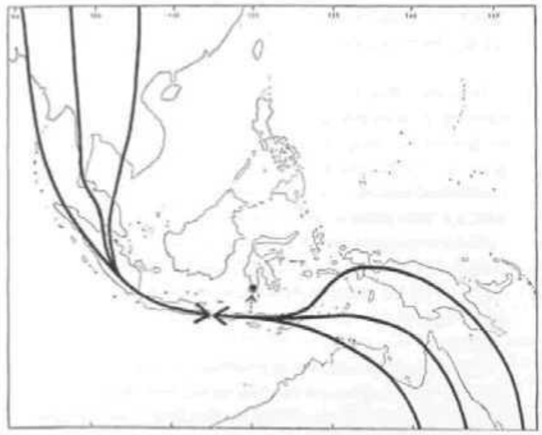


Fig. 16. A very Khcmatlc idea about the direction of the pithwayi which IILIV in Tertiary time have Kef veil fur the iTii^rioun of 1 Vic pcrc-Brine clement ro Jivn. from Asii and from Austral is with a dear but unexplained OCCdKSflCB an Mt. Ii<mlhnin in Sniiiti^csr CcEebcs,

Concluding on the evidence of the Australian pathway there are much less bur still distinct boranical indications that eastern genera, presumably from Australia, migrated towards Java, and faint evidence that this might have happened at least in part via New Guinea. The proportionally higher number of distinct species of these genera would point to an older pathway than that from Asia.

A critical reader will possibly ponder over the last sentence and cjuestion why only some genera have produced new species and others not, reminding me of having said that plants travel together and those using the pathway must then be equally old. So, why did not all produce new species?

To this digging in the mysteries of evolutionary forces I would reply as follows: we can only assume in a very general way that rhere will be a greater probability of new species the longer the span of time is.

But I would never subscribe the dogma that it is a 'must' for each plant species to undergo evolutionary change at either regular or irregular intervals, A quick Inok at the range map of *blatnrtigis mieruntba* in fig. *it* is sufficient to sec that this distinct liigh mountain species was able to at lain a colossal bi-hemispheric distribution, readying from its source area in the southern hemisphere to the northern tip of Japan, full} maintaining its identity and without giving rise to any other species of *Mstaragis* on the northern hemisphere where it represents a peregrine clement. And I recall the *Nypa* palm which once occurred in the tropics of all continents as early as the Upper Cretaceous Period, but hardly changed character onwards of that immense period nor did it give rise to any evolutionary offspring.

We remember the remarkable results of pajynnlogists who can in a number of trustworthy cases show by fossil pollen grains the former presence of plants in places where they do not occur any more. Among the oldest of such recognizable pollens is a tropical rain-forest tree of the flax family, the genus *Ctenolophon,* which existed already in the Upper Cretaceous, some 100 million years ago. It became extinct in tropical America, it still exists with two closely allied species, one in West tropical Africa and one in Indonesia. During this colossal period it obviously maintained its precise identity and time did not lead to any evolutionary development. And we think of the even more astounding example *oiGinkgo, a.* conifer genus found fossil onwards of the Jurassic (or even Permian), extremely uniform and not impossibly consisting of only a single (phylogenetic) species, with little change during the immense period of more than 200 million years, starting in the time when Dinosaurs roamed about.

After this excursion in the past returning to the question which we wanted to fathom, we understand that Willis* mathematical theory of evolution is a phantom, and that Nature offers a most erratic picture of evolutionary rate, a variety ranging from almost nil to extremely rapid as obviously occurred in orchids, grasses, and composites. We understand also that there is a similar erratic picture of extinction, because as far as fossils can tell their story, most plants did not live as long as *Ginkgo, Nypa* and *Ctenolophon.* Here again we fail to see reason why some are virile, that is vigorous, tough and successful and others have a short geological life, why some change and others maintain identity and remain unassailable in their self-containedness and can face any challenge. We observe, but cannot explain or foretell.

For all good and bad things, let us say in fashionable modern terms, the trick is in the gene pool of which such plants contain a stable bit. It may be redundant in the thinkings of the present society to hear that there is something good in ancient living beings able to withstand the vicissitudes of the ages.

Though the reader has had opportunity to become somewhat wiser, he may be disappointed at the conclusion which we will have to make, as it can only be vague.

It is clear that the Australian element is in Java far more feebly represented than the Asian one and this must be ascribed to a fragmentary ancient mountain pathway. There must have been one, as we have ruled out long-distance dispersal.

The waiting is now for some generous geologist who will provide us with some ancient mountain masses between Timor, New Guinea and Australia for the stepping stones needed. They must have subsided since, so he has to dig them up to give botany a geological foundation.

If he has solved this matter we will give him another problem to solve, namely how is it that of the 150 mountain species of Java we selected, and of which 80 occur in the Lesser Sunda Islands, no less than 50 are also found on Bonthain volcano, a threethousander in the tip of the SW. peninsula of Celebes, and of which none occurs on the Latimodjong Range in Southwest Central Celebes. Bonthain could botanically have been one of the Lesser Sunda Islands. Fig. 26.

Anyway it seems clear that we must assume that Java, with Sumatra and the Lesser Sunda Islands have had a share in a trans-tropical pathway from the northern to the southern hemisphere along which exchange of mountain plants could take place leading to the bi-hemispheric and bipolar ranges alluded to at the end of the preceding chapter. Fig. 22 & 24.

The question of dating the migrations is more difficult. It would seem to me that the Australian is more ancient than the Asian, let us guess that the Asian happened in the Upper Miocene to Pliocene, the Australian in Middle or Lower Miocene.

At this point I must stop guess work, from which this branch of botany can never be free. It makes it interesting as speculation amuses and refreshes the mind.

It is also pleasant to know that such speculations have not seldom proved useful and have in several instances led to forecastings which came true because plants are geographically arranged in an orderly way, according to certain disciplines and rules, and it is the purpose of plant-geography to become familiar with them.

CHAPTER 18

SELECT REFERENCES TO THjE JAVANESE MOUNTAINS

In the original plan it was my intention to give brief descriptions of trips to various mountains, with botanical summaries and commentaries, as a guide for hikers, naturalists and botanists. This is rather out of place in this book. It has at least in part also become out of date, because the local situation as to roads, accommodation, etc. has of course much changed in the past three decades and especially in the montane zone deforestation has taken its toll of the forest.

Still I feel that some information of the kind should be enumerated in a concise way, apart from the bibliography at the end of this book.

I therefore decided to give a select bibliography in which the references are arranged by mountains, so that of most some information is a\ailable, topographical, volcanological, botanical, and a little zoological. In this way naturalists and botanists can prepare themselves before making a tour or can afterwards compare their results with earlier accounts. The references are of various quality and length. I have tried to select relevant ones; sometimes a concise excursion report contained more information than much longer papers. Only of very few mountains the botany is treated at length, Ged6-Pangrango, Tengger and Idj&n making exceptions; of some I have no botanical data.

The bibliography consists of books and papers in various languages, but Dutch prevails as a consequence of the colonial history of Indonesia; this is the case too in much literature on the natural sciences. For that reason Indonesian scientists are invited to learn it, as otherwise a huge amount of accumulated information will not be available to them.

I omitted to cite or extract references of the famous early former century explorers such as Blume, Junghuhn, Zollinger and Teysmann, except in a very few cases where no more recent reports are available. The study of the two works of Junghuhn, 'Reisen in Java' (1845) and 'Java' (1850-1854; 4 vols) is recommended to the botanist.

An other recommendable work is the popular but informative booklet by Mrs. Geerts-Ronner,'Vacantie in de Bergen' (1927: 218 pp.) as an introduction to the mountain flora of Java.

Also the topographical and volcanological reports mentioned in two journals, 'Jaarverslag van den Topographischen Dienst' and "Bulletin of the Netherlands East Indian Volcanological Survey', have not been extracted as this would go too far for this book. The important serial ' Vulkanologische Mededeelingen' of the same survey has been extracted.

There remain two practical points to consider, *how should I prepare myself for a botanical tour,* e.g. organization, clothes, equipment, etc. and *how should collected plants be handled and dried* to preserve them for later checking and naming or filing for the record.

As to the first point it can be said that for the purpose of a naturalist, the field is perfectly free and safe, provided he is so wise to take a local Indonesian with him, who is acquainted with the terrain; this is for orientation and in case of fog or accidents a necessary provision. In my experience the guides enjoyed the excursions themselves.

Access to all mountains is easy for all energetic people and no special mountaineering qualities or gear are required. Some *practical hints for field work* are contained in a small booklet by C. N. A. de Voogd & Z. Salverda, 'Wenken voor de rimboe', first published in Tectona 32: 509-5 36 (1939), a 2nd edition edited by me in (pocket) book form under die same title at Bogor (1940:54 pp.). A more extensive guide for camping and equipment I gave in the first volume of Flora Malesiana (1950: xlv-lxix).

A most useful, almost indispensable book is further the geographical guide for mountain tours by Ch. E. Stehn, 'Gids voor Bergtochten op Java', the 2nd edition of which was edited at Djakarta (1933) by the Netherlands Indian Society for Mountaineering (pocket format, 188 pp.). This contains text with full but brief detailed descriptions of various ways of ascent, time tables, and detail maps. I shall refer to this as 'Stehn, p. 00'.

An other useful lavishly illustrated book is that by Taverne concerning the structure of various volcanoes and an excellent introduction to volcanology. This was edited in the series 'Vulkanologische Mededeelingen' as volume 7 (1927) by the Volcanological Survey, Bandung, 132 pp.

On the *preservation of plants and making a herbarium* I cannot go into detail here. It depends too much on purpose, duration of the excursion, available money and facilities, the panorama ranging from a fragment dried in a note-book to carrying a drying stove for preparing herbarium in ten sets. I refer the reader to the chapter on the 'Technique of plant collecting' in Flora Malesiana mentioned above (1950: xlv-lxix). For the rest botanists have experience in this field and often prefer to stick to their self-invented techniquės of which they are not seldom proud.

Unlike a stamp collection, a herbarium is a means of study; it is in fact the material basis of knowledge of plant forms and their distribution. It serves also to keep the memory alive, both of the trip and the plants themselves, to recognize them the next time.

It serves also for their identification. In this book only a restricted number of species have been depicted and in case of doubt and for other species one has to try to identify with the 'Flora of Java'. But for the amateur botanist this is not always available and then it is advised to apply to Herbarium Bogoriense, Bogor, which is ready to provide critical information, or in Europe to the Rijksherbarium, Leiden, Holland; but in both cases herbarium material is necessary I

The arrangement of the mountains is from west to east, the numbers corresponding to those of fig. 1. The detailed situation is to be consulted in the 'Atlas van Tropisch Nederland'(i938).

1. PULASARI, 1346 m.
Stehn, p. 10.

2. KARANG, 1778 m.
Funke. 1934. Med. Ned. Ind. Ver. Bergsport 8: 17—Stehn, p. 10.

5. SALAK, 2211 m.
Anonymus. 1925. Trop. Natuur 14: 161-162. Excursion report to solfatara fields—Bauduin. 1940. Med. Ned. Ind. Ver. Bergsport 18: 4-11. Ascent from Tjiapus gorge—Beumde. 1928. Trop. Natuur 17: 171-173. Botanical excursion report—Hartmann. 1939. Trop. Natuur 20: 177-188. General information; large bibliography—Lubbers. 1935. Med. Ned. Ind. Ver. Bergsport 11: 20-23. Ascent report G. Sumbul—Do. 1936. Ibid. 13: 4-7. Tour report; map—Stehn, p. 12—De Vos. 1937. Med. Ned. Ind. Ver. Bergsport 14: 11-13. Ascent of Tjiapus waterfalls.

6. GED£-PANGRANGO, 3019 m.
Anonymus. 1923. Trop. Natuur 12: 159-160. Excur-

sion notes lake Telaga Warna—Anonymus. 1934. Trop. Natuur 23: 19-20. Botanical excursion report G.Besfcr—Anonymus. 1934. Trop. Natuur 23: 39-40. Botanical excursion notes on the lake Situ Gunung—Blaauw. 1917. De Tropische Natuur in Schetsen: 27-73. General botanical sketch—Bonnike. 1935. Med. Ned. Ind. Ver. Bergsport 11: 24-28. Tour report G. Limo, G. Telaga, Telaga Saät—Dammerman. 1929. Tjibodas (Zoology). 4th Pac. Sci. Congr. Excursion Guide C 3—Docters van Leeuwen. 1929. Tjibodas. 4th Pac. Sci. Congr. Excursion Guide C 3: 17 pp.—Do. 1932. Med. Ned. Ind. Ver. Bergsport 6: 24-26. Ascent of G. Sfelo—Do. 1933. Verh. Kon. Akad. Wet. A'dam sect. II, vol. 31: 278 pp. Biology higher parts; vegetation; plant species; pollination; dispersal—Von Faber. 1927. Die Kraterpflanzen Javas. Weltevreden. Ecology of crater flora—Hoogerwerf. 1949. De avifauna van Tjibodas en omgeving: 158 pp., 244 col. fig. Account of birds of Tjibodas—Koorders. 1918-1923. Flora von Tjibodas. 3 vols. Flora with keys; not too good—Meijer. 1954. Penggemar Alam 34: 9-17. Sociological observations summit regions—Do. 1959. Acta Bot. Neerl. 8: 277-291. Inventory of 1 ha rain-forest; stratification and regeneration—Polak 1933. Natuur & Techniek 1933: 409-415. General biology—Ritman. 1939. Med. Ned. Ind. Ver. Bergsport 16: 2-5. Ascent from Tapos—Rock. 1920. The Hawaiian Planters' Record 22: 67-104. Botanical collecting trip; good account of vegetation—Seifriz. 1923. Bull. Torr. Bot. Club 50: 283-306. Plants at different altitudinal zones—Van Steenis. 1928. Trop. Natuur 17: 199-207. High forest vegetation—Do. 1933. Ibid. 22: 231-232. Botanical tour to Mt. Limo—Do. 1937. Natuur in Indië: 57-61—Do. 1941. Trop. Natuur 30: 170-172. Plants of *Sphagnum* peat swamp Rawa Gajonggong—Van Steenis & Van Steenis-Kruseman. 1953. Fl. Mai. Bull. 10: 312-351. Bibliography of botanical research on Mt. Pangrango-Ged6 —Stehn, p. 16—Taverne. 1926. Vulkan. Med. 7: 84-89. Volcanological.

SANGGABUWANA, 1291 m.
Anonymus. 1930. Med. Ned. Ind. Ver. Bergsport 3: 9-10. Tour report—Van Steenis. 1934. Trop. Natuur 23: 163-167. Flora of volcanic ruins W. of this mountain—Stehn, p. 27.

BURANGRANG, 2064 m.
Stehn, p. 30.

7. TANGKUBAN PRAHU, 2084 m.
Anonymus. 1933. Wandelgids voor den G. Tangkoeban Prahoe. Bandung: 18 pp. General guide; tew plants mentioned (author L. van der **Pijl)**—Docters van Leeuwen. 1929. Tangkoeban Prahoe. 4th Pac. Sci. Congr. Excursion Guide B 4: *3 PP- Vegetation—Schierbeek. 1935. De Wandelaar 7: 86-89. Brief sketch—Stehn. 1929. Tangkoeban Prahoe. 4th Pac. Sci. Congr. Excursion Guide B 3: 22 pp. Volcanological—Stehn, p. 33—Taverne. 1926. Vulkan. Med. 7: 71-77. Volcanological—De Wiljes-Hissink. 1952. Trop. Natuur 32: 115-119. Plants and animals.

8. BUKIT TUNGGUL, 2209 m.
Stehn, p. 40.

9. TAMPOMAS, 1684 m.
Van der Pijl. 1929. Trop. Natuur 18: 87-93. Popular; Hindu antiquities, but first botanical reconnaissance—Stehn, p. 45.

MANGLAJANG, 1862 m.
Stehn, p. 41.

10. PATUHA, 2434 m.
Lörzing. 1911. Tectona 4:490-501. Forest exploitation of rasamala—Do. 1917, 1921. Trop. Natuur 6: 81-86; ibid. 10: 97-105, 113-120, 134-141. Excellent botanical survey of many sites—Stehn, p. 48—Taverne. 1926. Vulkan. Med. 7: 96-98. Volcanological—Winckel. 1933. Mooi Bandoeng 1: 106, 179.

11. TILU, 2040 m.
Junghuhn. i860. Natuurk. Tijd. Ned. Ind. 21: 221-245—Stehn, p. 51.

12. MALABAR, 2330 m.
Van der Pijl. 1931. Med. Ned. Ind. Ver. Bergsport 4: 33-35. Tour reports—Stehn, p. 52.

13. WAJANG, 2182 m.
Stehn, p. 57—Winckel. 1934. Mooi Bandoeng 2: 25. On the solfatara field.

15. PAPANDAJAN, 2622 m.
Docters van Leeuwen. 1930. Trop. Natuur 19: 121-123 (Tegal Primula, on Mt. Ipis). Flora—Neumann van Padang. 1929. Goenoeng Papandajan. 4th Pac. Sci. Congr. Excursion Guide C 1, 2: 21 pp. Volcanological—Van Steenis. 1930. Trop. Natuur 19: 73-91. Vegetation; new finds—Do. 1932. Ibid. 21: 101-108, 188-191. Tegals; more new finds; [subfossil leaves of mountain plants in tuff—Do. 1932. Verslag Ned. Ind. Ver. Natuurbescherming 1929-1931: 77-82. General survey and conservation—Do. 1935. Trop. Natuur 24: 141-147. Influence of wind on crater plants; cushion plants—Do. 1937. Natuur in Indie: 19-22. General botany—Stehn, p. 57—Taverne. 1926. Vulkan. Med. 7: 78-83. Volcanological.

KAWAH MANUK, 1930 m.
Stehn, p. 68—Taverne. 1926. Vulkan. Med. 7: 30-34. Volcanological.

KAWAH KAMODJANG, 1650 m.
Anonymus. 1929. Trop. Natuur 18: 33-34. Brief

botanical excursion—Stehn. 1929. Kawah Kamodjang. 4th Pac. Sci. Congr. Excursion Guide C 2: 13 pp. Volcanological—Stehn, p. 72—Taverne. 1926. Vulkan. Med. 7: 27-30. Volcanological.

16. TJIKURAI, 2821 m.
Anonymus ('Andjing Utan'). 1919. Trop. Natuur 8: 178-181. Superficial botanical report—Junghuhn. 1854. Java vol. 2B: 571-584—Stehn, p. 76.

17. GUNTUR, 2249 m.
Kerkhoven. 1898. Teysmannia 8: 489-508. Colonization of lavastream 50 years old—Van der Pijl. 1938. Ann. Jard. Bot. Buitenzorg 48: 129-152. Pioneers lavastream vegetation 100 years old—Stehn, p. 70—Taverne. 1926. Vulkan. Med. 7: 102-107. Volcanological.

18. GALUNGGUNG, 2241 m.
Van Es & Taverne. 1924. Vulkan. Med. 6: 63 pp. Volcanological—Koorders-Schumacher. 1913. Systematisches Verzeichnis zum Herbar Koorders, I. Java, Lief. 10, § 5: 34-38. Tree list—Van der Pijl. 1940. Trop. Natuur 29:139-140. Recolonization of the famous lava-plug—Stehn, p. 77.

TELAGA BODAS, 1724 m.
Van Es & Taverne. 1924. Vulkan. Med. 6: 63 pp. Volcanological—Stehn, p. 79.

19. TJEREMAI, 3078 m.
Buck. 1937. Med. Ned. Ind. Ver. Bergsport 15:7-13. Mountaineering ascent—Lam. 1925. Trop. Natuur 14: 2-10. Botanical report—Neumann van Padang. 1938. Trop. Natuur 27:1-10. Eruptions of 1937 and reaction of flora—Stehn, p. 83—Taverne. 1926. Vulkan. Med. 7: 46-51. Volcanological.

20. SLAMAT, 3432 m.
Buck. 1936. Med. Ned. Ind. Ver. Bergsport 13: 12-14. Tour report—Lam. 1924. Trop. Natuur 13: 17-25. Botanical report; map—Raciborski. 1900. Natuurk. Tijd. Ned. Ind. 59: 234-253. Account of ferns—Stehn, p. 86—Taverne. 1926. Vulkan. Med. 7: 35-39. Volcanological.

21. DIËNG, 2560 m.
Biinnemeijer. 1918. Trop. Natuur 7: 43-48, 69-74, 101-104, 122-124, 135-138. Plants and vegetation—Van Gent. 1920. Jaarverslag Topogr. Dienst Ned. Ind. for 1919, 15: 69-88. General topographical description—Loogen. 1941. Trop. Natuur 30: 65-70. Grassland vegetation—Neumann van Padang. 1936. Trop. Natuur 25a (Jubileum Uitgave): 27-36. Geological history and volcanology—Ruttner. 1932. Arch. Hydrobiol. Suppl. vol. 11 (Trop. Binnengewässer vol. 3): 363-365. Waterplant and marsh flora of 3 lakes—Van Steenis. 1932. Trop. Natuur 21: 162-164. Vegetation; *Poljgonumplebeium*—Stehn, p. 90 (includes G. Prahu and plateau).

22. SINDORO, 3136 m.
Docters van Leeuwen, H. 1929. Treubia 10: 439-446. Vegetation; stomach contents of birds—Docters van Leeuwen, W. M. 1930. Bull. Jard. Bot. Buitenzorg III, 11: 28-56. Vegetation—Koorders. 1895. Tijd. Nijverheid & Handel Ned. Ind. 51: 241-287. Spontaneous and artificial reafforestation—Taverne. 1926. Vulkan. Med. 7: 40-44. Volcanological.

23. SUMBING, 3377 m.
Docters van Leeuwen. H. 1929. Treubia 10: 439-446. Vegetation; stomach contents birds—Docters van Leeuwen, W. M. 1930. Bull. Jard. Bot. Buitenzorg III, 11: 28-56. Vegetation—Jongert. 1940. Med. Ned. Ind. Ver. Bergsport 18: 11-15. Ascent report—Lastdrager. 1941. Med. Ned. Ind. Ver. Bergsport 19: 13-15. Tour report—Loogen. 1941. Trop. Natuur 30: 81-85. Botanical report; first record *of Primula* on this mountain—Stehn, p. 100—Taverne. 1926. Vulkan. Med. 7: 52-55. Volcanological.

24. UNGARAN, 2050 m.
Junghuhn. 1845. Reisen auf Java: 279-287. Ascent; vegetation; occasional plant names—Koorders-Schumacher. 1913. Systematisches Verzeichnis zum Herbar Koorders, I. Java, Lief. 10, § 5: 60-66. Tree list mountain forest reserve—Stehn, p. 103.

TELEMOJO, 1893 m.
Koorders-Schumacher. 1913. Systematisches Verzeichnis zum Herbar Koorders, I. Java, Lief. 10, § 5: 60-66. Tree list of mountain forest reserve—Stehn, p. 104.

25. MERBABU, 3142 m.
Docters van Leeuwen. 1913. Ber. Deut. Bot. Ges. 31: 151-157. Flora; influence of fire—Stehn, p. 106.

26. MERAPI (Djokja), 2911 m.
Den Berger. 1917. Trop. Natuur 6: 100-105, 117-123, 129-134. Botanical report—Kemmerling. 1921. Vulkan. Med. 3: 30 pp. Volcanological—Neumann van Padang. 1933. Vulkan. Med. 12: 135 pp. Volcanological—Stehn, p. 109—Taverne. 1926. Vulkan. Med. 7: 65-70. Volcanological—Vissering. 1910. Geweldige natuurkrachten. Description lahars.

27. MURIAH, 1602 m.
Kooiman. 1935. Med. Ned. Ind. Ver. Bergsport 10: 17-20. Tour report—Koorders. 1887. Natuurk. Tijd. Ned. Ind. 47: 260-275—Lörzing. 1909. Urania 1909 (not seen).

28. LAWU, 3265 m.
Van Balgooy. 1957. Penggemar Alam 37: 63-64.

Relations between animals and plants—Coert. 1936. Med. Ned. Ind. Ver. Bergsport 12: 17-23. Tour report—Docters van Leeuwen. 1925. Natuurk. Tijd. Ned. Ind. 85: 23-48. Flora higher parts—Elbert & Hallier f. 1912. Med. Rijksherb. Leiden 12: 31 pp. Altitudinal zones; large plant list—Stehn, p. 119—Taverne. 1926. Vulkan. Med. 7: 116-121. Volcanological—Thienemann. 1930. Der Naturforscher 7: 121-128. General account.

29. WILIS, 2563 m.

Koorders. 1894. Tijd. Nijverheid & Landbouw Ned. Ind. 48: 205-244. Composition of forest; lists of trees and shrubs—Lörzing. 1914. Trop. Natuur 3: 97-102, 120-123. Botanical reconnaissance—Stehn, p. 126—Swart. 1939. Tectona 32: 469-504. Vegetation and reafforestation.

30. ANDJASMORO (Dorowati), 2282 m.

Clason. 1934. Trop. Natuur 23: 195. Brief note on ferns and mosses—Drijfhout van Hooff. 1936. Med. Ned. Ind. Ver. Bergsport 13: 15-17—Stehn, p. 139.

31. ARDJUNO-WELIRANG (incl. Kembar summits), 3339 m.

Van Steenis. 1935. Gard. Bull. Str. Settl. 9: 64-69. Vegetation fumaroles Kembar peak—Do. 1936. Trop. Natuur 25: 37-44. Vegetation fumaroles Kembar peak—Do. 1937. Natuur in Indië: 68-70. General sketch—Stehn, p. 139—Taverne. 1926. Vulkan. Med. 7: 109-116. Volcanological.

PENANGGUNGAN, 1653 m.

Crommelin. 1940. Med. Ned. Ind. Ver. Bergsport 18: 19-20. Ascent report—Stehn, p. 142—Zollinger. 1865. Ausland 1865: 925-930, 950-955.

32. KELUD, 1731 m.

Clason. 1935. Bull. Jard. Bot. Buitenzorg III, 13: 509-518. Botanical analysis recolonization—Kemmerling. 1921. Vulkan. Med. 2: 120 pp. Volcanological; eruption 1920—Lafontaine. 1937. Med. Ned. Ind. Ver. Bergsport 14: 7-10, map. Ascent from the South —Van der Plas. 1936. Med. Ned. Ind. Ver. Bergsport 12: 24-26. Tour report—Stehn, p. 132—Stehn & Coert. 1929. Keloet. 4th Pac. Sci. Congr. Excursion Guide E 2a: 37 pp. Volcanological—Taverne. 1926. Vulkan. Med. 7: 61-64. Volcanological—Vissering. 1910. Geweldige natuurkrachten. Illustration lahars.

33. KAWI-BUTAK, 2868 m.

Anonymus. 1936. Med. Ned. Ind. Ver. Bergsport 13: 18-19—Docters van Leeuwen. 1935. De Levende Natuur (Thijsse Gedenkboek): 57-62. Flora—Stehn, p. 136.

34. TENGGER (incl. Penandjâan, Bromo, Batok, Widodarèn), 2770 m.

Van Bemmel. 1940. Trop. Natuur 29: 93-101. Biotopes; fauna.—Beumée. 1929. Djokja-Tengger-Soerabaja. 4th Pac. Sci. Congr. Excursion Guide E3: 28 pp. Vegetation—Blaauw. 1917. De Tropische Natuur in Schetsen en Kleuren: 103-149. General account; some plants—Gisius. 1936. Med. Ned. Ind. Ver. Bergsport 12: 11-16. Tour report—Kemmerling. 1922. Vulkan. Med. 4: 20-22. Volcanological—Koch. 1928. Mitt. Deut. Dendr. Ges. Jahrb. 1928: 71-75. Short tour report with plant names—Koorders. 1900. Teysmannia 11: 238-252. Botanical sketch—Do. 1900-1902. Natuurk. Tijd. Ned. Ind. 60: 241-280, 375-395; ibid. 62: 213-255. Enumeration Tengger flora; uncritical—Leefmans. 1914. Trop. Natuur 3: 45-47, 76-88. Short report plants and animals—Nyfessen. 1940. De Tengger. Mooi-Insulinde reeks: 104 pp. Tours; geographic; ethnographic—Postma. 1960. Penggemar Alam 39: 3-9. Vegetation and plants—Schröter. 1928-1929. Verh. Naturf. Ges. Basel 40: 511-535. Excellent account of Sandsea, Bromo, dunes and vegetation—Van Steenis. 1935. Trop. Natuur 24: 122-123. Dune formation by plants—Stehn, p. 144—Witte. No date. Mahameroe. Batavia: 75 pp. General survey, not much botany.

35. SMERU, 3676 m.

Van Bemmel. 1940. Trop. Natuur 29: 93-101. Botanical biotopes; list of birds and mammals—Van Heekeren. 1941. Trop. Natuur 30: 165-170. Witness report 1941 eruptions S. slope; origin of lahars and forest fire—Kemmerling. 1922. Vulkan. Med. 4: 1-18. Volcanological—Loogen. 1942. Trop. Natuur 31: 14-17. Pioneer vegetation screes; fire by ladus—Do. 1942. Med. Ned. Ind. Ver. Bergsport 20: 14-18. Tour report—Stehn, p. 145—Van der Veen. 1936. Trop. Natuur 25: 191-193. Some fungus galls and dead animals on summit—Vissering. 1910. Geweldige natuurkrachten. Lahars and ladus—Witte. No date. Mahameroe. Batavia: 75 pp. General survey, not much botany.

LAMONGAN-TARUB, 1669 m.

Anonymus. 1931. Trop. Natuur 20: 234. Brief excursion report—Kemmerling. 1922. Vulkan. Med. 4: 23-40. Volcanological—Stehn, p. 153—Taverne. 1926. Vulkan. Med. 7: 90-95. Volcanological.

36. JANG (incl. Argopuro), 3088 m.

Baart. 1941. Med. Ned. Ind. Ver. Bergsport 19: 2-6. Tour report—Franck. 1937. Natuur in Indië: 33-41. History; fauna; conservation—Kooiman & Van der Veen. 1936. Trop. Natuur 25: 161-167. Vegetation description—Loogen. 1940. Trop. Natuur 30: 81-85. Botanical report—Stehn, p. 157.

RINGGIT, 1252 m.

Alirol. 1939. Med. Ned. Ind. Ver. Bergsport 16: 5-6. Ascent—Clason. 1932. Trop. Natuur 21: 1-7, 23-29. Botanical report but only of lower part—Stehn, p. 159.

37. RAUNG, 3332 m.
Anonymus. 1932. Med. Ned. Ind. Ver. Bergsport 7: 11-22. Alpinistic descent in crater—Funke. 1942. Med. Ned. Ind. Ver. Bergsport 20: 9-13. Tour report—Richard. 1935. Leidsche Geol. Med. 7: 1-40. Geo-volcanology—Stehn, p. 161—Taverne. 1926. Vulkan. Med. 7: 56-60. Volcanological.

38. IDJEN highland plateau (incl. Suket, Pendil and Djampit), 2950 m,
and
39. MERAPI (Kawah Idjèn and Ranti), 2800 m.
Braak. 1920. Het klimaat van den Idjen. Het Idjen Hoogland. Monogr. 5: 51 pp. Climate—Kemmerling. 1921. De Geologie en Geomorphologie van den Idjèn. Het Idjen Hoogland. Monogr. 2: 162 pp. Geography, volcanology—Van Schravendijk. 1936. Med. Ned. Ind. Ver. Bergsport 12: 3-10. Tour report—Schröter. 1928. Vierteljahrschr. Naturf. Ges. Zürich 73, Beibl. 15: 554-600. Interesting botanical account of vegetation and Kawah Idjèn—Van Steenis. 1940. Trop. Natuur 29: 157-161, 180-184. Vegetation of plateau, Merapi, Kawah Idjèn and Suket—Stehn, p. 163—Taverne. 1926. Vulkan. Med. 7: 99-102. Volcanological.

40. BALURAN, 1247 m.
Appelman. 1937. Natuur in Indië: 49-56. Flora, fauna, map—Clason. 1934. Trop. Natuur 23: 121-129. Botanical survey but mostly of basal part—Hoogerwerf. 1948. Tectona 38: 33-49. Flora and fauna of the reserve; not the summit area—Sinaga. 1966. Rimba Indonesia 11: 21-38. Description game reserve; mostly low altitude.

CHAPTER 19

PROTECTION AND CONSERVATION OF THE MOUNTAIN FOREST

Corner's are the very wise words that the civilization of a nation can be measured by the care she bestows on wild things. The question now to be answered is what civilization in this connection can mean.

In the foremost place, civilization means freedom from superstition. The widest spread superstition prevalent in the present world is a belief in numbers. Much that cannot be expressed in numbers is in constant danger of neglect. Almost everybody is under the spell of the imperative: more. More money to make, more years to live, more crop to harvest, more cities to build—also more babies to feed. Yet nobody has ever succeeded in explaining why this should be so. Nobody knows why 6 or 8 billion people should populate the earth to which we are definitely confined instead of 2 or 3. The numbers seem nowadays to have a devilish power to make people dumb. Numbers are generally considered more important than the people themselves, without any logical reason.

In absence of a reasonable logical basis for the power attributed to the number, it is wise to make some mental reservation. Thinking in numbers has the consequence that nobody knows their limit. If there is a place for 2 billions, why not for 3, why not for 4, why not...? The answer holds a plea for modern thinking in terms of proportion. To begin with the present birth rate: the present high birth rate is really out of date. The stimulant has always been to maintain the population, the nation and their culture. There was always hard fighting against disease, hunger, and disaster, at the cost of great losses. When two-thirds of the children died, it was sensible to have seven. Now, thanks to modern medical care, children die no more, but this means that there are far more than is necessary to maintain the population. As a result, all the seven children are pushed unwillingly into an uncertain future.

Agronomists may go on to claim new forest for cultivation, also for the sake of multiplication. They declare that the Earth can feed twice or three times the present population, but they fail to tell why it is necessary to feed more than the present world population well, and their aim is too clearly in the sole interest of the agronomists themselves. They have interest in numbers, numbers of acres of converted land and numbers of people; they have no interest in wild animals which have to succumb for future generations—but no agronomist has been able to prove that an unborn baby to be added to the three billion of existing people is worth more for our civilization than the life of a now existing orang-utan or rhinoceros, magnificent creations of evolution, whose numbers run into a few thousands rapidly facing extinction.

As things go now, with the tremendous land pressure through immense increase of population all big animals are doomed within a century from now, simply because they need great wild spaces to live. And with them go the big trees, the final achievement of plant evolution. If some fanatical engineers and agriculturists have their way, this world will end up in huge industrial centres spreading pollution and mankind will live in cubicles of flats as a feeding and propagation automaton amidst fields with his crops, wild nature being pushed back to a margin of deserts, polar regions and mountain summits where his greed is of no avail.

As for the conversion of tropical forest into cultivated land, it should be widely known that tropical forest often grows on an exceedingly poor soil, and that in such cases great disappointments are to be expected without expert exploration and advice. The forest, once felled, is dead and lost; it takes centuries to return. But the country is in need of timber? Here modern thinking is required, too. Every man considers it normal that vegetables are grown in a garden—why not wood? It would be foolish to collect a lettuce leaf here and there in the jungle and return with a full basket after a day's walking. If long-term and intense cultivation of forests could be planned, as is already done with teak in East and Central Java, and if this could warrant the safety of primary forest, the latter could be used as a permanent reservoir of new and potentially useful species and for ecological study from which forestry could immensely benefit. But even if this is a Utopia, and if in most places Man has already cut more than a forest can bear, leaving the region with a depleted vegetation that is deemed worthless, a new crop of seedlings of valuable trees may have been left and can be attended by some simple silvicultural measures to reach maturity in order to serve Man. In general, attention should be focused on land where the vegetation has already been disturbed, in order to intensify cultivation on such land and to improve it. Primary vegetation should be left undisturbed. The agronomists will have enough to do with the secondary lands to improve them; the biologists will have enough to study the primary vegetation that has been left.

The primary forests on the slopes of the volcanoes are one of Java's most precious assets. Forests keep the soil in place with their roots, and in any country which is not flat, the soil tends to come down. The forests produce humus, wherein the roots like to spread, making the whole forest bottom a giant sponge. On-coming water is sucked up, and slowly given away to the wells, streams, and finally to the rivers.

We have said that mountain erosion—the coming down of the soil—is a natural process, which probably cannot be stopped by Man. But Man can hasten it to many times its natural speed, by destroying the forest. The soil comes bare, and dries up under the sun. If, during the time that it takes pioneer or crop plants to occupy the land and to hold it, rain falls in quantity, the soil is, in absence of the living sponge, suspended and runs down fast. The floods *(bandjirs)* increase, and the steeper the slope, the sooner the soil is washed away from the place where it is wanted, to places where it is not wanted: to the lowlands, where the irrigation works for the paddy fields get silted up with mud and where the crop is overflown with mud. At times of drought, there is no sponge with a storage of water; the rivers soon run dry, endangering the irrigation of the wet paddy fields and water supply for the generation of electricity.

Burning the forest of tjemara in East Java is similar in its effects to overall cutting. We have explained that tjemara causes forest fires to recur, that it is, in fact, a dangerous tree on the mountains of a country where so much lowland area is under careful and intensive cultivation, and where misharvest, due to precipitation of soil by bandjirs, may have such serious consequences. Moreover, tjemara is not a natural climax vegetation, and tends to be replaced by the more valuable, more protective mixed broad-leaved forest.

It is well-known that forests improve the climate as a whole. The higher moisture content protects the country from extremes in temperature, by day and by night,

Nature is, besides an actual, also a potential source of prosperity. New drugs are discovered time and again in supposedly insignificant plant species. Botanical work has brought to light excellent properties of timber of tree species hitherto deemed valueless, thereby greatly increasing the efficiency of forest exploitation. Genetical crop improvement requires crossing with wild congeners of cultivated species. If the former are extinct, this chance of improvement (resistance against disease or damage and extreme conditions, superior products, higher quantity) is lost for ever.

We have explained that also extinction is a natural process, which Man has never cared to stop. That was not very necessary, because as a natural process, extinction remained behind evolution, in other words: evolution produced more new forms than old ones became extinct. And the whole process went on at such a slow rate that there was time enough for the balance of nature to adjust itself imperceptibly. Unfortunately, Man has stepped up extinction of species without having been able to step up evolution, Whatever Man boasts of his power over Nature, Man has not given a proof of his having helped evolution to any significant extent. Man can make lunar modules but will never be able to make a living being. Many species collected in the tropical lowlands in the 19th century, are not to be found anywhere but in the Herbaria. They are extinct, and that means that they are lost for ever, and that they can never fulfill a role in the balance of nature that one time might be necessary, perhaps for Man's own benefit.

Beauty and recreation come at the end of our list of arguments. Finally, Man has to learn from Nature, to which he belongs and on which he is dependent, completely dependent, for his living, and he has not yet learned everything. Nature is a marvellous system of balances, which Man can apply for his benefit. The first step for Man is to look upon himself as a responsible being who in his hands holds the future of the world. Let him destroy nothing that took millions of years to develop, and that he is not able to replace himself. Let him take up the challenge instead and improve the land that has already been brought into various stages of degradation,

Fortunately sixty years ago initiatives were developed for nature preservation, in Indonesia an effort largely due to the forest botanist Dr. S. H. Koorders, who founded with a few congenial persons a Society for Nature Preservation. It was through this private Society that the Government became aware of the urgency to take measures, accept laws and appoint terrains which should be safeguarded for their beauty, their flora and fauna, Naturally this Society could not undertake their management and this was placed under the Department of Forestry. They include the reserves in the mountains, of which there are unfortunately not many. Omitting tiny ones of less than 10 ha they are the following:

West Java

Gedé: Tjibodas-Gedé-Pangrango, 1040 ha.
Patuha: Telaga Patengan, 150 ha.
Papandajan: Papandajan crater, 844 ha.
Telaga Bodas, 285 ha.

East Java

Ardjuno: Ardjuno-Lalidjiwo, 580 ha.
Tengger: Sandsea, 5250 ha.
Smèru: Ranu Pani & Regulo, 96 ha.
—: Ranu Kumbolo, 1342 ha.
Idjèn: Kawah Idjèn, 2560 ha.

Among these are many volcanic terrains and in East Java mostly reserves covered with tjemara forest.

We miss among them valuable biological reserves with the mixed mountain rain-forest ecosystem, the only exception being Mt. Gedé-Pangrango.

This is therefore the most precious among them. And it is more worthwhile because it has been the site where studies on the mountain flora were made and will have to be made in future, especially with regard to ecological studies on the relationships between animals and plants, as stressed in chapter 7.

As its nature is not a proper forest reserve, because felling is prohibited, it should be administered by Lembaga Biologi Nasional, as it makes together with the Mountain Garden Tjibodas and its laboratory an inseparable unit for biological study. It had that status onwards of Treub's time, almost a century ago, and why its status has recently been changed is a complete mystery to me.

I sincerely hope that this book, which is a testimony of the biological importance of this unique biological field station, will contribute to convince the conservation authorities and the Government to restore the situation as it was before.

Even more important for conservation of mountain forest than the reserves just mentioned is to maintain forest intact on all mountains: *the mountain forest is the umbrella shielding the welfare of the people living in the hills and the lowland.*

Formerly it was generally assumed that at least above some 1500 metres altitude the forest should be left strictly intact for *hydrologicalpurpose*, to safeguard the umbrella.

I am afraid that during the war, and in the time after, deforestation has in many places gone up where it never should have occurred. A plea is made to preserve what there is and take to reafforestation where possible.

This is not the whim of a biologist speaking, it is not an idiosyncrasy of a single-minded botanist, it is a necessary precaution to prevent that the mountains of Java become a waste with disastrous aftermath, as is experienced in some other parts of the world where Man has irreparably damaged his own environment leaving destruction and poverty.

The Forest Service carries the responsibility, but it should be given the power and money enabling to shoulder it.

CHAPTER 20

EXPLANATORY NOTES

a. *The choice of the assortment of the plates*

Several persons have asked me about the planning cq. the choice of the assortment depicted on the plates. As I will explain there is no single answer to this.

However desirable, it was impossible to have drawings of approximately all mountain species. The complete Flora of Java has treated some 6000 species of flowering plants. Of these c. 1480 occur only in a cultivated state. Of the residue of 4520 some 400 are aliens or naturalized introduced plants, leaving some 4100 native species. Of these some 2300 ascend to or are found upwards of 1000 m, and some 15 00 species ascend to or are found above 1400 m. Most of the c. 450 species depicted belong to the latter category. Some families are very richly represented above 1400 m, among them orchids of which there may be some 400; consequently of such families there are proportionally fairly many depicted.

The main idea was to make drawings of such species which will strike the eye or otherwise have the attention of the traveller, hiker, and naturalist along trails in the forest and glades and in the open spaces higher up. For this purpose I have frequently asked random persons to collect what they thought should be included. Some appeared interested in small and others in large plants, tastes appeared to vary. On the other hand several common and important species have small flowers not striking the eye. And what about the numerous tree species? Thus oaks and chestnuts are absent, as they are difficult to draw so as to be recognized, even from their acorns. Another practical limitation for trees was sometimes their size, as several *Meliaceae* and *Araliaceae* have enormous leaves not fitting our format and our purpose to have all plants at life size. For these reasons trees are under-represented (see the list of them on p. 37b). And what to say about palms which are still present above 1000 m, among them some rattans of which the huge *Plectocomia* is certainly an eye-striking plant on ravine slopes. Of the very large herbaceous gingers only inflorescences are drawn (Pl. 57).

All species depicted are native; an exception is the very doubtfully indigenous *Houttuynia* (50-1) which was once reported wild from an estate (S 1937).

An incorporation of introduced plants would have doubled the size of the book. And though the introduced weeds are sometimes common and conspicuous along trails and forest borders, introduced species of such genera as *Ageratum, Bri^a, Cestrum, Cuphea, Datura, Eupatorium, Mimulus, Verbena,* etc. have been omitted. This is admittedly a drawback, as the non-initiated visitor cannot always clearly decide in the field whether a species is native or not, especially not in secondary vegetation outside, and along trails inside, the forest. I refer for such weeds to the work by Backer & van Slooten (1924) in which 240 weeds of tea estates are described and depicted, tea being cultivated up to c. 2000 m.

Another problem was to have a more or less balanced presentation of West Javanese and East Javanese plants. I have not nearly explored all Javanese mountains, only some 13, but knew which were the richest and for the plates I had plants from Mts Halimun, Salak, Ged6-Pangrango, Papandajan in the West and Mts Ardjuno, Tengger, Jang and Idjfen (with Suket and Merapi) in the East, while I received from collaborating collectors certain species from other mountains.

In assembling the material for the drawings I occasionally collected some very rare species, some of which were at that time even unknown for Java. I have added a few of these rarities for botanical interest and to stimulate future collectors.

Summarizing, the assortment is an amalgamation in which opportunity also played a role.

I regret that the idea to depict the floral life cycle of each plant from bud to fruit was accomplished in too few species. It is, however, not so easy to get suitable material which had sometimes to be gathered in different seasons on a limited number of excursions.

Cryptogams have been excluded, though for example ferns abound in the mountains, both terrestrial and still more abundant as epiphytes. Of the total of some 750 odd fern species in Java I estimate that some 500 are found above the 1000 m contour line. For the identification of ferns and fern allies I refer those eager to find their name to the Dutch-written work by Backer & Posthumus (1939) and to the more modern English work by Holttum (1954), which, though dealing with ferns of Malaya, includes most of the Javanese species.

b. *Arrangement of the species on the plates*

The arrangement of the drawings had at one time been envisaged to reflect more or less their environment, e.g. high forest, elfin forest, swamps, heaths, craters, etc., but as nature is so much a continuum and as species are so often common to many of such biotypes, this plan was abandoned in favour of having them arranged by families. This also facilitates better comparison of allied species and acquirement of form knowledge.

The families have been arranged in an alphabetical order, but for practical reasons this was in odd places abandoned. Cross references behind the family names make it easy to see what members of a family are represented.

All names can also be found in the *alphabetical index,* in which vernacular names and some terms have been incorporated too.

All species have been given a *number* in the margin to which sometimes a letter (a, b, c) is added for different parts of the plant. If a drawing does not touch the margin of the plate the number is provided with an arrow. For example on Plate 1 number 6 is found left of number 5 and is the twig with one large white flower. In very few cases this procedure was still insufficient, namely on Plates 14, 36,41, and 47 where a few numbers are inserted in the plate itself.

c. *Details of plates*

All plants are depicted in natural si%e.

It has been attempted to draw all stages of the plant and especially those in which plants are most conspicuous to the traveller. This is mostly the flowering stage but sometimes also that in fruit, in a few cases only the latter, e.g. in *Sloanea* (15-4) and *Elaeagnus* (14-19). In quite a number of cases the *flush* (young foliage) strikes the eye, e.g. in *Wightia* (51-5), *Pyrenaria*(53-3b), and *Vaccinium* (17-6 & 8).

Care has been taken to place the plants in their natural position *(poise)* and if detached parts (fruits etc.) are drawn they are also in position, see e.g. *Codonopsis* (7-5), *Schima* (5 2-7), *Rhododendronjavanicum* (16-3), and *Aeschynanthus* (21-4/6). *Zanthoxylum scandens* (53-1) was drawn from a hanging twig in inverted position.

Several plants occur in two sorts, male and female; of such *dioecious* species mostly both have been depicted, e.g. of *Balanophora* (5-ia & ib) and *Coprosma* (46-8).

In other cases the sexes are also separated, but female and male flowers or inflorescences occur on one plant; to such *monoecious* species belong e.g. *Altingia* (2 3 ^ & 4b) and *Podocarpus* (13-1 & 2). Sometimes they differ only in the length of style and stamens, e.g. in *Allaeophania* (46-2), of which I failed to get the short-styled male form in time, which explains the empty space on that plate.

Usually a medium-sized representative specimen was chosen for the drawing, but in general proportionally large specimens were selected of small-sized species, as e.g. *Haloragis* (23-2) and small specimens when large-sized species were concerned, e.g. *Gunnera* (23-1), or only young upper leaves were drawn as in *Harmsiopanax* (3-2a).

In order to give the reader some idea of the *variation in si^e,* its global range is given in the brief descriptions in the explanation to the plate, in particular as to dimension of the plant and its leaves.

The huge leaves of the gingers were omitted by necessity, only inflorescences were drawn. Of the large araliads (PI. 3) only parts of leaves etc. could be admitted to the plates. In some cases stalks of large plants were 'contracted', as the stem of *Aeginetia* (40-4), the contraction being indicated by a small blank.

For the reasons given above the depiction of one species consists in a few cases of 2-3 partial figures which are marked a, b and c to indicate that they belong together in order to avoid confusion in the captions, see e.g. *Aralia* (3-1) in which ia shows a part of the spiny stem, ib part of a leaf, and ic a part of an inflorescence with flowers and fruit.

As to *colour* the pictures are decidedly true to nature and are superior to those published in the former century by Blume, Korthals, Bennett & Brown and Miquel.

It should be kept in mind that the plates give only the colour of the single depicted specimen.

And it should be realized that a species cannot be adequately illustrated from one specimen. Though decidedly less variable than the fades of Homo sapiens, mountain plants are variable (see chapter 15). This is in part due to hereditary differences caused by raciation, in part to the age of the individual plant or the stage of its floral parts, but also to no mean degree by its habitat, wet or dry, fertile or barren, etc. Plants in exposed habitats, for example, are often reddish tinged and have a more compact habit and smaller leaves than those of the same species in shaded places. Sometimes the flower discolours with age as for example in *Parochetus* (27-4), which might well deserve the epithet Versicolor' (many-coloured). Pale, mostly nocturnal, flowers are turning yellowish the next day as in *Fagraea* (28-7), *Hedychium* (57-4) and *Lonicera* (8-1 & 2). The colour of fruits often very strongly changes in the last stages before ultimate maturity, see *Ficus* (32-3). Heavy rains bleach flowers of *Rhododendron* and *Impatiens.* As much as possible distinct variations in colour have been depicted for various stages, from bud to fruit, but the limits of the work had to be observed.

d. *The explanations to the plates*

The explanation of each plate consists of captions to each numbered species which are arranged under the name of the plant family to which they belong.

Each species is indicated by a Latin name followed by the abbreviation of the name of the author who described it first, for example Plate 1 number 8 (indicated as 1-8) *Acer laurinum* was described by 'Hassk.', Dr. J. K. Hasskarl (1811-1894), a former curator of Kebun Raya Indonesia. Sometimes a second abbreviation between brackets precedes this, indicating the name of the botanist who described it still earlier but attributed it to an other genus.

In some cases the species name is followed by the name of a forma, variety or subspecies, for example in *Impatiens platypetala* (6-5) of which one flower of a special *subspecies* is depicted in 6-6, or in *Scutellaria* (25-8) where a special *variety* is drawn. The rank of subspecies is used in the case that it concerns a geographical race of a species as explained in chapter 15, a variety for a deviation which is not geographically or ecologically replacing, a forma for a distinction of still lower value.

Behind a hyphen following the plant name, sometimes a brief note of explanation is made on what has been drawn or what has been omitted. Then follows a second hyphen after which is the reference to the volume and page of the Flora of Java by Backer & Bakhuizen van den Brink Jr (1963-1968), where the species is keyed out and more fully described. If the name accepted in this book deviates from the one accepted in the Flora of Java, the latter is added in brackets. After the third hyphen is mostly indicated where the depicted specimen was gathered, sometimes followed by my collecting number of the voucher specimen in Herbarium Bogoriense.

The second paragraph of each caption gives some very brief descriptive notes about the variation in the height of the plant, its leaves and sometimes flower and fruit. It is rather necessary to consult these notes if one compares a living specimen with a plate, to ensure that the specimen one has collected is really the one depicted. This comparison should be done carefully to avoid confusion, as of some very large genera, containing one or more dozens of species, which are closely allied and may resemble each other, only one or two species are depicted, for example in the *Acanthaceae* (PL 1), several orchid genera *(Bulbophyllum, Dendrobium, Eria, Microstylis,* etc., PL 34/39), *Lasianthus* (PL 47) and some others.

Practical experience in 1940 learned that in almost all cases intelligent laymen were capable of identifying a plant with the correct figure. This is to no small degree due to the very accurate way in which Amir Hamzah and Moehamad Toha have made these drawings. Several species I could easily identify for checking with the keys in the Flora of Java merely on the basis of the drawings, proving their exactness and completeness.

The third paragraph of the captions sketches the geographical occurrence of the species and the environments in which it is found in Java, its altitudinal range and where it occurs outside Java.

A fourth paragraph is sometimes added for additional information on its life cycle, biology, vernacular names, uses, etc.

Only in rather few cases *vernacular names* have been cited, for various reasons. As elsewhere in the world they are often of very local use and too numerous to put on record, to which adds the existence of three languages in Java, viz. Sundanese, Javanese and Madurese. In other cases one name may stand for a whole assembly of species, sometimes coinciding with a genus, as *kaju (h)itam* or *ki arèn* for *Diospyros* alluding to the black bark or wood resembling charcoal, sometimes with a family, for example *binalu apé* or *dalu* (Malay), *kemaduan* (Javanese) or *mangandeuj* (Sundanese) for all members of the mistletoe family *Loranthaceae*, or *anggrek* for all *Orchidaceae*, sometimes relating to several genera as *pasang* for the acorn genera *Quercus* and *Lithocarpus.* In still other cases this goes far beyond a family, as for example *huru* which indicates many *Lauraceae* but other families with laurel-like leaves as well. Vernacular names can sometimes lead to serious confusion, for which I refer to the captions under *Podocarpus* (13-1 & 2) and *Kibessia* (29-6); the latter Latin name was derived from *ki besi* (iron-wood) but was the wrong vernacular ! Botanical confusion has even occurred because of the misleading use *oitjemara (tjemoro)* for the conifer *Podocarpus imbricatus* (13-2) on Mts Slamat and Dieng, from which botanists have derived that the true tjemara *(Casuarina)* occurred so far west, though it occurs only from Mt. Lawu eastwards. For the rest, it should be added, that by far not all Javanese in a village can provide adequate botanical-vernacular information and a random guide may supply a guess name to an eager non-trained traveller for reasons of courtesy.

e. *Adopted nomenclature and distribution*

On the whole I have kept to the nomenclature adopted in the 'Flora of Java' by Backer & Bakhuizen van den Brink Jr (i963-1968), but there are differences.

Backer mostly followed the 'system' of Hutchinson, as a random choice of a system for convenience, not, as he told me, from conviction or for scientific reasons. I do not accept this system and besides I feel that the inflation of subfamilies and tribes to family level is redundant.

Some family names I use differ from those in the Flora of Java: I do not want to adopt *Poaceae* instead *oiGramineae* and *Fabaceae* instead of *Leguminosae*, as the latter names are perfectly correct and in universal use until a few years ago, while their redundant alternatives are only invented for the sake of complete uniformity of the ending **-aceae*[9] of all family names, a sort of holy cow to satisfy people who seek perfection in administration to employ their intellect and in quibbles on clerical level rather than in the study of botany.

A similar principle led me to retaining genuine spellings of *Heleocbaris, Homa/antbus;* pedantic formalists want to retain here the so-called original spelling which is a nuisance as both genera have almost always been written beginning with an H, because the translation from the Greek words into Latin was due to an insufficient knowledge of the Greek in which the H is pronounced but in writing only indicated by an apostrophe before the vowel. The H is necessary to understand the words: *Homa/antbus* is derived from *homdlos* = flat, and *anthos* = flower, alluding to the flattened male flowers of the plant; *Heleocharis* is derived from the Greek *helos (helios)* = swamp, and *chârts* = graceful, together alluding to habitat and physiognomy. Both cases fall under Art. 73 of the Code (orthographic errors), like *Gluta renghas* and *Cyperus halpan.*

In other cases where names, status of species, or author names are at variance with those adopted in the Flora of Java, these are either factual corrections or are expressions of my considered opinion on these matters.

In the Flora of Java the authority of a species is in several cases correctly referred to two authors, for example: *Myrica javanica* Reinw. ex Bl., as Blume, who published the first description ascribed it to Reinwardt. Fortunately the Botanical Code permits to restrict this unnecessarily complicated authority to that of the publishing author only.

As the captions were composed thirty years ago they had to be carefully checked and emended, in fact they were entirely rewritten. Of each species postwar literature had to be consulted and the material in the Rijksherbarium had to be checked for the accurate distribution. This took about three months. It led to the correction of a few names in the Flora of Java, as for example in *Galiutn* (47-2 & 4) and the extension of the distribution of *Nasturtium backeri* (12-7), an assumed endemic species of Java, to Timor and New Guinea.

This brings me to a final painful confession, namely that in the present state of knowledge of the Malesian flora it is impossible to adopt names and geographical distribution which will all still stand in fifty years from now. Very many genera have not been subjected to reasonably complete regional botanical revisions, for example *Alyxia* (2-4), *Ardisia* (32-6/8), *Begonia* (5-4/6, 6-1/2), *Dischidia* (4-2/4), *Hoya* (4-5), *Lasiantbus* (47-5/8), *Maesa* (33-2), *Melothria* (18-4), *Spilanthes* (9-9), etc. Even in small genera as *Aralia* (3-1) and *Girardinia* (55-4) a critical study of the species is not yet performed. It may in a few cases even require a wholesale study of the genus to attain a critical insight in widely distributed species which 'disguise' themselves when entering foreign countries. Fortunately many species of Java were described very early by Blume, which is a certain guarantee that the names will stand by his priority; in other instances his name will have to give way to that of earlier botanists, notably to those who studied the Southeast Asiatic flora to which the Javanese flora is so much related.

Through the Flora Malesiana effort much has already been done for botanical enlightenment, but a very large exertion will have to be made in the following decades to bring Malesian botany up to a critical-scientific level. For this laudable purpose all hands will have to be called on deck.

f. *Notes on the origin of this book*

Being born in the Low Countries, on the shores of the North Sea, my first confrontation with the alpine flora of Europe was an unforgettable experience. This botanical hiking happened in April/May 1923, in Tirol, with my older friend C. Sipkes, under minimum conditions of comfort which possibly added to its flavour. Ever since I have held a predilection for mountain floras, not in the least because in general man has here least interfered with Nature and one is in close proximity of the result of the awe-inspiring organic and geological evolution of our unique planet. For me this is also the great attraction of the tropical flora and one experiences this in particular on the lone lofty summits where the commanding view over the steaming lowlands induces feelings of privilege to live and be capable to enjoy, leading to admiration and contemplation. One gets feelings closely akin to those religious, and this is nothing new, as testified by the retreats of Hindu monks on Mt. Diĕng; ruins of shrines are also still found on the summits of Mts Lawu, Ardjuno and Argopuro (Jang) and very simple graves *(kramat)* of holy persons on the ridges of Mts Dorowati and Sanggabuwana.

For more than a decade, from 1929-1941,1 spent much energy on the study of the Malesian mountain flora and thought this to contain the most fascinating aspects of the dynamics and genesis of tropical plant life. Though I have gradually come to the conclusion that the tropical lowland vegetation offers as many problems to fathom as those of the mountains, especially as to the evolution of the flowering plants, *my* interest in the mountain flora remains unwaned, and I am still contributing to the theory of them, which appeared also of intrinsic value to the study of island floras. Summit floras are essentially like island floras, isolated in and surrounded by an 'ocean' of an indomitable lowland vegetation.

Towards the end of the thirties interest in biology had distinctly increased in Java and societies of natural history and nature conservation thrived and made it possible to publish guides in these fields which in turn raised the interest of the general public. The staff of the Botanic Gardens at Bogor, later Kebun Raya Indonesia, now Lembaga Nasional Biologi, was instrumental in the publication of such works. Under these favourable conditions I advanced the plan for the present work to which the then director of the Gardens, the late Prof. Dr. L. G. M. Baas Becking, stood sympathetic. I had observed so much interest in native mountain plants by all sorts of persons whom I met in mountain hotels, resthouses and alpine huts that the wish arose to provide the general public with a coloured guide to mountain plants, similar to that made by Carl Schröter for Switzerland and of which I had so much profit on my first tour. It should serve not only for the diffusion of botanical information and knowledge, but also to stimulate love for and respect of wild Nature.

It was of course clear that such a guide should be selective, as the complete mountain flora of Java runs to some 2000 species. This necessitated that the drawings should be very accurate, as a fairly large number of genera have a dozen or some dozens of species of which some resemble each other rather closely, as mentioned in Ch. 20 d. Of these only few have been drawn; some additional information on floral details is incorporated in the captions to provide more certainty for the user.

In May 1939 the first sketches were made and by October of that year some 200 species were drawn. By September 1940 I decided that we should draw to a close and start compiling the plates. The 57 plates with drawings of 456 different species and varieties were finished before World War II started. During the war, in the years 1944-1945,1 was fortunate to be able to compose a very provisional handwritten MS in Dutch, but many captions remained unfilled, and several planned chapters unwritten. Its contents was tuned to the amateur as a concise popular text with a small Atlas like Schröter's, in pocket format. Though the essential plan of the Atlas remained unchanged this old text proved to be completely obsolete for the present generous format, necessitating the writing of an entirely new text.

g. *The publication of this book*

The publishing of this book has been curiously difficult. Before World War II it seemed easy as several societies in Java, of natural history, nature conservancy, alpinism, and physical sciences, had guaranteed to subscribe to a number of copies and the Topographical Service had agreed to print the book in 2000 copies, all on a non-profit basis. But the war intervened, and though everybody admired the drawings I found no publisher interested after 1945. In November 1947 Dr. Hutchinson made a laudable attempt to persuade a publisher in London, without success. I held a seminar on the subject at Harvard in February 1948, with slides showing the plates, but without consequences for publication. Since then I have approached some five large publishing firms in Austria, Switzerland, Germany and England, all of which declined publication or demanded substantial grants in support. Through the sympathy of Dr. W. T. Stearn I could publish four plates with a concise summary text in Endeavour (S 1962a). Without my knowledge, my staff member Dr. M. Jacobs made about 1966 another attempt for having it published and he translated my very provisional and unfinished MS into English, but also this effort was frustrated.

As my official duties and those for Flora Malesiana had of course priority I had abandoned the idea of publishing the work and had not touched the MS which I had filed for notice after my retirement. However, its fate took an unexpected turn about October 1970 when Dr. Jacobs approached the Committee on Cultural Relations between Indonesia and the Netherlands. The proposal to publish this joint botanical enterprise found a ready response in Indonesia through the ardent support of the director of Lembaga Biologi Nasional and the approval of the Council of the Sciences (L.I.P.I.) as 'well as with the Netherlands counterpart members. This decision, which was announced on my 70th birthday, October 31st, 1971, came as a complete most pleasant surprise. Tied up with it was a less agreeable condition, namely that I should undertake to make the text ready for the press within a few months time. Though knowing that it would mean a complete rewriting I had no other choice than to agree to it in a hesitant way, as this would seriously intervene with my already very tight time schedule for my last year in office. Furthermore it meant that I would probably not reach the textual perfection I had envisaged, though the recent Flora of Java appeared to be a most important asset to lean on. Anyway, the comfort is that the excellent achievement of my counterparts, Amir Hamzah and Mohamed Toha comes out in a superb way, as their plates which form the backbone of the work are here reproduced in natural size and are of superior quality.

The greatly extended text and addition of figures and photographs necessitated to augment the subsidy for the colour plates by the above mentioned Committee by other contributions. It is a privilege to express sincere thanks to the 'Foundation Flora Malesiana' and 'Greshoff's Rumphius Fund* for financial aid and to state that contributions from the 'Society J. P. Coen*, the 'Treub-Maatschappij* and the 'Royal Netherlands Geographical Society* are anticipated.

ERRATUM

Replace the last six lines of page 78, 2nd column; by:

contributions.

It is a privilege to express sincere thanks to the Board of the Royal Netherlands Institute for the Tropics in trust of the 'Society J. P. Coen\ to Greshoff *s Rumphius Fund, to the Society for Scientific Research in the Tropics ('Treub-Maatschappij'), and to the Foundation Flora Malesiana, for financial aid.

ACKNOWLEDGEMENTS

This work could only be accomplished on the basis of accurate plates which form its essence. For this I have to express my gratitude to my co-authors AMIR HAMZAH and MOEHAMAD TOHA, at the time artists of the Herbarium Bogoriense, Bogor. I vividly remember the time we spent together in the field, with accommodation in various resorts, resthouses (pasangrahan), guest-houses and small hotels. They could of course only work in a well-heated room with a good table and good day-light. My share consisted of collecting the living plants up mountain. This was sometimes strenuous work as for example on Mt. Ardjuno, where they had to work at Tretes at only 860 m altitude, because the Lalidjiwo abode at 2400 m offered no adequate conditions for their precise work. This necessitated that I had to ascend three times to nearly 3000 m in seven days. They worked fast and could manage to do some two to seven species a day, depending on the plants. Sometimes we made it a leisure day and went together on short trips. Occasionally we had to do this, as the flowers of a few species wilted so soon that drawings had to be made on the spot and those of *Sopubia* (51-2) and *Drosera* (14-18) were made on the lid of the boot of a car on Mt. Idjen.

Their procedure consisted of making first an accurate pencil drawing of the selected specimen in which they then filled the colours of each part of its structure, sufficient for finishing the complete drawing later at Bogor. Each of these sketches was checked by us both as to preciseness of colour and to details before approved. The composition of the final plates as reproduced here was later undertaken by means of transparents and is my sole responsibility. A curious event occurred during our stay in the guest-house/observation-post of the Volcanological Survey on Mt. Papandajan, situated at 2200 m, at the head of a ravine above the crater which lies at c. 2000 m. In the morning following the first work day they found that something or somebody had interfered with their drawings during the night as all the pale colours had faded greyish. To their relief I could soon solve the riddle by suggesting that the fault lay with the sulphureous gases often ascending the valley which caused the white lead-oxide paint they used, to change into dark lead-sulfide. For certain technical reasons they preferred this lead-oxide above zinc-oxide paint, but from then on never used it again.

Their technique of painting was remarkable and obviously self-invented. In the pencil sketch they started to fill the spaces with a thick white layer on top of which the other colours were laid; these were then subsequently very carefully partly removed with a just-wet paint-brush so that the white came shimmering through to the degree they wanted. A professional painter, Mr. Spies, who observed this technique, told me that it was entirely new to him. Amir Hamzah learned making drawings and painting from the mycologist Dr. C. van Overeem, from 1921-1927 a staff member of Herbarium Bogoriense; Toha in his turn learned from Hamzah, but they developed the art to perfection themselves. Unfortunately Amir Hamzah was killed in an accident in 1959 and did not live to see this work published.

As I could not climb all mountains in all seasons I had a number of friends, colleagues and keen amateurs who kindly collected certain species or plants in a desired stage, preferably with mature buds. The material was sent by post, packed in used biscuit tins in which small holes were made. The specimens were not moistened and had to be clean and free from soil and insects; if desirable a little dry moss or *Usnea* was added. Such material invariably arrived in good condition. Making specimens too wet or adding moist moss or cotton-wool proved unsatisfactory.

The following collaborated for this purpose, sometimes undertaking special trips in their district for the purpose:

Dr. J. H. COERT, Agricultural Adviser of the Sugarcane Industry, Surabaja.

Mr. A. GISIUS, land-owner, living in a homestead ('Smeroehoeve') on the wide saddle between Mts Tengger and Sméru.

Mr. P. GROENHART, Teacher at a secondary school, Malang.

Mr. J. G. T. LOOGEN, Employee on an estate at Selokaton, north of Mt. Diĕng, in nomination for assistant-curator at Kebun Raya Indonesia just before the war.

Dr. L. VAN DER PIJL, Teacher of Natural History at a secondary school at Bandung.

Ir. C. N. A. DE VOOGD, Forest Officer at Bogor.

Mr. C. VAN WOERDEN, Curator of the Mountain Garden at Tjibodas where he acquired a very large knowledge of the native forest flora.

It is most unfortunate that all these, my former loyal collaborators, who have admired the original drawings before the war, do not live to see the book printed, with the exception of Prof. Van der Pijl, who actually continued collaboration and gave liberal information and advice for the chapter on pollination.

Through the years many persons have generously given me photographs for the benefit of eventual publication in botanical works on the flora of Indonesia and I have thankfully used a number of them for this purpose.

For the captions of the plates I enjoyed great help from Dr. R. C. BAKHUISEN VAN DEN BRINK Jr, who checked plates of several families *(Orchidaceae, Rubiaceae,* etc.). For some other plates I could consult Drs. F. ADEMA *(Galium),* Dr. M. M. J. VAN BALGOOY for the maps of *Microtis* and *Sanicula,* Dr. B. HANSEN (Copenhagen), who provided me with an advance copy of his revision of *Balanophora,* Mr. N. K. B. ROBSON (London) who supplied data in *Hypericum,* Dr. C. KALKMAN *(Rosaceae),* Dr. H. KENG *(Labiatae),* Dr. J. H. KERN *(Cyperaceae),* Dr. A. J. G. H. KOSTERMANS *(Lauraceae),* Drs. J. F. VELDKAMP *(Gramineae),* and Mr. M. ZANDEE *(Rubus).*

As already alluded to I had, in order to keep to the time schedule set for the writing of this book, to delegate certain tasks to my senior staff members for which readily given help I express my gratitude.

Also I wish to express my thanks to Dr. J. HUTCHINSON, Dr. W. T. STEARN and Dr. P. AELLEN for their efforts in earlier years to find a publisher.

During the proof reading I enjoyed assistance from Dr. C. E. RIDSDALE for improving the English language as far as seemed urgent and as still could be managed.

From November 1971 till almost the end of May 1972 I had to work very hard indeed and I am afraid I had to neglect several other things. My wife stood this tension in a wonderful way. She took part in the work and read the MS, grooming it where necessary and she also read the proofs. She was admittedly as interested as myself in the Javanese mountain flora and accompanied me on most tours and excursions.

Finally I wish to express my gratitude to my typist, Miss E. E. VAN NIEUWKOOP, who in her intelligent way deciphered correctly and promptly my not too well hand-written scribbles in my typescript; she checked figures, corrected proofs and composed the index.

COLOUR PLATES

EXPLANATION OF PLATE 1

ACANTHACEAE (see also Plate 2-1)

1. **Justicia smeruensis** (Brem.) Steen., comb. nov.—Flora of Java 2: 590 (as *Rostellularia smeruensis* Brem., Verh. Kon. Ned. Ak. Wet. II, 45, 2: 70. 1948)—Sméru homestead. Gisius (in L).—Ascending, mostly branched, hairy herb up to 75 cm. Leaves 3-6 by 1-3 cm.—In East Java from Mt. Ardjuno eastwards, mainly in grassland and tjemara forest, at 1800-2600 m. Also in SW. Celebes and Mt. Mutis (Timor).

It may appear to be only a race of the Indo-Malesian /. *mollissima* Wall. I see no good reason to distinguish *Rostellularia* apart *itom Justicia* on generic level.

2. **Justicia obtusa** (Nees) Steen., comb. nov.—Flora of Java 2: 591 (as *Rostellularia obtusa* Nees in DC, Prod. 11: 374. 1847, inch *vat.grandifolia* Miq.)—Mt. Idjèn. 11981.

An ascending herb, 20-50 cm high, mostly branched. Leaves 2-7 by 1-3 cm.—Throughout Java, in sunny, mostly dry places, more common in East than in West, along roadsides, in grasslands, also in teak-forest, at 5-1600 m. Also in other parts of Malesia.—Possibly the same as/, *simplex* D. Don or *Rostellularia simplex* Wight from SE. Asia.

3. **Peristrophe hyssopifolia** (Burm. f.) Merr.—Flora of Java 2:581—Tjibodas (Mt. Gedé).

An erect herb to over 1 m high. Leaves 4-20 cm long, 2-8 cm wide. The vividly coloured flowers with their slender tube are shed at the end of the day, as in almost all members of this family. A very variable plant especially with regard to the size and shape of the two bracteoles under each flower. On their variations several "paper species" were based by analytical botanists; they are no good and grade into each other in nature by intermediate stages. The nodes of the stem are swollen-articulated, to which the Sundanese name *bubukuan* alludes, a characteristic of many species of the family *Acanthaceae.* In drying for the herbarium these shrink into a constriction.

In Java a widely distributed plant of forest, trails, secondary growths and other shaded terrain, from the lowland up to 1700 m. Also in Sumatra, Celebes, etc.

4. Strobilanthes cernua Bl.—Flora of Java 2:568.

Much-branched, up to 3 m high. Leaves 8-25 cm long, 3-12 cm wide, in juvenile specimens in the shade often white-blotched.—Only in West Java it seems in great colonies the dominant constituent of the undergrowth of the rain-forest, at 750-2100 m. Also in Central Sumatra.

Almost all species of this genus in Malesia, India and Ceylon are pluri-annual, monocarpic plants, that means that they flower and fruit only once, after a number of years. Besides, there is a common rhythm in the flowering and upgrowth which appears to take a number of years which is a fixed one for each species, resulting in a gregarious synchronous flowering of the same species over large districts. This makes a great show and has drawn attention from scientists and people alike. This period may vary from 5 to 6, 8, 9, or even 12 years, depending on the species; of *S. cernua* it is 9 years and this was constant on Mt. Gedé from 1902-1956. Hence, in 1974 the forest on Mt. Gedé must be again in bridal dress. It seems that on Mt. Salak and Mt. Burangrang the same period prevails. From Mt. Patuha I have two dates, 1914 and 1941, obviously with the same 9-year rhythm. The phenomenon, which I treated in general (S 1942) and for Java in particular (S 1940), is unexplained and not induced by the climate. The stands fruit and die simultaneously leaving a peculiar "empty" forest floor; amidst the withering stems seedlings come up again simultaneously. Readers are invited to record simultaneous flowering and deposit voucher specimens in Herbarium Bogoriense.

5. **Strobilanthes paniculata** (Nees) Miq.—Flora of Java 2: 566 (as *Microstrobiluspaniculatus).*

Erect, branched herb 1-2 m high. Leaves of a pair very unequal, one sometimes fugacious, 7-18 cm long, 3-7 cm wide. Bracteoles under the flowers small.

In West Java, but also in Central (Lawu) and East (Tèngger, Sméru, Tarub-Lamongan), in rain-forest, at 600-1800 m. I do not accept Bremekamp's splitting of the very natural genus *Strobilanthes* into microgenera which only deserve the rank of section.

6. **Strobilanthes involucrata** Bl.—Flora of Java 2: 564 (as *Pachystrobilusinvolucratus).* Robust, branched herb, £-1 \ m high. Leaves of one pair mostly unequal, 6-18 cm long, 3-7 cm wide.

In Java common in West, rare in East (Pantjur-Idjèn), in rain-forests, at 900-2200 m. Also in Sumatra.

7. **Strophacanthus membranifolius** (Miq.) Bremek.—Flora of Java 2:585.

Ascending or erect herb, sometimes straggling, £-2 m long, often rooting at the base, glabrous to viscid-hairy. Leaves 3-16 by 1-7 cm. Inflorescence 3-30 cm long, a few- to rich-flowered panicle.

In Java from Mt. Karang eastwards to Mt. Idjèn, in rain-forests and tjemara forests, in plantations, along trails, on river-banks, often common, at 500-2400 m. Also known from Sumatra, all Lesser Sunda Is., Celebes, and Ceram.

The specimen depicted shows two fruits below the flowers. They have this characteristic shape through a large part of the family. The pod explodes with two valves and the hardened funicles (umbilical cord of the seed) forcefully ejects the few flattened seeds.

ACERACEAE

8. Acer laurinum Hassk.—a. Leaf undersurface, b. young foliage, c. a fruit—Flora of Java 2:143—Mt. Papandajan.

A tree, up to 50 m tall. Trunk to 1J m 0. Leaves opposite, white-waxy underneath, and with 3 nerves from the base, 10-23 cm long, 4-7 cm wide. Axillary buds covered with scales. The tree is short deciduous (June 1940 on Mt. Papandajan) and after the foliage is shed, thickly covering the ground, after some days the whole tree flowers on the bare branches with yellowish-green flowers in 3-5 cm long panicles from the leaf-axils, the young foliage appearing at the same time. The fruits are often bright red.

Throughout Java in rain-forest, scattered, nowhere dominant, at 900-2300 m. Siam, and also in Sumatra (down to 630 m), Flores (to 750 m), Timor, Celebes (to 450 m), Borneo (both in the lowland and on Mt. Kinabalu) and the Philippines. Flowers April to August, the least rainy season.

A flowering tree, loaden with sweet-smelling, honey dripping flowers on its bare branches, with red-brown flush peeping out of the buds, is a gorgeous sight, enlightened by the humming of thousands of bees and bumble-bees feasting on the honey of *huru bodas,* as the Sundanese call this tree after the chalk-white underside of the leaves by which it is easily spotted by those fallen on the forest floor.

AMARANTHACEAE

9. Achyranthes bidentata Bl.—Flora of Java 1: 237.

Erect or ascending herb, J-2 m long, often reddish tinged; stems branched, frequently rooting at the base. Leaves 7-20 by 1-8 cm. The fruits are recurved and the spiny, slightly curved bracteoles make them adhere to fur of animals and clothes to be dispersed.

Throughout Java, in moist shady places, in forests, forest borders, and along trails, often locally gregarious, at 350-2500 m. From tropical Africa and India to Japan, also in Sumatra, Malaya, Bali, Lombok, Philippines, Celebes, New Guinea, and the Solomons.

AMARYLLIDACEAE (see also Plate 2-2)

10. **Curculigo capitulata** (Lour.) O.K.—a. Leaf tip, b. inflorescence—Flora of Java 3: 209 (as *Molineria capitulata)*—Purasèda, SW. of Bogor. 11746.

Stemless, coarse herb, with a strong rootstock with a bunch of thick roots, often producing subterranean stolons. Leaves tufted, very tough and plicate, on a long petiole, 25-100 cm long, 4-25 cm wide. One or two inflorescences emerging from between the petioles above the ground. Berries ellipsoid, whitish or pale pink.

Throughout Java in shady forest on moist humus soil, also in bamboo- and sometimes in teak-forest, often in ravines, not rarely locally gregarious, at 50-2200 m. SE. Asia to China and tropical Australia, throughout Malesia.

Often one leaf is seen moving to and fro in a perfectly quiet forest owing to otherwise imperceptible air currents caused by spots of sunlight penetrating through the canopy. Eurasians call it hence the *"rustelo%e %ieltje"* (restless soul), the Javanese more objectively *daun tjonkok.* The movement is facilitated by the laterally flattened petioles like in *Populus tremula.*

PLATE 1

EXPLANATION OF PLATE 2

ACANTHACEAE (see also Plate 1-1/7)

1. **Rungia coerulea** (Bl.) Warb.—Flora of Java 2: 593—Papandajan. 12237.

Erect or ascending herb to 60 cm high. Leaves 4-12 cm long, 2-5 cm wide. Each flower has only 2 stamens. The colour of the lip is very variable, sometimes with blue lines across, sometimes with purple spots.

In West Java, in forests, forest fringes, and sometimes in secondary forest, at 1000-2400 m, on some wet slopes found down to 700 m. Also in Sumatra, and possibly in Borneo, Celebes, the Moluccas, and New Guinea.

AMARYLLIDACEAE (see also Plate 1-10)

2. **Hypoxis aurea** Lour.—Flora of Java 3: 209—Mt. Ardjuno. **11889.**

A stemless perennial herb with a subterranean tuberous rhizome. Leaves 5-30 cm long, flower stalks 2-20 cm.

In Java from Mt. Lawu eastwards, among herbs and grasses in dry sunny localities, on open slopes and lavastreams, at 900-2300 m. Also known from SE. to E. Asia (Japan, Formosa), Sumatra (northern half), Bali, the Philippines, S. Celebes (collected at only 300 m), and New Guinea (even in lowland savanna forests).

The plant might be mistaken for *Curculigo orchioides* of the same family and grows often in similar places, but is distinguished by the fine-hairy, narrow leaves and the non-beaked ovary.

ANNONACEAE

3. **Orpphea hexandra** Bl.—Flora of Java 1: 110—Tjibodas.

Shrub or small tree, 2-14 m tall. The young foliage is pale and appears all at the same time; adult leaves 4-22 cm long, 2-8 cm wide. In the Chinese-lantern-shaped flowers 3 fertile stamens alternate with 3 sterile ones (so-called staminodes). The fruit is suggestive of a lombok (fruit *of Capsicum).*

In Java in mixed forests and teak forests, on limestone and volcanic soils, at 50-1600 m. Also in Sumatra.

APOCYNACEAE

4. **Alyxia reinwardtii** Bl.—Two branches, flowering and in fruit—Flora of Java 2: 230—Tjibodas (Mt. Gedé).

A straggling or climbing shrub to 6 m long. Leaves in whorls of three, 3-8 cm long, 1-2 cm wide. Flowers fragrant, variable in shape and colour, axillary.

In Java a common plant in forests and forest fringes, also on ridges, at 400-1900 m, and perhaps lower. Probably also in SE. Asia, Malaya, Sumatra and the Lesser Sunda Is.

The tough bark can be peeled off and is in renowned use in various drugs. It has a rather strong scent of cumarin. *Pulasari*is the native name.

AQUIFOLIACEAE

5. **I lex spicata** BL—Flora of Java 2:5 2—Tjibodas (Mt. Gedé). ?12923.

Shrub or tree, 5-20 m tall, mostly epiphytic on trunks or hemi-epiphytic (see 51-5). Leaves 4-10 cm long, 2-5 cm wide. The cushion-like stigma and the ovary which on section appears to be many-celled (star-shaped arranged drupelets) are typical for this genus.

In West Java found between Nirmala and the Priangan Mts in forests and forest fringes, also on ridges, at 1400-1800 m. Also known from Sumatra; probably of much wider distribution.

On young twigs the inflorescences are sometimes transformed into pink galls which look completely different.

ARACEAE

6. **Arisaema microspadix** Engl.—On the left, the spadix, taken out of the white spathe; no leaves—Flora of Java 3: 125.

Herb to 1 m high; perennial, with a subterranean tuber as in all species of this genus. Leaves 1-2 in a plant, the stalk 30-65 cm long, with 3 leaflets all of the same shape, to 10-28 cm long and 4-15 cm wide. The colour of the spathe is rather variable, pale green to yellow. The end of the spadix is sterile and, unlike in the following species, erect and branched. As in all species of the genus there are male and female specimens. The picture here is of a male specimen.

In Java only from Mts Lawu, Ungaran & Muriah eastwards, in mixed rain-forest, tjemara forest, and sometimes in plantations of coffee and cinchona, at (5 00-) 1300-2000 m. Also known from Central Timor.

Flowering time is between Sept. and Febr. Later on, the spathe disappears and the berries ripen; see the next one.

7. **Arisaema filiforme** Bl.—a. Inflorescence in flower, b. ditto in fruit—Flora of Java 3: 124—Tjibodas (Mt. Gedé).

Herb, to 1 m high. Leaves 1-3 per plant, their stalk 15-60 cm long, mostly pedately divided into 5 leaflets (rarely 3), these 8-27 cm long, 3-16 cm wide, the lateral ones very unequal-sided at the base. Petiole and peduncle often dark-spotted or -blotched. The sheath of the inflorescence is commonly dark-brown to brown-black, but there is much variability, and green sheaths are also known. The unbranched sterile end of the inflorescence always extends far outside the sheath and is swollen at the base. Male plants mostly outnumber the female ones.

In Java known between Nirmala in W. Java and Mt. Sindoro in Central Java, a conspicuous plant in rain-forest and old secondary forest, at 900-2200 m, rarely down to 450 m. Also known from Sumatra and Malaya. See my account of the genus in Java(S 1948). A popular name, alluding to the curious shape **is *Jack in the pulpit,* a Batak name *aturbung haladi.***

8. Arisaema inclusum N.E. Brown—A complete plant, of small size—Flora of Java 3: 124—Tjitalahap (W. Java). 12728.

Up to 50 cm high. Leaves 1-2 per plant, their stalk to 28-42 cm long, the 3 leaflets 9-28 cm long and 4-15 cm wide. Not to be confused with another small-sized species, *A. laminatum* Bl. (Flora of Java 3: 125), which has also a slender spadix of about the same length, but has a dark cross-band separating the tube of the sheath which is pale and the limb which is green.

In West Java (common on Mt. Gedé) in forests, at 1150-1600 m. A rare species, also known from Central Sumatra and Flores.

CELASTRACEAE (see also Plate 8-10)

9. **Euonymus japonicus** Thunb.—Flora of Java 2: 53—Mt. Papandajan. 12262.

Shrub or climber to 8 m high, with twigs, leaves and flowers of the same light green colour. Leaves 2-9 cm long, 1I-4 cm wide. When the fruit ripens, the seed with its fleshy coat is pushed out but remains attached to its funicle for birds to eat.

In Java from Mt. Patuha eastwards, in forest fringes and open plains, at 600-3000 m; semi-cultivated in hedges. From India to Japan, also in Central Sumatra, Sumbawa, Flores, Timor, Celebes and the Philippines, not in Malaysia; in Europe often cultivated in many forms. If the plant grows up in the shade of forest, it develops as a long, slender, almost unbranched root-climber which hardly ever flowers. Exposure to full light leads to profuse branching and fertility.

SCHISANDRACEAE (see also Plate 29-3/5)

10. **Schisandra elongata** (Bl.) Baill.—a. Twig with buds, b. spike of fruits—Flora of Java 1: 99—Mt. Idjèn. 12118. Mt. Papandajan. 12247.

A liana 5-20 m long, the stem to an inch thick. Leaves 7-15 cm long, 4-8 cm wide, with a red stalk. The flowers are produced in the axils of leaves but also on the older branches; they are either male or female but occur on the same plant. The female flowers have many separate ovaries (carpels) on a common receptacle, which stretches during the development of the fruit. The whole raceme or spike, which looks like peppers, thus stems from one flower. In Java mainly the western part, but also in Central Java on Mts Sumbing & Lawu, and in East Java on Mts Tengger & Idjèn, in forest and forest fringes, at 1200-2000 m. Also known from Sumatra.

['LATE 2

EXPLANATION OF PLATE 3

ARALIACEAE

i. **Aralia dasyphylla** Miq.—a. Part of stem with 2 leaf insertions, the petioles cut off at different height, showing their sulcate structure, b. apical part of leaf, 2 pairs of jugae drawn, c. small part of inflorescence, with flowers, young fruit and mature fruit, combined from different parts of the inflorescence —Flora of Java 2: 170—Mt. Papandajan. Probably 11664.

A spiny, sparsely branched shrub or treelet, I-2(-J?) m high. The leaves are ± crowded at the stem apex and are 60-90 cm long; they are composed of 5-8 pairs of lateral pinnae, each carrying 3-8 pairs of leaflets; the lower leaves are even more compound and 3-pinnate. Usually the plant is brown hairy, besides being provided with spines. The inflorescence is a large terminal compound panicle of flower umbels, reaching some 40-70 cm height. The species is variable and the depicted form comes near var. *strigosa* Miq. (see the cited Flora of Java) with short and rough-hairy stalks. This form leads via var. *urticifolia* (Miq.) Bakh. f. towards the little-known *Aralia javanica* Miq. (only known from Mt. Diëng), which has more bullate leaves but may be the same species.

In Java mainly in the western part but also on Mt. Ungaran in Central Java, in primary and secondary forests and on forest edges, at 300-2000 m. Also known from Sumatra (even to 2500 m) and North Borneo (Ranau).

Pangangbadak or p. tjermè'm Sundanese.

2. Harmsiopanax aculeatus (DC.) Boerl.—a. Stem top with young, small leaves, b. top of flower panicle—Flora of Java 2: **171.**

An erect or crooked, little-branched shrub or treelet, 2-4 m high (to 16 m high and 25 cm thick?), with a very spiny stem, very decorative with its large peltately attached leaves which are snow-white felted underneath and its large, white, erect panicles which may attain 2 m in length. Full-grown leaves are up to 50 cm diameter. It is suspected that the primary axes of the inflorescence bear mostly female flowers, the secondary ones mostly male ones.

In Java from the Djampangs eastwards to Mt. Idjèn, a characteristic pioneer on lavastreams and in grassfields, often together with *Wendlandia* (48-6), on Mt. Idjèn with *Wightia* (51-5), *Plectranthus* (30-2), *Dodonaea viscosa* (49-5), and young tjemara *{Casuarina,* 8-9), at 325-1700 m. Also known from the Lesser Sunda Is. (Bali, Lombok, Sumba, Timor) and S. Celebes.

Djangkorang in Sundanese, *gorang lanang* or *gungrang* in Javanese.

3. **SchefHera rugosa** (Bl.) Harms—a. Leaf, b. part of panicle with 2 racemes, c. very young developing leaf—Flora of Java **2: 164.**

An unarmed treelet or shrub, up to 8 m tall. The stem may attain 15 cm diameter. The branches are often bent like snakes, and the leaves are crowded towards the twig-ends. Each leaf consists of 5-7 leaflets on top of the petiole; the leaflets are thickish, have a dark green, bullate, rugose upper surface and a glaucous under surface; they are 14-23 cm long, and 6-11 cm wide. In juvenile plants the leaflets may have a serrate margin. The petiole is 10-30 cm long and has a short, stem-clasping sheathing base. The flowers occur in a large terminal panicle of spikes up to J m long. Leaves and inflorescences are initially brownish woolly hairy, but this wears off with age. The mature berries are black.

Throughout Java a common species in mixed mountain forest, also in tjemara and elfin forest of *Vactinium* (17-8) and *Myrsine* (32-9), once found dominating on Mt. Slamat in an almost pure girdle below the *Albi^ia* stands (26-4), at 1800-3100 m. Also known from Sumatra.

A Javanese name *is putangan,* a Sundanese *onepangang bulu.*

PLATE 3

EXPLANATION OF PLATE 4

ARISTOLOCHIACEAE

i. **Aristolochia coadunata** Back.—Flowers in various stages of development—Flora of Java i: 164—Forest edge Tegal Pandjang(Mt. Papandajan). 12625.

A high climbing, proportionally thin liana, up to 50 m long. The terete stem is characteristically covered with coarse, grey, lengthwise ridges of cork; the wood is in cross-section marked with conspicuous radial rays. Leaves 9-25 cm long, 4-10 cm wide, felty underneath and bullate between the vein areoles. The plant climbs with its petioles. The beautiful flowers are found both on the young parts but sprout also from the nodes of thick, leafless wood. The fruit is yet unknown.

In Java on the Priangan mountains (Malabar, Papandajan), east on Mt. Lawu, above Pudjon, SE. Smèru, G. Pendil (Mt. Idjèn), in mixed forest, at 1000-2100 m.

There is also a variety *bosschai* Back, with sulphur-yellow flowers.

The plant is not yet known outside Java and there are only few collections, but the flowers are always high up hidden in the canopy and difficult to locate. The beautiful specimen from which the plate is drawn had come down when part of the crown of a tree had crashed. The flexible stems with their thick cork ridges are characteristic dangling forest cords *[tali utari)* and by them a specimen can be more easily located. As we did on Mt. Idjèn, which made it a day later possible to answer a request from an estate manager, Mr. H. Lucht, who was an ardent amateur butterfly collector on Blawan coffee estate and who had caught a beautiful, large *Papilio* of the subg. *Pharmacophagm,* of which the caterpillars are said to feed exclusively on species of *Aristolochia,* but who had not succeeded in finding the host plant.

At a certain stage the flowers of *Aristolochia* emit a fetid smell attracting certain insects which are said to be compulsory for their pollination.

This species is allied to a group of SE. Asian species, notably *A. saccata,* from which it differs by the leaf-shape widest below, and the smaller, not saccate flowers.

ASCLEPIADACEAE

2. **Dischidia angustifolia** Miq.—Flowers & dehisced capsule —Flora of Java 2: 264—G. Pendil (Mt. Idjèn). 12139.

All species of this genus are living epiphytic on trees and branches to which they are attached by roots emitted from the stem nodes; they do not root or germinate in the soil. They have all fleshy leaves, urceolate flowers, linear pods and plumed seed. Their tissue contains a mostly white latex, as all other members of the family *Asclepiadaceae.*

Slender and wiry stem up to 1 m long. Leaves 2J-4 cm, less than 1 cm wide.

In Java only in the east, on Mts Tengger, Baluran & Idjèn, in light forest, at 800-2000 m.

3. **Dischidia nummularia** R.Br. var. **rhombifolia** (Bl.) Bakh. f.—Flora of Java 2: 261—Tjibodas (Mt. Gedé).

Stems up to c. 80 cm long, often profusely branched, forming a netting over tree trunks. Leaves ii-2j cm long, J-i cm wide.

The species is widely distributed in lowland areas of Indo-Malesia, the variety occurs more restricted; it is common in the West Javanese mountains in forests, at 1300-1800 m, and is also known from Mt. Ungaran in Central Java and Mt. Singalang in Central Sumatra.

Another *duduwitan,* a Sundanese name alluding to the coin-shaped leaves, is *D. truncata,* but that species has distinctly pointed leaves and besides differs in technical detail in the floral structure, it possesses a light violet corolla.

4. **Dischidia lanceolata** (Bl.) Decne—Plant drawn upside down—Flora of Java 2: 264—Tjibodas (Mt. Gedé).

Stem up to 1 m long, not much branched. Leaves 5-9 cm long, 1J-3 cm wide. Flowers pale violet, speckled.

In Java only in the western part, in damp forests, rather common, at 1300-2000 m, possibly also in Sumatra and Lombok.

5. **Hoya purpureo-fusca** Hook.—Flora of Java 2: 271—Probably Mt. Tengger, received from Dr. Coert.

Coarse, climbing, epiphytic plant. The flattish rotate-stellate waxy flowers in axillary umbels are a characteristic structure of the genus *Hoya.*

Only found in East Java, possibly only on Mt. Tengger, in forest, at 15 00-1800 m. Obviously a rare plant, or rarely flowering as many Javanese *Hoyas.*

Thomas Lobb collected this first for the horticultural firm of Veitch as it makes a nice greenhouse plant.

6. **Tylophora villosa** Bl.—a. Flowers, b. the forked pod—Flora of Java 2: 260—Rarahan, near Tjibodas (Mt. Gedé).

A branched, twining, soft-hairy vine, up to 3 m long, the stem becoming woody at the base. Leaves 3-15 cm long, 2-8 cm wide. Follicles 2, spreading, lengthwise dehiscing, containing many seeds c. 1 cm long, each provided with a plume of very fine hairs 2-3 cm long.

In Java all over the island, in forest edges mostly in secondary thickets, locally often common, sometimes in grassland, from sea-level up to 2000 m.

PLATE 4

EXPLANATION OF PLATE 5

B.ALANOPHORACEAE

i. Balanophora elongate Bl.—a. Part of a male specimen, b. ditto of a female plant—Flora of Java 2: 79—Telaga Warna near Puntjak Pass(Mt. Gedé). 12280.

This curious plant belongs to the plant family *Balanophoraceae* of which all members are parasites on the roots of other plants from which they suck their nutrients. These include also carbohydrates because they are devoid of the green pigment chlorophyll with which green plants manage to develop this themselves from water, carbon-dioxide from the air and the energy provided by sunlight. This species is not restricted to a single host plant, but is known to parasitize on roots of various plants, mostly trees and shrubs. In passing it may be said that they do not kill the host on which they have to depend for a long time. How long a plant may live is not known, but judging from the fairly slow growth and the colossal dimensions of the tuber exceeding the size of a man's head a single plant can probably live for several decades and maybe even longer. On the root of the host it develops a tuber in which the root tissue of the host also participates, but outside the tuber the host root is at both sides of the tuber not swollen and sometimes remarkably thin. The tuber may attain various shapes, sometimes more solid, sometimes more coral-like branched (compare a and b). Its surface is rough to the touch and shows (in this species) star-like warts. The unbranched short stem and terminal inflorescence is formed inside the tuber and breaks forth, leaving the remains of the rind of the tuber as a sort of cup. The stem carries up to 20 red bracts (leaves) increasing in size upwards, to below the terminal spike, which carries either many white male flowers (a) or an immense number of microscopic female flowers (b). One tuber produces only flowers of one sex in this species. In the forest the number of males and females is about the same. Very rarely the red colouring substance is lacking and the plant is lemon yellow.

In Java it occurs mainly in the western part and is sometimes common (e.g. on Mt. Gedé), but it is yet not found east of Mt. Lawu, always in forest, at (850)1000-3000 m. It is also known from Sumatra. It flowers mostly from March to September.

A problem is still how the minute seeds, measuring only 1/3 mm, are dispersed and how the primary infection of the root takes place. Experiments with another parasite, the famous *Rafflesia,* have shown that the seed cannot attack an undamaged root and the idea is that larger animals (deer, swine, kantjil, etc.) treading on the forest floor carry the seed with mud on their hoofs and in injuring roots thus bring the seed into contact with the root tissue. This must be checked by experiments.

Host plants recorded are *Schefflera* spp. (3-3), *Debregeasia* **(56-1),** ***Albivya*** **(26-4),** ***Ficus, Vaccinium{\^-%),***

In section the tuberous rhizome is very sticky by wax, as in all species of the genus, but *B. elongata* contains very much wax (and not starch). In former times of slump Sundanese on Mt. Gedé at Tjibodas boiled the cut rhizomes, extracted the wax, and used this for making candles (Ultée, 1924).

2. Balanophora fungosa Forst. var. **globosa** (Jungh.) B. Hansen—Flora of Java 2: 79 (as *B. globosa* Jungh.)—Tjibodas (Mt.Gedé).

This species is distinctly different from the preceding by hard appressed scale-leaves, a different surface of the tuberous rhizome and a globular inflorescence. It is far less common. Only female plants are known of this species which Lotsy aptly called a "widowed" plant. See his paper in Ann. Jard. Bot. Buitenzorg 16:174-18;. 1899.

It is **only known from West Java** from **Mt. Salak to the East** Priangan, in forest, at 1250-2000 m.

It parasitizes on trees, *puspa* (52-7) and possibly *Podocarpus* (13-1*1).

Bertel Hansen relegates this to a very widespread species ranging from India to the Pacific and Australia, of which the dioecious subspecies *indica* (Arn.) Hansen occurs from India to West Malesia, to which this variety should belong.

The third species of *Balanophora* in Java is quite different from the two preceding, producing not such large rhizomes, being more delicate in size and stature, and having both male and female flowers in one inflorescence; it is not a mountain plant.

3. **Rhopalocnemis phalloides** Jungh.—Massive rhizome not drawn—Flora of Java 2: 79—Telaga Warna near Puntjak Pass (Mt. Gedé). 12278.

A root parasite which in general structure is very similar to the *Balanophoras,* with a huge rhizome from which the inflorescences emerge, but without leaf-like scales below the spike. This is instead initially completely covered by a curass of closely fitting, tooth-like caducous scales which leave a pit in the spike at the flowering stage. The male flowers are large and are found below the minute female flowers (like in *Balanophora)* on the apical part of the spike; one rhizome may produce both bisexual (as depicted here) and unisexual spikes. Instead of wax the rhizome contains starch.

In Java from Mt. Gedé eastwards to Mt. Kawi, in forest, at 1000-2800 m. Also known from SE. Asia, Sumatra, S. Celebes and Buru.

It parasitizes on various hosts, e.g. on oaks, figs,/>/KT/>J (52-7), *Albi^ja* (26-4), etc.

Between the female flowers are a vast number of very thin hairs which secrete drops of honey at anthesis.

BEGONIACEAE (continued on Plate 6)

4. **Begonia bracteata** Jack—Male plant—Flora of Java 1: 312—G. Menapa near Nanggung (WSW. of Bogor). 17406.

A rather delicate, mostly unbranched, erect herb, 30-50 cm high, often from a short-creeping base, with large, red or green, persistent stipules and bracts and a raceme-like inflorescence with dark-red flowers, here figured with male flowers. Leaves 5-15 cm long, 2-8 cm wide. Fruit (not drawn) 1-2 cm long, with 3 equal thin wings.

Only in West Java, from Mt. Karang eastwards to Tjiandjur, in humid places in damp forest, at 200-1500 m. Also in Sumatra.

5. **Begonia longifolia** Bl.—Part of a flowering male specimen and a loose bunch of fruits—Flora of Java 1:313—Puntjak. 1231 T . Megamendung. 12200. Both Mt. Gedé.

A stout, erect plant with a juicy stem, up to ij m high. Leaves 12-28 cm long, 6-12 cm wide. Fruit green, not winged, but ribbed, the ribs with pale warts.

In Java from Nirmala and Mt. Salak to Priangan, but also found on the SW. slope of Mt. Sméru near Pantjur, in moist places in forest, at 500-1600 m. Also in Sumatra.

6. **Begonia muricata** Bl.—Plant with female flowers only—Flora of Java 1: 309—Tjisarua South (Mt. Gedé). 12221.

Stem a creeping rhizome emitting leaves and inflorescences, but the internodes of the rhizome between the leaves **are** usually longer than here depicted for reasons of economy. Leaves 5-17 cm long, 4-13 cm wide. Fruit with thin equal wings. A single plant may carry both female and male inflorescences, the latter not drawn here; male flowers have much shorter pedicels.

In Java only from Nirmala eastwards to Garut, in damp forest, often on steep slopes and in stony places, at 900-2000 m. Also in Sumatra.

PLATE 5

EXPLANATION OF PLATE 6

BEGONIACEAE (continued)

1. **Begonia isoptera** Dryand.—Flora of Java 1:312—Tjibodas (Mt. Gedé).

An erect herb, profusely branched, up to 1 m high. There is great diversity, the oblique leaves being shorter or longer stalked, above white-spotted or not, and more or less red-tinged, particularly beneath; their size varies from 8-21 cm length and 2-4 cm width. The inflorescence may show differences in structure and in distribution of male and female flowers on one plant. Shape and size of the fruit are very variable too. The ovary and fruit have three equal wings.

In Java mainly in West, also on Mt. Tele mo jo in Central Java and Mt. Idjèn in East Java, in shady old -forests, the soil whether or not calcareous, at 150-2400 m. Also known from Malaya, Sumatra, Flores, and ? Celebes.

2. **Begonia robusta** Bl.—Buds and open male flower and fruit—Flora of Java 1:313—Tjibodas (Mt. Gedé).

Coarse, rough-hairy, beautiful herb to 1 m tall, with rough-hairy petioles and intensely red young leaves. The mature leaves are normally 30-40 cm in diameter (the leaf here drawn being one of the smallest that could be found). One wing of the fruit much larger than the other two.

In West Java in the undergrowth of mixed rain-forest, at 700-2400 m. Also known from Sumatra.

In the same places *B. multangula* Bl. can be found, which looks like the present one, but lacks the typical hairs and has fruits of different shape.

The Sundanese name is *hariang beureum,* the name *hariang* being used for all species of *Begonia.*

BALSAMINACEAE

3. **Impatiens chonoceras** Hassk.—Flora of Java 1: 249—Mégamendung.

An ascending delicate herb to 40 cm tall. Leaves thin, 4-12 cm long, 2-6 cm wide. The flowers are white to light pink-tinged; their spur is inside mostly red-veined.

In Java known from Nirmala eastwards to the Priangan Mts, in moist places in shady forest, and along forest trails; locally often gregarious, at 1200-2200 m. Also known from Sumatra (?).

The only other Javanese species with a trumpet-shaped corolla and scattered leaves is /. *microceras* Backer, not illustrated here. It has inconspicuous, much smaller flowers and a .spur of 1-3 mm. It is found only at the Puntjak Pass (Mt. Gedé) and at Tjadasmalang south of Tjibeber.

4. Impatiens javensis (Bl.) Steud.—Flora of Java 1: 250—Tjibodas (Mt. Gedé).

Erect or ascending herb to 80 cm tall. Leaves opposite, 2-14 cm long, 1-4 cm wide, glabrous to distinctly hairy (mostly so in small-leaved specimens). The flowers vary in colour from almost white **to** pink, partly depending on their age, but they always have a dark centre and a long filiform spur.

In West Java common, in East Java only on Mts Lamongan, Jang & Idjèn, in moist places in shady rain-forest, along forest fringes and forest trails; often gregarious, sometimes epiphytic on tree trunks, at 1000-2500 m. Probably also in Sumatra.

5. **Impatiens platypetala** Lindl.—Flora of Java 1: 250—Rarahan(Mt.Gedé).

An erect herb to 1 m tall, but stems of 3 m length have been found. Lower leaves mostly opposite, the upper ones in whorls of 3-4, 3-15 cm long, 1-6 cm wide, finely serrate. Flowers in different shades of purple, but the colour fading with age; two petals mostly with a darker base. The spur of different length, up to 4 cm long. Once a purely white variety has been found (near Tjidadap, W. Priangan).

In Java the most common species, in shady moist places, but also in open places provided the soil is wet or swampy, not rarely locally gregarious along small streams and ditches, from the hills up to 2500 m, but descending to 300 m along streams and rarely even to near sea-level.

The species is widely distributed all over Malesia, in its genuine form, but also represented partly by distinct geographical races which I have elucidated in a separate paper (S 1948) and which has been extracted in Flora of Java 1: 250. The next number of this plate represents one of these, a clearly ecological race. In Celebes the species is represented by a topographical race with orange flowers, now often cultivated in **Java.**

As in all other species of the genus the ripe, fleshy, swollen elongate capsules (see figure) open abruptly on being touched and eject the seed for several metres.

6. **Impatiens platypetala** ssp. **nematoceras** (Miq.) Steen.—One flower only—Flora of Java 1: 250—Trètès (Mt. Ardjuno). 118 5 9.

A small-flowered subspecies of the former species, with more delicate habit; leaves 2-9 by 1-3 J cm.

In Java only east of Linggadjati and Tjiamis (about Mt. Tjeremai), in open or little-shaded localities which are subject to the dry season, also in teak forests, at 50-1300 m. Also known from the island of Madura and the Lesser Sunda Is. (Bali, Sumbawa, Timor).

A distinct ecological race of the former species.

A variety with white flowers may occur in Java.

7. **Impatiens radicans** Zoll. & Mor.—Flora of Java 1: 250—Kandangbadak(Mt. Gedé).

A rather lush, erect or ascendent herb to 75 cm tall. Upper leaves in whorls of 5-10, sharply serrate, 2-6 cm long, 1-1J cm wide. The only Javanese species with spotted, long-spurred flowers, which occur in various shades of pink, and are only slightly variable in size. A very distinct species.

Endemic in West Java, as far as known, from Mts Pangrango, Tjikurai & Papandajan, locally common, sometimes even gregarious, in mostly moist places, along brooks, in swamps and in low forest, at 1800-2800 m.

Backer claimed to have found intermediates (? hybrids) between /. *platypetala, I. javensis* and /. *radicans* but I cannot corroborate this from my experience; I have found them not rarely together.

PLATE 6

EXPLANATION OF PLATE 7

BERBERIDACEAE

1. **Mahonia napaulensis** DC.—a. Leaf and flowers, b. raceme in fruit—Flora of Java i: 150 (as *Berberis nepaulensis)*—Tjibodas (Mt. Gedé).

Erect shrub, 1-6 m tall, sparsely branched. Wood (as in all *Mahonia* & *Berberis)* canary yellow which accounts for the Sundanese name *ki konèng.* Leaves conferted near the twig ends, with mostly 5-9 pairs of stiff, spiny leaflets 3-8 cm long, 2-5 cm wide. Berries when ripe dark blue, pruinose, bitter and acid.

In Java on Mts Gedé, Patuha (Rantja Gedé), Sindoro & Sumbing, a very rare plant, on steep rocks, in shrubberies, forest fringes and in semi-open rain-forest, at 1000-2200 m. Throughout SE. Asia to Formosa, also in Sumatra (Atjeh, Karo-Toba) and the Philippines, described under several dozens of names evaluating minor racial segregation.

The stamens in this and the next genus are sensitive and at a light touch on their inside base the anther cells explode with a flap releasing their pollen.

2. Berberis wallichiana DC.—Berries only in pencil—Flora of Java 1: 150—? Mt. Papandajan. 12244. Mt. Ardjuno. 11866.

A stiff, erect shrub or sprawling in shrubbery, 1-5 m long. Each leaf-bundle in the axil of a 3-partite spine, on a scaly knob. Leaves hard, spiny, 5-11 cm long, 2-4 cm wide, glaucous underneath. Berries purple, pruinose. Old leaf bright red.

In Central & East Java, in West Java only on Mts Pangrango & Papandajan, then from Mt. Diëng eastwards to Mt. Suket (Idjèn), in forest edges, on grassy plains, in tjemara forest, at 1600-2800 m, not common, sometimes locally so. SE. Asia, also in Sumatra (up to 3 300 m), Lombok, and Luzon.

Teysmann, who transplanted it on Mt. Pangrango in the eighteen-fifties for experiment from East Java, said not to have had success. I detected the species in a remote unexplored place on Mt. Ged£ slightly below Kandangbadak in 1940 (S19 5 2) and hope that this was not an offspring of Teysmann's supposed failure.

The leaves are frequently infested by an orange rust fungus.

BURMANNIACEAE

3. **Burmannia** lutescens Becc.—Flora of Java 3: 214—G. Bèsèr(Mt.Gedé). 11722.

A very delicate, mostly unbranched herb, up to 23 cm long, mostly not over 15 cm above the ground, with thick, fleshy, unbranched roots. Leaves reduced to scales. Flowers 3-5, rarely to 11, in a candelabra-like pattern. Capsule with very fine seed. The roots which are in the clay, not in the litter, live in symbiosis with a fungus which prepares the food for the plant from the raw humus of the litter. Such plants are called saprophytes (see others in 34-3 and 37-4).

In Java common in West, more rare in Central Java, in the deep shade of primary rain-forest, also in bamboo forest, at c. 500-1400 m, throughout Malesia.

These mostly tiny saprophytic plants occur in several families. They grow mostly in colonies together; they flower mostly in the rainy season. None occurs above 1500 m anywhere. See the key I gave for the saprophytes of Malesia (S 1934).

BUXACEAE

4. Sarcococca saligna (D. Don) **M.A.** var. **zollingeri** (Baill.) J.J.S.—Flora of Java 1: 647—Mt. Jang. 11949.

Erect subshrub, £-2 m high, all parts bitter. Leaves 5-10 cm long, 2-5 cm wide. Flowers of one sex, all without corolla, the female flowers with a green calyx, the male white. Fruits blue when ripe.

In Java from Mt. Malabar eastwards to Mt. Idjèn, in shady forest and forest edges, at 1500-2400 m. A polymorphous species, described under various names, ranging from Afghanistan to Formosa, also in Sumatra, Bali and Luzon.

CAMPANULACEAE

5. Codonopsis javanica (Bl.) Hook. f.—Flora of Java 2:448.

Very slender, branched herbaceous vine, twining to the left, 2-4 m long, with swollen roots. Leaves 3-8 by 2-5 cm. Berry with many tiny seeds.

In Java from Mt. Gedé eastwards to Mt. Idjèn, in forest fringes, shrubberies and along trails, at 1000-2200 m. From India to China and Japan, also in Sumatra(Mts Kerintji, Kaba & Dempo).

On Mt. Gedé called *ketjépot* by the Sundanese.

6. **Lobelia chinensis** Lour.—Flora of Java 2:451—Bogor.

A branched, caespitose, rooting herb, mostly in dense tufts; stems to 15 cm long. Leaves in two rows, 5-15 mm long, 2-6 mm wide. Capsules extremely rare.

In Java eastwards to Mt. Diëng, in moist grasslands, by ditches, near rice-fields, in tea and cinchona estates, locally often common, at 500-1500 m, descending along rivers to 225 m (Bogor). From India to China and Japan, in Java probably introduced, not found in proper native vegetation. Experiments are desired to see whether ever viable seed is produced in Java.

7. **Lobelia heyneana R.** & S.—Flora of Java 2: 450—Rawa Tjibitung (Pèngalèngan). 11646.

Erect or ascending herb with triangular stem, 15-60 cm high. Leaves 1-5 cm long, \-z\ cm wide, spirally arranged.

In Java from Mt. Patuha eastwards to Mt. Idjèn, in open localities, often on marshy soil, in grassland and on steep talus, at 1000-2400 m. From E. Africa to S. China, also in Sumatra, all Lesser Sunda Islands and N. Luzon (and ? New Guinea).

8. Lobelia montana Bl.—a. Stem top with flowers and young fruits, b. ripe fruit in basal part of stem—Flora of Java 2: 450—Mt. Gedé.

An erect, sometimes coarse herb, \-\\ m high. Leaves 4-12 cm long, 2-4 cm wide. Flowers scentless. When ripe berries (nodding) are found in the lower leaf-axils, flowers are still produced towards the top of this pretty plant; they are more or less secund.

In Java from Nirmala eastwards to Mts Petung Kriana & Diëng, mostly in ± shaded places, along forest trails, in mossy forest, at 1400-2600 m. From India to Yunnan, also in Malaya (rare) and Sumatra.

9. **Lobelia angulata** Forst. f.—Flora of Java 2:450—Mt. Gedé.

A creeping herb, profusely branching and rooting at the nodes, 8-60 cm long. Leaves \-*i*\ cm long and wide. Flower stalks }-4 cm long; corolla 7-11 mm long. Flowers and fruits mostly together on a single plant.

In Java in shaded places, from Mt. Salak eastwards along forest trails, on earth walls, secondary forest, mossy forest, also invading tea and cinchona estates, at 1000-3200 m, rarely descending to 600 m, in New Guinea up to 3700 m. From southern S. America through New Zealand, Tasmania, eastern Australia and Malesia to Formosa, southern China and the Himalayan tracts; through Malesia, but not yet found in Borneo and Moluccas.

10. **Wahlenbergia marginata** (Thunb.) DC—Flora of Java 2: 448—Mt. Papandajan.

An erect or ascending, sparsely branched, thin, finally perennial herb up to 75 cm high. Leaves narrow, 2-8 cm long, 1-5 mm wide. Flowers open in sunshine.

In Java from Mts Patuha & Papandajan eastwards to Mt. Idjèn, in open, often rocky or sterile places, grassland, forest trails in tjemara forest, on talus, at 1300-3300 m. From New Zealand and Australia through Malesia to SE. Asia, China and Japan, but absent in Sumatra, Malaya and Borneo, from which it is concluded that the plant shows a distinct preference for areas subject to a dry season.

This species displays a considerable variation ably discussed by Moeliono in Flora Malesiana 6:117. The flowers are bisexual and Docters van Leeuwen assumes that self-pollination is the rule. The stamens are shed before the end of anthesis and then they may seem to be female. The plant is perennial, but annual unbranched dwarfs may flower and possess very small flowers.

PLATE '

EXPLANATION OF PLATE 8

CAPRIFOLIACEAE (see also Plate 9-1)

1. **Lonicera acuminata** Wall.—Branch tip with flowers, another with ripe berries—Flora of Java 2: 360—Mt. Papandajan. 11663.

A liana to 10 m long. Leaves often bullate in exposed places, distinctly veined, 3-8 cm long, i£-4 cm wide. As usual in the genus flowers are cream-coloured the first day, darker the next; in anthesis only one lip is recurved. Calyx purplish or green. Flowering parts without capitate-glandular hairs. Plant with rather coarse yellowish hairs, but glabrescent. Berries black, sometimes pruinose.

In Java from Mt. Gedé eastwards to Mt. Idjèn, in elfin forest and shrubberies, on crests and summits, or leaning against rocks, at 1600-3300 m. Also known from SE. Asia, Sumatra, Bali, Celebes, and the Philippines.

Flowers sweet-scented, as usual in the genus. Pollinated by bumble-bees.

2. **Lonicera javanica** (Bl.) DC.—Flora of Java 2: 360—Tosari (Mt. Tengger). 11920.

As the preceding, but more slender, without the coarse yellowish hairs, but finely hairy and hairs partly capitate-glandular. Twigs soon glossy brown. Leaves 4-11 cm long, 2-6J cm wide. Flowers slender, both lips recurved.

In Java from Mt. Gedé eastwards to Mt. Idjèn, in forests, forest edges, and shrubberies, at 1000-2000 m. Also in Bali.

3. **Viburnum coriaceum** Bl.—Part of the flowers replaced by fruit at left—Flora of Java 2:35 9—Tjibodas (Mt. Gedé).

Shrub or small tree, up to 14 m tall, stem to 20 cm through, crown dense. Leaves glabrous, ± coriaceous, 10-24 cm long, 4-8 cm wide. Flowers in a flattish corymb.

All over Java, in shrubberies, on crests, often in secondary vegetation, also a pioneer on lahars and screes of volcanic ash, sometimes in great numbers. Also in SE. Asia, Sumatra and the Lesser Sunda Is.

CARYOPHYLLACEAE

4. **Cerastium indicum** W. & A.—Flora of Java 1: 208—Mt. Ardjuno.

Mostly ascending, sometimes erect, branched herb, ± viscid by gland hairs all over, 30-100 cm long. Stems slack, patently villous. Leaves in pairs rather far apart, 1J-6J cm long, 1/5-1 cm wide. Petals slightly notched at apex. Styles 4-5. Capsule dehiscent with 8 or 10 teeth or valves.

In Java from Mt. Sindoro eastwards to Mt. Jang, on grass-slopes, in brushwood and tjemara forest, at 2400-3300 m. E. Africa, SE. Asia and SW. Celebes (Mt. Bonthain).

5. **Sagina macrocarpa** J.K. Maly—Flora of Java 1:209—Mt. **Jang.**

An annual, largely prostrate, often strongly branched, delicate herb, 7-15 cm long. Leaves very narrow, J-2$ cm long, opposite but in one axil of each pair two leaves of an axillary bud, thus each node seemingly with a whorl of 4 leaves. Flowers mostly 5-merous. Petals often ± longer than the sepals, not bifid.

In Java only known from Mt. Jang on a soggy stream bank and a lake shore. Also in Celebes, the Philippines, Ceram and ?New Guinea (as *S. papuana* Warb.).

6. **Stellaria australis** Zoll.—Flora of Java 1: 208—Mt. Idjèn.

Herb with many stems, mostly prostrate, often strongly-branched, 40-80 cm long, sometimes purple-tinged. Lower leaves 3-8 mm stalked, higher ones subsessile; margin of the older leaves hairy; leaf blades 2£-7$ cm long, 1J-3 cm wide. Sepals glandular-hairy with glabrous top. Petals bifid to half-way. Stamens 5. Styles 3. Fruit 3-valved, with 1 seed.

West Java (Mt. Papandajan) eastwards from Mt. Diëng to Mt. Idjèn, in mixed and tjemara forest, on shady roadsides, locally in great numbers, at 1550-2700 m. Also known from Bali, Lombok, and SW. Celebes (Mt. Bonthain).

7. **Stellaria pauciflora** Zoll. & Mor.—Flora of Java 1: 208—Mt. Idjèn.

Much like the former, but the lower leaves are 1-4 cm stalked, the stalk decreasing in length to £-1 cm near the top; leaf blades 1 j-5i cm long, 1-3$ cm wide. Margin of the older leaves glabrous or very sparsely hairy. Sepals rather blunt, glandular-hairy.

In Java from the Priangan Mts eastwards to Mt. Idjèn, in moist shaded habitats, locally common, at 900-2100 m. Also in Sumatra and Bali.

8. **Stellaria vestita** Kurz—Flora of Java 3: **644;** 1: 207 (as *S. stellato-pilosa* Hayata)—Tosari (Mt. Tengger).

Creeping, drooping or leaning perennial herb, £-2 m long, sprawling with mostly branched quadrangular stems. Leaves 1 £-3 cm long, J-1 cm wide, with stellate hairs, and distinctly grey-green when young. Inflorescences lax, also stellate-hairy. Calyx **not** glandular; the petals very deeply bifid, 6-8 mm long; stamens 10.

In Java only on Mt. Tengger-Sméru, common on talus, along roadsides, in tjemara forest, at 1650-2400 m. SE. Asia, S. China and Formosa, also in Lu2on and New Guinea.

In old dried-up stems the glossy, straw-coloured outer tissue of the stems separates from the tenacious core, forming tubular fragments.

CASUARINACEAE

9. **Casuarina junghuhniana** Miq.—a. Male flowering branch, b. twig of female tree with fruit cones—Flora of Java 2: 10—Mt. Ardjuno.

A dioecious tree, up to 40 m tall. Lateral twiglets of male and female trees unbranched, noded, each node with a whorl of 5-9 minute scale-like leaves, these needle-like branches caducous as a whole. Flowers in whorls arranged in spikes, the female short, the male slender elongate. Each female (nut) fruit provided with a small caducous winglet enclosed by 2 woody bracts which open valve-like at maturity. Male trees make a great show in flower being loaden with the pendent pale brown flower spikes.

In Java from Mt. Lawu eastwards above c. 1100 m on all mountains subject to a dry season, in huge pure stands due to fire (see text), also gregarious as a pioneer on volcanic ash-slopes, lahars and in grassfields, particularly on ridges. Also in the Lesser Sunda Is. where sometimes descending along river-beds to low altitude.

The mountain tjemara should not be confused with the beach tjemara which is monoecious. Though physiognomically resembling a conifer it does not belong to this phylum (compare *Podocarpus imbricates,* 13-2). On Mt. Dorowati (above Pudjon, East Java) I found a tree planted on a rain-forest-clad ridge near an old grave.

CELASTRACEAE (see also Plate 2-9)

10. **Perrottetia alpestris** (Bl.) Loes.—Flora of Java 2: 56—Tjibodas (Mt. Gedé).

Slack shrub or small tree, 1 £-8 m tall, in all parts more or less red-tinged. Leaves 11-23 cm long, 4-9 cm wide. Flowers small, white. Berry 6-10 mm long; seeds 4.

In Java east to Mt. Lawu, common, in forest fringes, along trails, on ridges, in subalpine brushwood, at (600)1000-2500 m. SE. Asia, Malaya, Sumatra. Other varieties elsewhere in Indonesia.

CLETHRACEAE

11. **Clethra javanica** Turcz.—Flora of Java 2: 178—Mt. Jang. 11946.

A shrub or low-branched tree, 3-6 (-10) m tall. Leaves 6-10 cm long, 2^-4 cm wide, with (15-) 17-20 pairs of nerves.

Only known from East Java on Mt. Jang (e.g. around the lake Taman Hidup) in forest and forest edges, at 1900-2300 m. A variety is found in Lombok.

Dr. Sleumer distinguishes this in his key (Fl. Mai. 7: **141)** from the widely spread *C. canescens* Bl. by the fewer number of nerves (10-12, rarely to 15 pairs) of the latter, but I find this insufficient for specific distinction and regard it as a race (subspecies) of the latter variable species.

PLATE 8

CAPRIFOLIACEAE (see also Plate 8-1/3)

1. **Sambucus javanica** Bl.—Flora of Java 2: 358—Puntjak Pass (Mt. Gedé).

Erect shrub, 1-3 £ m tall, with opposite, 2-6-jugate leaves, the leaflets 7-22 cm long, i£-6£ cm wide, in the higher leaves but 1-3 in number. The stems contain white pith. Inflorescences rather plane, 8-30 cm wide, with 3-5 main branches. Among the white flowers a number of cup-shaped glands are found, 3 mm through, mostly yellow-orange, rarely green. These glands produce nectar and are persistent. Ripe berry ovoid, black, 3-4 mm 0. Seeds 1-3.

All over Java, in humid forests, forest fringes and secondary forests, at 700-1800, mainly above 1000 m. Also known from SE. continental Asia, going eastwards through Malesia (not in Malaya 1) to the Philippines, Celebes, the Lesser Sunda Is. to New Guinea.

COMMELINACEAE

2. **Aneilema scaberrimum** (Bl.) Kunth—In fruit—Flora of Java 3: 17—Tjibodas (Mt. Ged£).

Erect herb ascending from a creeping base, 60-100 cm high, rooting at the base. Leaves 7-18 cm long, 2-4 cm wide, above rough to the touch when rubbed between the finger from top to base. Petals 3, pale lilac, or almost white, 6-7 mm long. Style almost central. Ovary and fruit more or less globose, provided with hooked hairs.

In Java in West and Central, in shady places, particularly in forests, at 800-1600 m. Also known from SE. Asia, Sumatra, the Lesser Sunda Is., Celebes and the Philippines.

3. Commelina paludosa Bl.—Flora of Java 3: 21—Tjibeureum(Mt. Gedé).

An erect or ascending herb, rooting at the base, 60-100 cm high, rather fleshy. Leaves 9-20 cm long, 2-5 cm wide, with stem-clasping sheaths. Inflorescences with 3-10 conferted, at most 6 mm stalked, emerging from a flattened-cucullate bract; this bract ± glabrous, 2-3 cm long, often containing large quantities of mucilage wherein the inflorescence develops, cuneate when still closed. Corolla bright- or light-blue, seldom white.

All over Java, in mixed forest, by ditches and in marshes, at 125-2000 m. SE. Asia to S. China, also in Sumatra and Celebes and possibly other islands.

4. Cyanotis ciliata (Bl.) Bakh. f.—Flora of Java 3: 14; 3: 659 (as *Belosynapsisciliata* (Bl.) Rao)—Puntjak-Pass (Mt. Gedé).

Ascending herb, 15-50 cm long, rooting at the base, often profusely branched. Stem with a lengthwise row of fine hairs. Leaves 2-8 cm long, i-2£ cm wide, densely ciliate along the margin. Flowers crowded into short-stalked, head-like inflorescences. Bracts hairy at the margin, 7-12 mm long. Petals acute. The filaments have long purple hairs near the top.

All over Java in shady, not too dry habitats, and kampong groves, up to 1600 m. Also known from SE. Asia and throughout the Malesian islands as far as New Guinea.

5. **Forrestia mollissima** (Bl.) Koord.—Flora of Java 3:15.

An ascending, robust perennial herb, £-3 m long. Stem with nodes, at each node a leaf with a stem-clasping sheath. Leaves 8-30 cm long, 4-10 cm wide. Floral clusters axillary, perforating and emerging from the base of the sheath; fruiting clusters the most conspicuous, also found when floral leaves have rotted away. Sepals white to (mostly) violet, navicular, enlarging and persistent in fruit. In the dehisced, purple, 3-valved capsule the 3-6 orange seeds with a fleshy coat.

A very variable plant, described under various names of species and variety, widely distributed throughout SE. Asia and the Malesian islands, all over Java, in shaded, humid or moist places, in thickets, old clearings, along ravines, both in mixed forest and teak-forest, often gregarious, at 30-1600 m.

6. **Pollia hasskarlii** Rao—a. In flower, b. in fruit—Flora of Java 3: 17—Tjibodas (Mt. Gedé).

Ascending herb, £-1 m high. Leaves n-35 cm long, 3-7 cm wide, with a stem-clasping sheath. Inflorescence 3-9 cm long, on a stalk protruding 4-14 cm above the highest normal leaf, covered with small hooked hairs, like the calyx. Calyx early caducous, not present under the glossy metal-blue indehiscent dry fruit.

All over Java, more common in West, in forests and secondary growths and thickets, often common, at 800-1700 m. Also in SE. Asia and Sumatra, Borneo and New Guinea.

cOMPOS 1 TAE (continued on Plates 10 to 12)

7. **Adenostema Phirsutum** (Bl.) DC.—Flora of Java 2: 376.

Erect herb up to 1/3-1 m high. Bracts supporting the heads acute, with reddish-violet hairs. Stem and stalks red-glandular-hairy. Leaves ovate, 3-13 cm long, 2-8 cm wide, somewhat bullate. Nuts with short, thick glandular hairs.

In Java from Nirmala eastwards to Mt. Idjèn in humid, shaded or grassy localities, also in tjemara forest, along forest trails, at 1200-2400 m. Also in the Lesser Sunda Is. and New Guinea.

The identification is not quite certain; the species of the *A. Iavenia(L.)* O.K. complex are very similar.

8. **Youngia japonica** (L.) DC.—A leaf and an inflorescence—Flora of Java 2:437.

An erect, annual, rather delicate herb with milky juice, up to 80 cm high. Leaves in a basal rosette, 3-12 cm long, in the middle of the rosette a single stem carrying 1-2 cauline small leaves. Nuts crowned by long white pappus hairs.

Throughout Java a common weed, on steep talus, in estates, in clearings and along riverbanks, at 200-2300 m. From India to Japan, Australia and the tropical Pacific islands, throughout Malesia.

During rains and at night the heads are closed.

9. **Spilanthes ?calva** DC.—Flora of Java 2: 408—Papandajan, along stream.

Branched perennial herb, decumbent and rooting from the nodes, 30-80 cm long. Leaves 1-5 cm long, £-2£ cm wide. The solitary heads have no ray flowers, the disk flowers being inserted on a conically elevated receptacle. Fruits minute, 2 mm, without pappus.

Common throughout Java, in grassland, along streams, in other humid localities, but also in monsoon forest, from sea-level ascending up to c. 2500 m. Also in SE. Asia, Malaya, Bali and Lombok.

10. **Vernonia cymosa** Bl. var. **eupatorioides** (Bl.) Koster—Flora of Java 2: 373—Sméru homestead, between Mts Tengger & Sméru. Gisius.

An erect herb, J-ij m high, sometimes a bit woody at the base. Stem glandular. Leaves 7-16 cm long, 2-5 cm wide. Nuts plumed by pappus bristles.

A polymorphous plant in Java found from Mt. Burangrang eastwards to Mt. Idjèn, in grassfields, open forest, tjemara forest, but also as a weed along roadsides, at 500-2700 m. The species also in Sumatra.

This variety with tomentose stems and underside of leaf and often purple involucral bracts especially common in East Java.

11. **Wedelia urticaefolia** (Bl.) DC—Flora of Java 2: 405—Mt. Ardjuno. 11835.

An ascending or straggling, more or less hispid-hairy herb, often branched from the base, £-4 m long. Leaves often bullate (inflated between the veins), 4-13 cm long, 2-8 cm wide. Nuts c. 4 mm long, at the top with 1-2 awns.

Common throughout Java, along roadsides, in hedges, open forest, also in teak and tjemara forest, bamboo thickets and grassfields, from sea-level up to 2500 m. Also in Celebes, Lesser Sunda Is., Moluccas and New Guinea.

Somewhat similar to the non-depicted *Spilanthes grandiflora*, which has, as all species of that genus, a conically elevated receptacle; the disk flowers in *Wedelia* are in one plane.

PLATE 9

EXPLANATION OF PLATE 10

COMPOSITAE (continued)

i. **Anaphalis javanica** (Bl.) Boerl.—Flora of Java 2: 393—Mt. Gedé.

A white-felted, profusely branched, often crooked shrub, up to 4 m high, rarely even up to 8 m, the stem as thick as a wrist. The twigs, bearing the drooping greyish-withered leaves, carry at the apex the crowded narrow leaves and a profusion of white flower heads, in which the disk flowers are yellow. The leaves are not provided with gland hairs and are, hence, not sticky.

Frequently gregarious on unfertile, open terrain, flat or sloping, sandy or rocky, on screes of lapilli, mainly in active or extinct crater valleys, rarely in open spots on forest ridges, sometimes in huge stands e.g. in the aloon-aloon of Mt. Gedé (between the crater rims of Mts Gedé & Gemuruh). A characteristic long-lived pioneer of volcanic ash screes, crater soils, etc., invading burned elfin forest but ultimately smothered by the latter, as its regeneration by seed is prohibited by the dense shade of its own stand and the litter beneath it.

In Java from Mt. Gedé east to Mt. Tengger, but rather rare in East Java, at 2000-3600 m. Also in Central Sumatra (Kerintji, Singalang) and S. Sumatra (Mt. Dempo), Celebes (Mt. Bonthain in SW. and Mt. Lokon in NE.), and the Lesser Sunda Is. (Bali & Lombok). Obviously only on volcanoes.

The scentless "Javanese Edelweiss" {*tjapo gunung,* Sumatra, ***sembung lango,*** **Mt. Gedé,** ***sendoro,*** **Papandajan,** ***widodarèn,*** **Ardjuno**) is a glorious plant. On Mt. Gedé pilgrims consider it a gift from heaven and take fragments down as a blessing, as is done in Bali on Mt. Agung. The latter mountain is so much stripped of it, that below the place of ascent (Besakih) farmers cultivate it for sale, in a similar way as is done with Edelweiss in the European Alps, to comply with the demand.

Seedlings grow slow; in sheltered spots on Mt. Sumbing trees may grow to 8 m tall with stems over 15 cm diameter, estimated at over 100 years old. The rough, fissured bark is full of lichens. Pollen is liberated in the morning; in the afternoon the stigmas become receptive. Many insects, bees, diptera, hemiptera, butterflies, thrips, etc. (but no bumble-bees) feast on the profuse corymbs of flowers in sunny weather and cross-pollination seems the rule, but on gloomy days selfing is not excluded. Flowering is largely from April to August.

2. Anaphalis viscida (Bl.) DC—Flora of Java 2: 393—Mt. Ardjuno. 11868.

Of similar stature as the preceding, but the leaves green, without white felt, viscid by glandular hairs, and flower heads larger.

In Java only on mountains subject to a dry monsoon, from Mt. Tjeremai east to Idjèn-Merapi, also on Mt. Rindjani on Lombok, at 1650-3250 m, in similar places as the preceding species but also on less sterile soils, glades in tjemara forest, locally often gregarious but not in such extensive stands as *A. javanica.* On Mts Ardjuno and Tengger both species occur but I have never seen them together.

3. **Carpesium cernuum** L.—Flora of Java 2: 397—Smèru homestead, between Mt. Tengger and Mt. Smèru. Gisius.

An erect, sometimes profusely branched herb with woody stem-base, up to over 1 m high, with solitary, nodding heads of a rather inconspicuous greenish-brownish colour supported by a whorl of small leaves, the stem leaves tapering to the base, 6-15 cm long.

In Java only on Mt. Tengger, locally common, at 2200 m, widely spread from South Europe through S. Asia to **Japan,** also known from N. Sumatra, Mt. Kinabalu (N. Borneo), and Luzon, at 1000-2400 m, often more or less as a weed in open places and light forest.

In the tropics it may be perennial, the root crown is thick, woody, **and** resembles a rhizome.

4. Gnaphalium purpureum L.—Flora of Java 2: 394—Tjibodas(Mt.Gedé).

A simple or branched annual, up to 75 cm high. Leaves spathulate, 1-8 cm long, green above, white-appressed woolly beneath, with apiculate tip. Flower heads clustered, collected in an interrupted spike-like whole.

Throughout Java, at 1000-2000 m, along trails and on talus, in waste places, cinchona and tea estates.

A native of the Americas, but thoroughly naturalized, also in Australia, New Zealand and New Caledonia. The Sundanese **name is *kembang urug.***

5. **Gnaphalium japonicum** Thunb.—Flora of Java 2: 394—Mt. Papandajan.

An erect, perennial herb, up to 60 cm high, little branched, not seldom emitting small runners from the root crown on which new rosettes of daughter plants arise. Leaves 1-9 **cm** long, 1-6 mm wide.

In West Java rare (Mts Tangkuban Prahu & Papandajan), eastwards to Mt. Idjèn, at 1850-3125 m, in open places, glades, often gregarious in thin turf of frost plains (Mt. Jang), sterile old crater soils, also in open tjemara forest. Also known from E. Asia, Central Sumatra (Mt. Kerintji), Luzon, and the Lesser Sunda Is. (Bali, Lombok, Timor). The Javanese name *hsindura* ***sabrang.***

6. Anaphalis longifolia (Bl.) DC.—Flora of Java 2: 393—Mt. Papandajan. 11665.

An erect, branched plant, sometimes slightly woody at the base, up to \\ m. The leaves are 3-16 cm long and 2-18 mm wide and are narrowed to the base. The stem **and** lower surface of the leaves is white, **rarely** yellowish, woolly (on Mts Tengger 6 Smèru), the upper surface is green when fresh and laxly arachnoid hairy. Most plants have heads with female ray florets and very few bisexual disk flowers.

In Java from Mt. Salak eastwards to Mt. Idjèn, in grassy wastes, on talus, along trails, both in mixed and in tjemara forest, often pioneering on lava rocks and volcanic ash slopes, at 1200-2850 m, rarely descending to 800 m. Also in Sumatra, all Lesser Sunda Is., S. Celebes, Morotai in the Moluccas, and New Guinea. Common but never forming stands as *A. javanica* and not woody.

Vernacular names are *tjapa gunung, ganjo gadang,* Malay in Sumatra, *sembung langu,* Sundanese, *kedusan* and *widodàren* in Javanese.

7 & **8. Gnaphalium luteo-album** L.—Flora of Java 2: 394.

An erect herb, mostly branched from the base, often flaccid, up to 50, sometimes to 80 cm high, greyish woolly, sometimes with canary-yellow heads, very polymorphous.

In Java from Mt. Salak eastwards, common but conspicuous and never gregarious, in dry sunny places, on talus, along trails, roadsides and in waste places, also in open tjemara forest, at 1700-3000 m, sometimes only 850 m. Widely distributed from Europe and Africa to India, China and Japan towards Australia, scattered through Indonesia. In Javanese called *sinduro.*

The form with lemon- to golden-yellow involucral bracts (fig. 8) is distinguished as variety *multiceps* Hook. f.

9. **Anaphalis maxima (O.K.) Steen.—Flora of Java 2:** 393—Mt. Sumbing. Loogen.

A tall, profusely **branched, lush plant, up to** 3 m high, woody at the base, whitish hairy, but the green of the leaf remaining visible. Stem and upper surface of the leaves with gland hairs. Leaves large, 6-14 cm long and i-2£ cm wide and with a truncate, almost auriculate base to the stem in which differing from all other species on this plate. Heads with only few disk flowers.

Endemic in Java, on few mountains and very local, on **Mts** Pangrango (below Kandangbadak), Tjikurai, Tjeremai, Dièng (G. Prahu), and Sumbing, at 2000-2800 m, in glades, open places in light forest, landslips and in scrub.

The bruised, sticky leaves emit an agreeable lemon scent. On Mt. Dièng called *sendora bengala* in Javanese.

PLATE 10

COMPOSITAE (continued)

1. **Centratherum frutescens** (Bl.) Clarke—Flora of Java 2: 371—Mt. Papandajan.

Erect or straggling coarse herb, up to 2 m. Heads solitary or 2-3 together, 1-2J cm diameter. Leaves beneath glandular and white-tomentose, 3-14 cm long, 1-4& cm wide.

In Java rare on Mt. Gedè, common from West Priangan Mts (Mt. Patuha) eastwards to Mt. Sindoro (also Mt. Wilis ?), in open places and scrub forest, along trails and humid localities, at 1500-2500 m. Also in SE. Asia (as *C. reticulatum* (DC.) Benth.).

2. **Dichrocephala chrysanthemifolia** (Bl.) DC—Flora of Java 2: 381—Mt. Ged<L

An erect, rigid herb, with patent branches, up to 70 cm high. Leaves 2-8 cm long, 1-3 cm wide.

Throughout Java from Mt. Gedé eastwards, at 1650-3300 m, in grassy, sandy or stony places, along trails and roadsides, and in light mixed and tjemara forest. From tropical Africa, Sokotra, through SE. Asia, to Luzon, Celebes and the Lesser Sunda Is. (Bali, Lombok, Timor).

In rock clefts at high altitude the stem-base and root-crown may become very thick and woody. The peripheral female florets open in the morning, the inner bisexual ones later in that day. They are not visited by pollinating insects. The nutlets have no pappus but are sticky.

3. **Ethulia megacephala** Sch. Bip.—Flora of Java 2: 370—Mt. Ardjuno. 11879.

A lush, branched perennial, up to 1J m high. Leaves gland-dotted beneath, 4-18 cm long, 1-5 cm wide. Flowers with an offensive smell.

In Java from Mt. Sumbing eastwards to Mt. Idjèn (but not yet found on Mts Tengger and Jang), in grass wastes, in mixed and tjemara forest, locally common, at (1000-) 1500-3000 m. Also found in Bali.

4. **Inula cappa** (D. Don) DC.—Flora of Java 2: 396—Mt. Ardjuno, near Tampuwono. 11724. 11878.

Rather stiff, aromatic perennial herb, }-ifc m high, the lower part woody. Younger parts densely yellowish to grey silky tomentose. Leaves 5-20 cm long, 1-5 cm wide, felted beneath.

In Java only on mountains subject to a dry monsoon, in West Java only on the summit of Mt. Parang (Krawang, at 934 m), otherwise only from Mt. Telemojo eastwards to Mt. Idjèn, at 1300-2600 m, rarely lower, in grassy wastes, jungles, and light tjemara forest, on Mt. Lawu locally gregarious. In SE. Asia from India to China; also in Bali and Lombok.

5. **Lactuca rostrata** (Bl.) O. K.—Flora of Java 2: 436—Mt. Pangrango.

A graceful, slender herb, up to 2 J m high, containing white, bitter latex. Stem hollow. Leaves very thin, pinnately dissected, up to 40 cm long, with 3-7 leaflets. Terminal inflorescence large. Only one head in flower at the same time on one branch.

In Java from Mt. Salak eastwards to Mt. Idjèn in light subalpine mixed and tjemara forest, in glades and on forest borders, at 1500-2700 m. Also in SE. Asia and possibly in Sumatra.

6. **Laggera alata** (D. Don) Oliver—Flora of Java 2: 390—Priangan.

Often much-branched annual plant, up to i£ m high. Stem with narrow crispy wings from the decurrent leaf-bases. Panicles terminal and axillary, leafy, up to 50 cm, rather narrow. Leaves serrate, hairy, 5-12 cm long, i-2j cm wide.

In Java from Tjiandjur and Purwakarta eastwards to Mt. Idjèn, mainly in grasslands, pastures, along roadsides, on grassy old lavastreams (rèdjèngans), mostly above 500 m, up to 2000 m. From South and tropical Africa and the Comores to SE. Asia, also in N. Sumatra (Atjeh, Toba Lands), Luzon, Celebes, the Lesser Sunda Is. (Bali, Lombok, Sumba, Sumbawa), and New Caledonia. In Sumatra Karo-Batak names are *si mar kurak kurak* and *si rukkas.*

7. **Rhynchospermum verticillatum** Reinw.—Flora of Java 2: 382—Rantja Gedé near Kertasari (Pèngalèngan). 11654.

A rather inconspicuous herb, up to 1 m high, at the top often with a whorl of short patent branches. Leaves 2-12 cm long, ±-4 cm wide.

In Java very rare and local, only in the Priangan mountains (S. Gedè above Tjiandjur and near Pèngalèngan), in open moist spots in the forest, at c. 1800 m. From India through China to Japan, also found in N. Sumatra (Atjeh; Mt. Kerintji) and on Mt. Kinabalu in N. Borneo, at 1300-2400 m.

8. Emilia prenanthoidea DC. forma **angustifolia** (DC.) Clarke—Flora of Java 2: 428.—Rantja Gedé near Kertasari (Pèngalèngan). 11651.

An ascending, sparingly branched, usually flaccid herb, up to 1 m high, rooting from the lower nodes, containing a white latex. Heads few. Stem slender, fragile; leaves sessile, auricled at the base, narrow, 4-12 cm long, 4-2 cm wide.

In Java characteristic of banks of swamps and lakes and damp places between reeds and high grasses, mainly in the Priangan mountains (Malabar, Patuha, etc.), at 1400-1700 m. The species occurs also in SE. Asia, Sumatra, and in New Guinea; the Javanese form is certainly indigenous.

PLATE tl

EXPLANATION OF PLATE 12

COMPOSITAE (continued)

1. **Conyza maxima** Zoll. & Mor.—Flora of Java 2:386—Mt. Papandajan. 11667.

A shrub up to 1 £ m high. The leaves often congested, 4-15 by 1-3 cm.

In Java from Mt. Papandajan eastwards to Mt. Idjèn, at 1500-2800 m, occasionally as low down as 1100 m (on Mt. Muriah at 700 m ?), in grassy wastes, brushwood, in mixed and in tjemara forest, locally often common. Also known from Bali and Lombok.

The nuts are provided with pappus hairs and are dispersed by wind.

2. **Senecio pyrophilus** Zoll.—Flora of Java 2: 426—G. Penandjaăn, a summit of the rim of the Tengger caldera. 11932.

A perennial herb, with very thick roots, up to 75 cm high, often rather flaccid, with somewhat glaucous foliage. The leaves arachnoid hairy on both surfaces, densest below, 2-10 cm long, 2-10 mm wide.

In Java only in the eastern part from Mt. Ardjuno eastwards to Mt. Jang, between 2000 and 2700 m, and found mostly in sterile places, on screes and volcanic ash plains, and invading burnt-over areas, also in tjemara forest. Also known from E. Timor (G. Tatamailau).

The ribbed nuts are on top provided with pappus hairs and are dispersed by wind.

3. **Gynura aurantiaca** (Bl.) DC.—Flora of Java 2: 425—Tjibodas.

A rather coarse, usually little-branched herb, erect when young, soon leaning or scrambling, up to 3 m long. The orange heads and purple hairs provide a lively contrast of this beautiful plant of which the flowers have, however, an offensive smell. The leaves are variable in shape, the larger ones with a pinnatipartite lower part, the smaller with an auricled base, 6-20 cm long, 4-12 cm wide.

In Java from Mt. Gedé eastwards to Mt. Wilis, in damp mixed forest, along trails, in thickets and shrubberies, near swamps, at c. 700-2400 m, along watercourses rarely descending to 325 m. Also in Sumatra, Celebes, and the Philippines, but its precise distribution can only be established after a comprehensive study of the genus.

The flowers turn purple with age. The brown, linear nuts carry thin pappus hairs on top and are dispersed by wind, but probably also by water (see above).

Vernacular names are *hareuga badak* in Sundanese, *{twruk) umjung* and *trasen* in Javanese. Heyne says that on Mt. Diëng pounded leaves are used against ringworm.

4. Myriactis javanica (Bl.) DC—Flora of Java 2: 382—Mt. Pangrango.

Erect herb, usually little-branched, up to \\ m high. Leaves 2-9 cm long and 2-4 cm wide. Heads flattish above with brightly coloured ligulate female ray florets and bisexual disk florets. The sticky nutlets have no hair pappus and are not dispersed by wind but by adhering to passing animals and possibly by water.

In Java from Mt. Gedé eastwards to Mt. Tengger, in elfin forest, along trails, subalpine grassland, and damp sterile places, at 1500-3100 m, also in N. Sumatra (Gajo Lands and the high mountains of Central W. Sumatra).

This is obviously a self-pollinating plant, as Docters van Leeuwen did not observe visiting insects. He observed opened anthers in the morning in bud and in the afternoon opened flowers with protruding stigmas covered with pollen. On Mt. Papandajan I observed dragonflies carrying the sticky nuts while on the wing in their bride's flight (see De Trop. Natuur 21:191.1932).

5. Sonchus **malaianus** Miq.—Flora of Java 2: 435—Mt. Papandajan. 11674. Mt. Tengger. 11935.

An often much-branched, coarse, white latex containing herb up to 2 m high. Stem hollow. Involucre of the heads and their stalk first often white-floccose. Stem in the upper part often glandular-hairy. Leaves with a sagittate base with rounded or acute basal auricles, 13-30 cm long, 1-4 cm wide.

In Java known from Mt. Salak eastwards to Mt. Idjèn, in grass-fields, thickets, along roadsides and trails, and in tjemara forest, at 1100-3250 m, rarely descending along streams lower down (e.g. in Tjiapus gorge of Mt. Salak, at 850 m), probably carried by water. Also known from N. Sumatra (Gajo Lands). A Javanese vernacular name is *kumindelan.*

The laterally compressed ribbed nuts carry on top numerous hairs and are wind-dispersed.

6. **Vernonia arborea** Buch.-Ham.—Flora of Java 2: 371—Trêtês, on Mt. Ardjuno.

A large tree, up to 36 m tall, with a thick bole up to over 1 m diameter, the younger parts short-hairy. Leaves 10-20 cm long, 3-8 cm wide. Heads in a wide corymb, each with 5-6 series of involucral bracts and containing 5-6 florets. Nuts glandular, with bristly straw-coloured pappus hairs, serving for dispersal by wind.

In Java throughout the island in forests, along forest borders and on ravine slopes, ascending from the lowland to c. 3000 m, in SE. Asia and throughout Malesia. It is more found in secondary forest than in true primary forest and easily invades tjemara forest. It may well be a long-lived pioneer species which can maintain itself in high forest. A careful study of its germination and regeneration in the latter is desirable.

It is a polymorphous species distributed from tropical SE. Asia through the entire Malesian archipelago as far as New Guinea. It belongs to a special section of a few species which are arboreous, in contrast to the many other herbaceous species of this genus.

Some common vernacular names are *bernaik, sarung-mornaik, sorì marnăek,* in Karo-Batak language, *bambirtmg* in Sundanese, and *sembung* in Javanese.

CRUCIFERAE (see also Plate 13-5/6)

7. **Nasturtium backeri** O.E. Schulz—Flora of Java 1: 191—Mt. Suket, the highest western summit of the rim of Mt. Idjèn caldera. 12167.

An erect annual herb, up to 1 \ m high. The simple, pinnately incised leaves are sagittate at the base and are 7-15 cm long. Flowers arranged in 20-60 cm long racemes. The pods borne on patent \~\ cm long stalks, with 8-20 small seeds in one row in each of the two cells.

In Java only on a few of the high eastern volcanoes (Merbabu, Wilis, Jang & Idjèn), at 1700-3000 m, in thickets, burnt-over areas and in tjemara forest, locally very common, but otherwise rare and not yet known outside Java. Also in Portuguese Timor on Mt. Tatamailau (18424) and common in **East New Guinea.**

PLATE 12

EXPLANATION OF PLATE 13

PODOCARPACEAE

1. Podocarpus neriifolius D. Don—Female flowers should not be attached as depicted—Flora of Java i: 90—Partly from Tjibodas (Mt. Gedé), partly from Mt. Papandajan. 12224.

In mature state a colossal tree, with a straight columnar bole up to 40 m high, unbranched for 15-20 m, diameter i(-ii) m. Leaves 4-23 cm long, f-2 cm wide. As in other species of this genus of conifers male and female flowers occur on different trees; male flowers in catkins, the females solitary, and stalked, the naked seed supported by a fleshy receptacle.

Throughout Java, in humid, primary forest, scattered, never in stands, at (400-) 1000-2600 m, even at high altitude a sizeable tree. From India to China, Formosa and throughout the Malesian archipelago and the Solomon Is., in still forested islands down to the lowland and said to reach 60 m height.

Some vernacular names are *ki tadji* (Malay, Sumatra), *ki bima* or *ki putri*$_y$ in Sundanese, *malẽla* in Javanese (Mt. Diẽng) and ***wuluan.***

An excellent timber tree for building and furniture.

2. **Podocarpus imbricatus** Bl.—A sterile twig and two fertile tips, one female, the other with 2 drooping male catkins—Flora of Java 1: 89—Tjibodas.

Stature as the preceding species, up to 50 m with a bole to 2 m through, even above 2500 m a stately tree to 20 m tall. Leaves of two kinds, narrow on short pinnate twigs and scaly on other twig ends, the fertile parts always on the latter. Seedlings and young trees carry only the former. Seed supported by a fleshy coloured receptacle.

Throughout Java, in humid mixed and tjemara forest, at 700-2900 m, but in N. Sumatra and New Guinea up to 3300 m, and in the New Hebrides found as low as 170 m. Common but scattered; on the south slope of Mt. Tjeremai it occurs dominant in a zone from 2400 to 2700 m altitude, a unique unexplained phenomenon. From Burma to China, throughout the Malesian archipelago, to the Bismarck Is. and the New Hebrides.

Some vernacular names are *ru* or *sampinur bunga* in Karo-**Batak, *ambun* in Minangkabau, and *{ki) djamudju, ki putri, ki*** *tjemara* in Sundanese.

As the preceding an excellent timber tree, probably exterminated in the lower deforested altitudes.

CONVOLVULACEAE

3. **Cuscuta reflexa** Roxb.—Parasitizing here on tjemara "needles"—Flora of Java 2:485—Tosari(Mt. Tengger).

A herbaceous winding plant which parasitizes mainly on woody plants and adheres to the host by means of haustoria, through which it sucks its food substances. It cannot produce its own organic food as other plants do by means of the green colouring matter chlorophyll, the entire plant is chlorotic and pale, often tinged pale reddish. It may gain colossal dimensions and hang in dense curtains or garlands up to 10 m long from high tjemara trees, but it parasitizes also on various other hosts. Haustoria may even become attached to itself.

In Java it is found in West Java on Tegal Pandjang (Papandajan) and further from Mt. Lawu eastwards to Mt. Idjẽn, at 1900-2700 m. Asia to Australia, also in Sumatra, Malaya, and New Guinea.

CRASSULACEAE

4. Kalanchoẽ integra (Medik.) O.K.—Flora of Java 1: 201—East Mt. Jang.

Erect or ascending fleshy herb, ±-i± m high, mostly branched. An ornamental plant, often largely leafless when flowering. Leaves with an entire or crenate to dentate margin, the lower leaves up to 30 cm long and 12 cm wide. Calyx J-i J cm long, the corolla also variable in size, its free segments J-i£ cm long.

In West Java only on the summit of a steep degraded volcanic ruin G. Parang (Krawang) at some 900 m, otherwise only in East Java, east of the line Malang-Mt. Dorowati (above Punten) on Mts Kawi, Jang & Idjẽn, at 1000-2250 m, in dry, sunny, rocky places, redjẽngans (old lavastreams), but also in tjemara forests, and on Mt. Dorowati even in mixed forest, particularly on the dry eastern slopes, locally often abundant, but also in the very dry lowland near Mt. Baluran and in Madura island. In Brazil, South Africa, and tropical SE. Asia, also in all Lesser Sunda Is., SW. Celebes, and the Philippines, always in dry spots. Flowering mainly in the dry season from June to October.

Easily grown; a leaf with a bit of the stem is sufficient to raise a new plant.

CRUCIFERAE (see also Plate 12-7)

5. **Cardamine hirsuta** L., sens. lat.—Flora of Java 1: 191—Mt. Papandajan. 11647. Mt. Ardjuno. 11876.

A herb with erect or ascending, later often hollow stems, 10-80 cm high, sometimes rooting at the nodes. Leaves very variable in number of leaf-segments (5 to 11), and their size (3-25 mm long, 1-25 mm wide). Racemes 3-22 cm long. Fruit not elastically dehiscent.

Through Java and Malesia (except in Borneo), mostly in moist places, often along small streams, also as a weed in cleared land, and in tjemara forest, at (700-) 1200-2600 m. Almost ubiquist over the world.

It seems to me that there is in Java an introduced form from Europe, but also a native one which has been described under various names.

6. **Cardamine africana** L. ssp. **borbonica** (Pers.) O.E. Schulz —An apical part of the raceme in fruit drawn separately—Flora of Java 1: 191.

A perennial herb with a solid, erect or ascending stem rooting .at the base, 12-80 cm long. Leaflets 3 (very rarely 1 in Papua), i-7i cm long, i-4 cm wide. Flowers 3-20. Pods 2H cm long, elastically dehiscent and flinging away both the valves and the seed leaving a reticulum.

All over Java, essentially a forest plant, also in secondary forest, in preferably moist places, in tjemara forest, and invading tea and coffee estates, often by trails, along streams, and by waterfalls, a common species, at 1100-2700 m. Also in Sumatra, the Lesser Sunda Is. and New Guinea. The species a tropical ubiquist.

CUNONIACEAE

7. Weinmannia blumei Planch.—a. In flower, b. flush—Flora of Java 1: 506—Above Purasẽda(SW. of Bogor). 11747.

A shrub or tree, 3-25 m tall, the trunk to 75 cm diameter. Leaf pairs separated at the base by two large, roundish stipules. Leaflets c. 9-13 on each leaf, 4-12 cm long, 1J-3 cm wide. Fruit a capsule, 4-5 mm long. Seeds many, hardly 1 mm long, at both ends provided with a plume of hairs 1 mm long.

All over Java, from Mt. Pulasari to Mt. Idjẽn, in forests, also in tjemara forest, and not rarely a pioneer on screes, lahars and ash-slopes, where very young plants may already flower and fruit (e.g. on Mt. Lamongan), at 800-2400 m. Widely distributed in the Archipelago.


5
3
4
1
7b
6
2
7a

EXPLANATION OF PLATE 14

CYPERACEAE (see also Plate 15-1)

1. Carex nubigena D. Don—One culm—Flora of Java 3: 494—Ranu Kumbolo (Sméru). Coert 15 74.

Tufted, up to 60 cm.—In Java on Mts Diëng, Kawi, Tengger-Sméru and Jang (tussocks around Taman Hidup), in marshy meadows, along streamlets and lake shores at 2000-3000 m, locally sometimes gregarious (Diëng). Ceylon and India to Formosa.

Deer feed on it (Mt. Jang); leaf-bases have a sweet taste.

2. Carex myosurus Nees—Inflorescence—Flora of Java 3: 493—Mt. Papandajan. 12267.

A tufted, tall sedge to 1 £ m high.—In Java from Mt. Gedé-Pangrango east to Mt. Idjèn, on dryland, in heaths and scrub and pioneer on sterile crater soil (dominant in the craterpit Kawah Lanang, Mt. Gedé), at 1700-3300 m. SE. Asia, Sumatra, Luzon, SW. Celebes (Mt. Bonthain), and Lombok.

3. Carex jackiana Boott—Culm top—Flora of Java 3: 490—Rant ja Gedé. 1165 6.

Lax tufts, up to 1 m.—In Java on Mts Patuha, Papandajan & Diëng, and near Ranu Kumbolo (Sméru), in marshy grassland, at 1500-2600 m. India to Korea, also on Mt. Kerintji (Sumatra).

4. Carex remota L. ssp. aha (Boott) Kiik.—Culm top—Flora of Java 3: 495—Mt. Papandajan. 11648.

Tufted, up to 80 cm high.—In Java from Mt. Patuha eastwards to Mt. Jang, in marshy grassland, at 1500-2500 m. India to China, also Sumatra (Mt. Kerintji).

5. Carex maculata Boott—Culm—Flora of Java 3: 489—Mt. Papandajan. 11662.

Tufted, up to 60 cm, spikes ± glaucous.—In Java on Mts Papandajan, Diëng & Jang, in boggy meadows, at 1800-2500 m. India to Japan, E. Australia & Samoa, also in Malaya, the Gajo Lands, Central Celebes & New Guinea (up to 3 500 m).

6. Carex longipes D. Don—Culm top—Flora of Java 3: 493.

Lax tufts, up to 80 cm.—In Jàva on Mts Patuha, Papandajan, Diëng, Tengger-Sméru & Idjèn, in swampy meadows, at 1500-2200 m. Nepal to Hupei, also in East New Guinea.

7. Carex phacota Spreng.—Culm top—Flora of Java 3: 494—Rawa Tjibitung(Mt. Papandajan). 11650.

Tufted, up to 1J m high.—In Java from Mt. Gedé eastwards to Mt. Jang in swampy grassland and shallow lake banks, on Tegal Pangonan (Diëng) in large, solid, hummocky tussocks 75 cm high and 50 cm thick in *Scirpus mucronatus* (14-17) stand, at 1500-2700 m. Ceylon to Japan, also N. half of Sumatra, Luzon, N. Celebes, and New Guinea.

Characteristic by purple-brown fibrously withering sheaths.

8. Carex capillacea Boott—Culm top—Flora of Java 3: 488—Mt. Papandajan. 11680.

Culms thin, inconspicuous, leaning, up to 50 cm.—In Java (Mt. Papandajan) in swampy stream valleys, at 2000-2500 m. Himalaya to Sachalin, New South Wales & New Zealand, also Sumatra (Gajo Lands; Mt. Singalang), N. Borneo (Mt. Kinabalu), Luzon, Central Celebes (Mt. Latimodjong), and New Guinea, at 1200-4000 m.

9. Carex graefTeana Boeck.—Culm top—Flora of Java 3: 494.

Densely tufted, to 1 m high. Fruiting spikes dark.—In Java only below the waterfall at Tjibeureum on Mt. Gedé, in a dominant stand, on swampy soil between rocks, at 1750 m. Samoa & Fiji to New Guinea, the Philippines, and N. Borneo (Mt. Kinabalu), 800-3800 m.

10. Cyperus flavidus Retz.—Culm top—Flora of Java 3: 471 *(nsC.g/obosus)*.

Annual herb, up to 60 cm.—Throughout Java in swamps and other wet places, also in rice-fields, rare in the lowland, ascending to 2100 m.

11. Fimbristylis consanguinea Kunth—Culm top—Flora of Java 3:464.

Tussocky tufted culms up to 90 cm.—In Java on Mts Patuha, Papandajan, Diëng & Jang, in swamps, swinging bogs, lake edges, often dominant (together with 14-1 & 14-15), at 1600-2500 m. Also in Africa and SE. Asia.

12. Gahnia javanica Zoll. & Mor.—Inflorescence, leaf tip—Flora of Java 3 : 483.

Coarse, leafy stems up to ij m, forming thick tussocks; woody rhizome. Inflorescence dark-brown. Leayes sharp-edged. Nuts dangling out, finally black, held by the elongated filaments.

In Java from Mt. Karang east to Priangan, further Mts Diëng & Sumbing, a pioneer near craters and solfatara, at 1600-2700 m. SW. China and throughout Malesia, 1200-3560 m, mostly on non-volcanic rock.

The sheath-base and stem-base pith have a delicious taste of sweet nuts. The Sundanese name is *serèh wulung.*

13. Heleocharis tetraquetra Nees—Culm top—Flora of Java 3:461.

Tufted, leaves reduced to basal sheaths, culms (-1 m, sharply edged.

In Java on Mts Gedé, Patuha, Papandajan & Diëng, in swampy places, swinging bogs, at 1000-2500 m. From Ceylon to Japan and Australia, throughout Malesia.

14. Cyperus melanospermus (Nees) Valck. Sur.—Culm top—Flora of Java 3: 470—Rarahan(Mt. Gedé).

Tufted, leafless culms, up to if m. Nut black.

Throughout Java, in swamps, at 1650-2200 m. Africa through Malesia to Fiji, in New Guinea 75-2500 m.

15. Rhynchospora rugosa (Vahl) Gale—Culm top—Flora of Java 3: 484.

Tufted, 30-75 cm high, sometimes forming tussocks (Mt. Jang).

In Priangan Mts (Burangrang, Patuha, Papandajan), Diëng & Jang, with sedges *Eriocaulon* and *Xyris* in shallow lakes, and edges of bogs, at 1600-2100 m. Worldwide distributed, also in Malaya, Sumatra, Philippines, New Guinea (1000-2800 m), at Pajakumbuh once at 500 m and in Sarawak at sea-level.

16. Scirpus fluitans L. — Flora of Java 3:458.

Floating in streamlets to 40 cm long, terrestrial forms shorter, crowded.

In Java from Mt. Gedé east to Mt. Jang, at 1800-3200 m. From Europe to Australia, but nowhere else in Malesia.

17. Scirpus mucronatus L.—Culm top—Flora of Java 3: 459.

Stiff, erect, 3-sided culms up to 1 m, with sheath at base.

Throughout Java in swamps and pools, from sea-level to 2100 m, often gregarious, e.g. on Mt. Diëng, in roundish "islands" in shallow lakes.

DROSERACEAE

18. Drosera peltata J.E.Sm.—Flora of Java 1: 203—Mt. Idjèn, on redjèngans near Sempol. 11966.

Delicate herb, sprawling among grass, 15-40 cm long, sometimes branched, with a small subterranean tuber. Small insects are caught by the red, viscid glands on top of hairs along the leaf margin which bend inwards and produce a protein-dissolving fluid by which the insects are digested.

In Java on Mts Wilis, Tengger & Idjèn, in grassy, stony or other open places, at 900-2000 m. From Ceylon to Japan, Australia & Tasmania, also known from Bali, Lombok, Timor, S. Celebes, Luzon and New Guinea (up to 3225 m).

The flimsy flowers wilt very soon; afterwards the corolla becomes marcescent and covers the fruit. There is always only one flower open.

ELAEAGNACEAE

19. Elaeagnus conferta Roxb.—Part of flowering branch and a single orange berry—Flora of Java 2: 86.

An irregular-branching sprawling or climbing shrub up to 5 m, all its parts with characteristic, appressed, brown scales. Branches often armed with thorns. Leaves 8-15 cm long, 4-7 cm wide. The flower consists of a tubular perianth which is halfway constricted to envelope the ovary, above the constriction it continues into 4 lobes. When setting fruit these lobes are caducous, but the tubular part swells considerably into the orange berry-like envelope concealing the proper 1-seeded fruit.

All over Java in forests and thickets and along streams and gravelbeds, at 1000-15 00 m, widely distributed in SE. Asia and in Malesia.

The species is variable and is possibly only a race or form of a much wider concept, *E. latifolia* L.

I'L \TK 14

CYPERACEAE (see also Plate 14-1/17)

1. **Carex** baccans Nees—Culm in fruit—Flora of Java 3: 493—Tjibeureum (Mt. Gedé).

A sturdy species in dense large tufts, to over 1 m high; the only species of this genus with lively coloured berries.

All over Java, preferably in more or less open places like trails, forest fringes, near craters, in sand seas, often on landslips and talus where the big tussocks are very useful in holding the earth; rarely in the depth of the forest, 1000-3300 m. Also known from SE. Asia, Sumatra, Malaya, the Philippines, Celebes, Bali, Lombok, and New Guinea. Never found in Borneo!

SAURAUIACEAE (formerly reckoned to *Dilleniaceae)*

2. **Saurauia bracteosa** DC.—Flora of Java 1: 326—Tjibodas (Mt. Gedé).

A small tree, 3-15 m tall. Leaves 18-36 cm long, 8-18 cm wide, felty grey or brown hairy beneath. The axillary inflorescences carry two large, leaf-like bracts at the top surrounding the flowers, but the inflorescence finally much larger and more branched than the young one depicted here. Ovary hairy.

All over Java, in forest, preferably in less gloomy places, along streams and in valley bottoms, at 600-2100 m. Also in Sumatra and SW. Celebes (Mt. Bonthain).

In the undergrowth of the rain-forest the genus *Saurauia (ki lèho* in Sundanese) is represented by more than a dozen species. They have in common a white waxy corolla, the lobes of which are ring-like connate at the base and carry there a large number of stamens with yellow anthers. These corollas are often found on the forest floor, as the small trees usually flower abundantly. In some species flowers are borne from the old wood on trunk and branches.

ELAEOCARPACEAE

3. **Elaeocarpus pierrei** K. & V.—a. Two leaves, b. flowers, also in bud and one beyond, and below a stone, cleaned from a fruit pictured in c—Flora of Java 1: 398—Mégamendung (Mt. Gedd). 12196.

Tree, 10-25 m taH- Leaves 8-20 cm long, 3-7 cm wide. Flowers in racemes, mostly only few or one leading to fruit. Fruit 4-6 cm long, a drupe containing a single, extremely hard stone (pyrene) containing the seed(s).

All over Java, in forest, at 600-2000 m. Also in West & N. Central Sumatra.

I have found kernels in which a hole was gnawed by animals (which?) to reach the seed, an almost unimaginable achievement.

This tree genus comprises in Java some dozen species, which have all the same fruit structure and that of the flowers which possess fringed petals.

4. Sloanea sigun (Bl.) K. Sch.—Only an opened capsular fruit drawn—Flora of Java 1:400.

A tree, 10-40 m tall, to 80-120 cm diameter. Leaves ovate-oblong, cordate at base, 6-23 cm long, 3-12 cm wide. Flowers rather smallish, axillary, inconspicuous, pale yellow; calyx lobes |-i cm long, petals pale, i-ij cm long, short-lobed at the top. Seeds glossy black-brown, provided with an orange to dark red aril, within the 3-5-valved, thick-walled capsule.

Throughout Java, in forest, locally sometimes almost dominant, at 800-2100 m. Also known in Burma, Cambodia, and Sumatra.

EPACRIDACEAE

5. **Styphelia javanica** (De Vriese) J.J.S.—Flora of Java 2: 184—Mt. Ardjuno.

A creeping, much-branched, often mat-forming dwarf shrub, 10-30 cm long, with scaly runners. Leaves glaucous beneath, 6-13 mm long, i£-2 mm wide, ending in a needle tip. Flowers fragrant, densely white hairy inside.

Endemic in Java, only known from Mts Ardjuno, Penangunan & Kawi, Tengger-Sméru & Jang, in sunny, sandy or stony places, occasionally also in sparse tjemara forest, locally common, even gregarious, at 1650-3300 m.

This is the only representative of this largely Australian family in Java. In the Tengger sand sea (Dasar) it is a sand-binding pioneer forming low dunes, on Mt. Penangunan it occurs interlaced in low mats with the tussock grass *Festuca* ***nubigena(n-ii).***

ERICACEAE (continued on Plates 16 and 17)

6. **Diplycosia heterophylla** Bl.—Flora of Java 2: 181—Mt. Salak.

A small shrub, 3-3 m. Leaves variable in shape, lanceolate to obovate, 3-14 cm long, i±-8 cm wide. The urceolate corolla is dull greenish, axillary. Ripe berry sky-blue.

Common in West Java, rare in Central and East (Mt. Tengger), mostly epiphytic, in the mossy or elfin forest, on ridges sometimes terrestrial, at 1000-2700 m, rarely as low as 700 m. Also in Thailand, Malaya, Sumatra (up to 3300 m), Bali, Lombok, Borneo, and Mindanao.

7. **Diplycosia pilosa** BL—Flora of Java 2: 181—Near Tjibeureum (Mt. Gedé). 11686.

A small epiphytic shrublet, 1-2 m, with slack hanging twigs, typically coarse-hairy. Leaves 3-6 cm long, 1-2& cm wide.

Endemic in West Java, only on Mts Halimun (above Nirmala), Salak & West Gedé (Gegerbintang and Rawa Dènok), in mossy and elfin forest on ridges.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3b
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ERICACEAE (continued)

1. **Rhododendron album** Bl.—Flora of Java 2: 180—Puntjak Pass (Mt. Gedé). 11696.

Epiphytic shrublet, 1-2 m. Leaves stiff, brown-scaly underneath, 5-12 cm long, 2-3 cm wide. Corolla with scattered brown scales. Stamens 10.

Endemic in Java and rare, only in West Java on Mts Halimun (above Nirmala), Salak & the western spurs of Mt. Gedé, always epiphytic in trees, mostly on mountain ridges, at 1200-1700 m.

The flowers were originally by error described and depicted as being white *("a/bum"* in Latin).

2. **Rhododendron citrinum** (Hassk.) Hassk.—Flora of Java 2: 180—Tjibeureum (Mt. Gedé). 11716.

An epiphytic shrub, up to 1 m diameter, smaller than the former species. Leaves pale green beneath and not stiff, 24-5 cm long, i£-2£ cm wide. Corolla without scales. Stamens only 5-

In Java on Mts Salak, Gedé & in Priangan (Patuha, Galunggung, etc.), rather rare, on high trees and on ridges also in elfin thickets, sometimes found together with *R. javanicum* and *R. walayanum.* Also in Sumatra and Bali.

3. **Rhododendron javanicum** (Bl.) Benn.—One maturing fruit crowned by the persistent style is drawn in poise in the just expanding inflorescence—Flora of Java 2: 179—Tjibeureum (Mt. Gedé).

A branched shrub, up to *z* m high. Leaves, as is often the case in this genus, crowded at the nodes, 4-15 cm long, 2 £-6 cm wide. In flower colour varying from light salmon to dark orange, and varying with age too, withering pale; in bud the corolla is sometimes lemon-yellow but gains a salmon-red in expanding. The early caducous bracts are pale pink. The corolla varies in size, and smaller-flowered specimens are known. The pedicel is hairy or scaly. As usual in the genus the pod dehisces with finally recurving valves, releasing an immense number of extremely fine seed.

In Java from Mt. Karang eastwards to Mt. Tengger, mostly epiphytic in the forest, but also terrestrial on stony ridges, rocks near waterfalls, lavastreams, and crater rocks and screes, sometimes close to solfatara, at 800-2400 m, rarely descending to 500 m; at lower altitude always epiphytic. Also known from Sumatra, Banka, Lingga & Natuna Is., and Bali, but not in Borneo; a variety in the Philippines and NE. Celebes.

4. **Rhododendron loerzingii** J.J.S.—Flora of Java 2: 180—Mt. Sumbing. Loogen.

A terrestrial shrub, rather profusely branched, to *z* m high. Leaves 6-9 cm long, 2^-3 J cm wide.

Endemic in Central Java, on Mts Sumbing, Merbabu & Tierep, in light low forest and grassy slopes of open country, at 1800-2000 m.

5. **Rhododendron malayanum** Jack—Flora of Java 2: 180—Tjibeureum (Mt. Gedé). 11690.

An epiphytic shrub, £-2 m through. Leaves 5-10 cm long, 1-3 cm wide, densely brown-scaly underneath.

In West Java from Mt. Halimun (above Nirmala) eastwards to the Priangan Mts, mostly in scrub forest on ridges at 1100-2200 m. Throughout the Malesian archipelago, but not yet found in New Guinea.

6. **Rhododendron retusum** (Bl.) Benn.—One withered, old, dehisced capsule also drawn—Flora of Java 2: 180—Tjibeureum (Mt. Gedé).

An exclusively terrestrial shrub or treelet to 5 m tall, mostly densely branched. Leaves 2J-4 cm long, 1J-1J cm wide. The shape of the flowers is somewhat variable, and so is their colour ranging from brick-red to more orange-red in different shades.

Common in West Java from Mt. Karang to the Priangan Mts, in Central Java only on Mts Diëng & Merapi, in East Java only on Mt. Ardjuno, on ridges, screes, rocky slopes, often especially in the vicinity of craters and near solfatara, and a pioneer in dwarf size in the latter extreme localities, at 1400-3400 m. Also throughout Sumatra, in the Gajo Lands on non-volcanic mountains. Around solfatara sometimes (e.g. in Papandajan crater) forming "wind-clipped" forms through the poisonous sulfuric fumes growing as "Spaliere" with minute leaves and even rooting stems.

Docters van Leeuwen found the flowers protandrous. "During anthesis the style elongates and the then receptive stigma brushes past the anthers, coming into contact with pollen-masses which hang down from the anthers in threads. At the bottom of the corolla nectar is secreted. The flowers are visited by small honey birds and bumble-bees, which apparently take part in the pollination".

7. **Rhododendron zollingeri** J.J.S.—Flora of Java 2: 180—Mt. Sumbing. Loogen.

A terrestrial shrub or treelet, up to 4 m high. Leaves 3J-5J cm long, 1 J-i J cm wide. Leaves *i\-}* cm long, 1 J-iJ cm wide. The limb of the corolla never expands flat.

In Java only in the eastern half, on Mts Diëng, Sumbing, Sindoro & Jang, rare, on ridges and in light forest, also tjemara forest, bare slopes, volcanic rocks and crater walls, near solfatara and then dwarfed into a compact cushion-like miniature, locally sometimes common, at (i2oo-)i800-3100 m. Also in Bali and Lombok, the southern half of Celebes, and Luzon.

The flowering takes predominantly place in the dry season between April and October.

PLATE 16

EXPLANATION OF PLATE 17

ERICACEAE (continued)

i. **Gaultheria fragrantissima** Wall. ssp. **punctata** (Bl.) Steen., comb. nov.—A flowering branch and some fruits separately at right side bottom—Flora of Java 2: 181 (as *G. punctata* Bl. Bijdr. 856. 1826)—Tjibeureum (Mt. Gedé). 11691.

An often strongly branched shrub to 2 m high or higher. Leaves pale and glandular-punctate beneath, 5-10 cm long, 1-4 cm wide, aromatic.

In Java from Mt. Salak eastwards to Mt. Jang, locally common on open ridges, near craters, and a pioneer in rocky volcanic places, at 1400-3100 m. Himalayan tracts, also in Sumatra (1000-3700 m) and in Bali (Mt. Agung).

Especially from this *Gaultheria* species the leaves and other parts give an agreeable strong aromatic smell of wintergreen oil when crushed. The people take *tjantigi wangi* (in Sundanese) or *gandapura* (Javanese) for extracting this oil and use it against several ailments, mainly rheumatism. Its constituent, methyl-salicylate, is also a strong antiseptic. It is also used in hair oil and to perfume sarongs. The fruits are sweet, with a bitter aftertaste, but cannot be called edible.

The Malesian specimens differ from those of the Himalayas and Khasya Mts, but the differences are merely quantitative and in my opinion insufficient for specific distinction, just good enough for racial distinction.

Tjantigi is a supergeneric vernacular name for both *Gaultheria* and *\dccinittm.*

2. **Gaultheria leucocarpa** Bl.—A flowering branch and in reversed position on it a bunch of pink fruits—Flora of Java 2: 181.

An erect branched shrub to 2 m tall, differing clearly in leaf-shape and arrangement of the flower racemes from the former. Also aromatic, but less so than the former. Leaves 4-14 cm long, 2-6 cm wide. Berries whitish or with a pink shade (as here), rather variable in shape.

In Java from Mt. Halimun (above Nirmala) eastwards to Mt. Idjèn, on open stony places preferably near craters etc., in the same places as the former, but much more common. In SE. Asia from Upper Burma, Indo-China and S. China to Formosa, also in Malaya, Sumatra and the Philippines, Some varieties are distinguished on minor variations in hairiness of floral parts and colour of the berry.

According to Docters van Leeuwen flowers remain open for up to 5 days and are seldom visited by insects, mainly bumble-bees. The pollen is sticky and self-pollination seems the rule. The fruits are eaten by birds.

3. **Gaultheria leucocarpa** Bl. var. **melanocarpa** J.J.S.—Only a bunch of fruits—Flora of Java 2: 181.

Different from the former by the fruit colour and the short-pubescent inflorescence.

In Java from Mt. Lawu eastwards to Mt. Idjèn, in the same places as the former, at 1200-3300 m. Also in Sumatra and Malaya.

4. **Gaultheria nummularioides** D.Don—Flora of Java 2: 181—Kandangbadak (Mt. Gedé).

A creeping, miniature, mostly branched plant, with rooting stems and nodding solitary flowers and berries. Leaves 6-13 mm long, 5-9 mm wide.

In Java from Mt. Gedé eastwards to Mt. Idjèn in open sunny rocky places, on volcanic ash, steep crater slopes, largely from 2000-3500 m, rarely lower (to 1300 m), sometimes a trunk-base epiphyte in moss in ridge forest. Himalayas to SE. Tibet and W. Szechuan, Assam and Upper Burma, also in Sumatra and Bali.

According to Docters van Leeuwen flowers would be protandrous, and last only one day and are self-pollinated.

5. **Vaccinium korthalsii** Miq.—A flowering branch with flush and some maturing fruits, all in natural poise—Flora of Java 2: 184—Tjibodas (Mt. Gedd).

An epiphytic shrub to 4 m long, slack, with pendent branches, thick leaves and waxy corolla. Leaves 6-10 cm long, 2I-4 cm wide. The secund flowers are sometimes whitish and are fragrant.

In Java from Mt. Karang to the Priangan Mts, possibly also on Mt. Lamongan (East Java), in forest and forest borders, rarely on rocks, at 600-2000 m. A beautiful species. Also in Sumatra and Bali.

6. **Vaccinium laurifolium** (Bl.) Miq.—Twig with one leaf and 2 racemes of flowers and a stem tip with red flush; no fruit —Flora of Java 2: 183—Mt. Papandajan. 11675.

A large shrub to 4 m through, very pretty when covered with abundant flowers and flush. Leaves 4-15 cm long, 2 £-74 cm wide. Flowers secund, fragrant; honey is secreted by a yellow disk on top of the ovary. Berry globose, deep purple, 5-6 mm diameter.

All over Java, mostly epiphytic, but also on stony slopes and ridges, in mixed and tjemara forest, also near solfatara of craters, common, at 800-1400 m more rarely flowering than from 1400-3000 m. Also in Sumatra and the Lesser Sunda Is. (Bali to Sumbawa).

A variable species of which several varieties are distinguished. Docters van Leeuwen supposes that the plant is self-pollinated, although visiting insects are observed. The berries are greedily eaten by birds, as in the following species.

7. **Vaccinium lucidum** (Bl.) Miq.—Flora of Java 2: 183—Tjibodas (Mt. Gedé).

Normally an epiphytic shrub, £-6 m, if terrestrial a stiffly erect broom-like shrub to 2-3 m. Leaves 1 £-2J cm long, \-\\ cm wide. Berries (not drawn) globose, c. 5-6 mm diameter.

All over Java, in tall forest but also in elfin and mossy forest, at 1500-3150 m, very rarely lower. Also in Sumatra, the Lesser Sunda Is. (Bali to W. Flores) and the southern half of Celebes.

The flower colour varies and two different ones from two different places are depicted on one twig.

After germination the young seedling develops very soon a tuberous hard hypocotyl (stem-base?) and also swollen roots. This lignotuber can reach a handsome dimension. Whether this tuber has a function is very doubtful as in the everwet rain-forest there seems little necessity for storage of nutritive matter or water. Also some other members of the *Ericaceae* possess such thickened stem-bases.

8. **Vaccinium varingiaefolium** (Bl.) Miq.—A flowering branch tip, left of which a bit of the red flush and one mature berry—Flora of Java 2:183.

An always terrestrial shrub or treelet, often broom-shaped, mostly gnarled or crooked, up to 10 m tall, the trunk up to 50 cm through. Wood very hard. Leaves 2J-6 cm long, 1-2J cm wide. Berries edible, but rather tasteless.

All over Java over 1350 m altitude, but especially common from 1800-3340 m, the main constituent of the elfin brushwood and mossy forest on ridges, slopes and summits. Its dominance can easily be observed when its red flush colours the summit forest. With *Rhododendron retusum* (16-6), *Myrsine* (32-9), the ferns *Histiopteris incisa, Selliguea (Pleopeltis) feei*, and *Dianella javanica* (28-2) the most resistant against the sulphur fumes and poisonous soil of craters. Also in Malaya, Sumatra, and Bali.

PLATE 17

EXPLANATION OF PLATE 18

BORRAGINACEAE

1. **Cynoglossum javanicum** (Lehm.) DC.—Flora of Java 2: 463—Mt. Tengger. 11930.

A branched, erect, hairy herb, 1-1J m high. Leaves very variable in shape and size, the lower ones large (up to 20 cm long and 4 cm wide), on a petiole, the upper ones smaller and almost sessile. Corolla pale to sky-blue, its flat limb 6-17 mm across. The tip of each spike cincinnately rolled. Fruit reflexed, surrounded by the calyx, consisting of 4 nutlets each some 3-4 mm long, provided with drag-shaped bristles.

Throughout Java from Mt. Gedé to Mt. Idjèn, in grassy terrains, along roadsides, fallow fields, and in light tjemara forest, at 1100-2900 m. Also in the northern half of Sumatra, SW. Celebes (Mt. Bonthain), Bali, Lombok, Flores and New Guinea.

CUCURBITACEAE

2. **Bryonopsis laciniosa** (L.) Naud.—One leaf and 2 fruits—Flora of Java 1: 301—Puntjak Pass (Mt. Gedé). 11540.

Climbing herb 2-4 m long. Leafstalk 2-10 cm long, blade to 6-20 cm long, 7-22 cm wide, hairy when young, glabrous when adult, rough when dried. Flowers in bundles, either male or female, but on the same plant, the latter with an ovary. Fruit 2-3 cm long. Seeds embedded in slime, thickened on the two broad sides.

In Java from Mt. Gedé to Mt. Panderman (above Punten), in brushwood and forest fringes, at 600-1800 m, rarely in the lowland. Tropical Africa, through SE. Asia to Australia; also in Celebes, the Philippines and New Guinea.

3. **Gynostemma pentaphyllum** (Thunb.) Makino—Flora of Java 1: 306.

Climbing herb 4-8 m long. Leafstalk 3-7 cm, blade to 4-15 cm long, 2-5 cm wide. A tendril is inserted beside the leaf on the same side of the stem. Twig-ends and inflorescence drooping, the latter to 30 cm long.

In Java in open forest and brushwood, at 600-2300 m, rarely lower. Tropical SE. Asia, also in Sumatra, Borneo, the Philippines, Celebes, the Moluccas and New Guinea.

In the sterile state it may be confused with some species of *Cayratia (Wtaceae),* in which, however, the tendril is inserted opposite a leaf.

4. **Melothria leucocarpa** (Bl.) Cogn.—Female—Flora of Java 1: 297—Tjibeureum (Mt. Gedé). 11715.

Climbing herb, a few metres long. Leaves 4-10 cm long, 5-7 cm wide, above roughish with fine warts. Female flowers (and fruit) usually solitary or in twos, male flowers (not drawn) 4 or more together in a leaf axil. Fruit f-i£ cm long. The seeds are smooth and not margined.

All over Java in brushwood, hedges and forest fringes, sometimes in dense garlands, at 50-1500 m. SE. Asia, also in Sumatra, the Philippines, the Lesser Sunda Is., the Moluccas and New Guinea.

EUPHORBIACEAE (see also Plate 19-4/5)

5. **Antidesma tetrandrum** Bl.—Fruiting twig, one female inflorescence separately—Flora of Java 1: 458—Tjibodas (Mt. Gedé). 11711.

A common shrub or tree 3-19 m high. Leafstalk to i£-3± cm, when young at the base with two conspicuous large, leafy stipules which are early caducous. Leaves 7-20 cm long, 3-10 cm wide. Flowers either male or female, and on different plants.

All over Java in mixed forests and thickets, at 600-1500 m, rarely lower or higher. Also known from Sumatra (down to sea-level!) and Bali.

The drupe which contains a pyrene is edible but sour. *Ki seu'eur* in Sundanese.

6. **Breynia microphylla** (T. & **B.)** M.A.—Flora of Java 1: 465.

Abundantly branched shrub 2-5 m high. Twigs and leaves in two rows (alternate), the branches in the axil of a bract (not a leaf). Leaves 2-3 cm long, 1-1 \ cm wide. Flowers either female (as here) or male, both occurring on the same plant. The ripe fruit breaks up into three 2-valved parts each of which containing 2 seeds with a red sarcotesta.

All over Java in more or less sunny places, in hedges, and forest fringes and secondary forest, a common species, mainly from 600-2000 m, but also lower; also in Sumatra and Celebes.

In Sundanese *tjetjèrèn'ean.*

7. **Glochidion rubrum** Bl.—Twig with a female flower and a fruit—Flora of Java 1: 464—Puntjak (Mt. Gedé). 11709. Mt. Papandajan. 12263.

Shrub or tree, 2-18 m high. Twigs mostly glabrous. Leaves 5-12 cm long, 2-4 cm wide, somewhat oblique. Flowers either male or female, both on the same plant. Fruit 3-5-lobed, dehiscing into 3-5 one-seeded cocci.

Throughout Java common in forests, thickets, villages, secondary growths, and along trails, from sea-level up to 2400 m. Throughout the Archipelago, but not yet collected in the Moluccas and New Guinea.

H-ATE IS

EXPLANATION OF PLATE 19

ERIOCAULACEAE

1. **Eriocaulon sollyanum** Royle—Flora of Java 3: 26—Mt. Papandajan.

A glabrous herb, the culms 7-3 5 cm tall. Leaves 3-10 cm long. The receptacle of the heads densely long-hairy.

In Java on the Priangan Mts (not on Mt. Gedé), on Mts Diëng & Jang (Taman Hidup), locally common, sometimes in dense tufts, in marshy places, and swinging bogs, at 1500-2000 m. Also known from SE. Asia and Sumatra (as low as 750 m), and from New Guinea.

2. **Eriocaulon brownianum** Mart.—One culm, contracted, being too long to draw as a whole, with sheath and apical part of a leaf—Flora of Java 3: 25—Mt. Patuha.

As the former with a rosette of leaves and the flower heads on a scape, but much coarser and up to 1 m high. Stem and leaves fine hairy to a degree. Leaves 10-80 cm long, £-2 cm wide.

In Java in swamps and on marshy banks of lakes (rantjas), only known from Mts Patuha (Telaga Patèngan, Rantja Walini), Pèngalèngan (Rantja Gedé) & Diëng, where this conspicuous plant is common, even gregarious, often together with ***Sphagnum*** **and associated with *Machaerina, Xyris* (57-1), *Juncus* (14-i), *RAjncbospora* (14-15),and JWr^or (14-17), at 1600-2300 m.** Also in SE. Asia and in Atjeh and in the mountain swamps and lakes of Sumatra's Westcoast.

DAPHNIPHYLLACEAE

3. **Daphniphyllum glaucescens** Bl.—A male flowering twig, a loose female inflorescence and a bunch of fruits—Flora of Java 1: 505—Puntjak(Mt. Gedé). 11700.

A treelet or tree up to 15 m tall, rarely up to 30 m. Leaves glaucous beneath, 7-19 cm long, 2-4 cm wide. Flowers in short racemes, greenish and inconspicuous, males and females on different plants.

Throughout Java in forest, not rare on ridges, at 600-2000 m. Also in SE. Asia and the islands of West Malesia.

The genus *Daphniphyllum* was formerly mostly included in the *Euphorbiaceae*, but now mostly kept apart as belonging to a separate family.

EUPHORBIACEAE (see also Plate 18-5/7)

4. **Euphorbia javanica** Jungh.—Flora of Java 1: 502—Mt. Ardjuno.

An erect, perennial, branched, robust plant, with milky juice, J-ii m high, often having more than one stem from the root, stems woody at the base. Leaves more or less heaped at the ends, 5-10 cm long, J-i J cm wide, the lower parts of the stems with many leaf-scars.

In Java known only from Mts Ardjuno, Kawi, Tengger, Jang & Idjèn in East Java, in forest borders, forest glades, along forest trails, characteristic of tjemara forest, almost always gregarious, and sometimes carpeting the forest bottom, at 1300-2800 m. From India to China, in Malesia also in the Lesser Sunda Is. (Bali, Lombok, Flores and Timor), and on Mt. Bonthain in SW. Celebes.

5. **Homalanthus giganteus** Zoll. & Mor.—Flora of Java 2 : 498 (as *Omalanthus)*—Mt. Ardjuno. 11829.

A large, rapid-growing tree, with milky juice, 15-30 m tall. Leaves peltate and large, 5-40 cm long, 5-30 cm wide. Buds enveloped in the spindle-shape rolled large stipules. Flowers in a spike, rather few, lower ones female and developing into fruit, the upper ones male and mostly disappeared when fruit is mature.

In Java only in the eastern part, from Mt. Wilis eastwards to Mt. Idjèn, especially along ravines, in grassy areas, and thickets, characteristically invading tjemara forest as a pioneer tree preparing the ground for later developmental stages of the mixed forest, together with *Vernonia* (12-6), *Dodonaea* (49-5), ***Trema orientalis, Parasponia parviflora,*** **and species of *Rubus* and** *Cucurbitaceae*, locally often numerous, at 1000-2300 m. Also occurring in all the Lesser Sunda Is.

In old trees leaves are smaller in size and seem also to become hardly peltate at the base, thus obscuring one important difference with the common *Homalanthus populneus.*

The generic name was (obviously by error) originally written as *Omalanthus*, but soon corrected to *Homalanthus*, the name being derived from the Greek words *homálos*, meaning flat, and *anthos*, which is flower, alluding together to the compressed male flowers.

PLATh 19

EXPLANATION OF PLATE 20

GENTIANACEAE

i. **Crawfurdia trinervis** (Bl.) Dietr.—Node with 2 leaves, one flower and one fruit—Flora of Java 2: 439—Kandangbadak (Mt. Gedé).

A slender glabrous herb, twining to the right, 1-2 m long. Leaves 2-7 cm long, 1-4 cm wide, pale underneath. Flowers solitary in an axil. Flower stalks at least 1 cm long, often longer. Calyx about half as long as the corolla, the latter 2-3 cm long. Fruit an ellipsoid berry.

In West Java only, from Mt. Salak to the Priangan Mts, in shaded places, forest borders, thickets, elfin forest and mossy forest on ridges, at 1900-3000 m. SE. Asia, also in Malaya (once found), Sumatra, and Celebes.

In Malaya, Sumatra and Priangan (Papandajan & Mt. Kendeng near Pèngalèngan) a closely related second species is found, in similar places and of similar habit, *C.fasciculata* Wall., which has several short-stalked (4-6 mm) flowers per axil and a larger corolla (c. 3 £-4 cm) (Flora of Java 2:440).

The genus *Crawfurdia* differs from *Gentiana* only in the climbing habit which is to some botanists not of sufficient value for its keeping apart.

2. **Gentiana quadrifaria** Bl.—a. A specimen from exposed places, b. one grown up in the shade—Flora of Java 2: 440—Mt.Gedé.

A small annual herb, with a long taproot branching from the base, often contracted into a semi-globose cushion. Leaves 2-10 mm long, 1-6 mm wide, their tip very acute and recurved, often reddish tinged.

In Java from Mt. Pangerango eastwards to Mt. Idjèn, but only on mountains which are higher than 2100 m, in short-grass plains, in sand seas and aloon-aloons (plains), often in very sterile and exposed places, at 1560-3340 m. Also in SE. Asia, but apparently curiously enough absent from Sumatra and the Lesser Sunda Is.

As in many gentians shade specimens have longer internodes between the leaves; both forms can be found in a single plant.

The flowers open in sunshine, and close at darkness (heavy clouding, fog, night); this is not so much a matter of light but of temperature which depends in the mountains on light. The closing reaction lags sometimes behind because of tissue tension but can be released by touching the corolla; this movement is hence not a reaction on irritation according to L. van der Pijl (1940).

According to Docters van Leeuwen the flowers are protandrous, last 3 days, and are self-pollinated.

Some people reported to have found yellowish flowered specimens but they were deceived by plants in fruit in which the dehisced valves surrounded by the withered corolla resembles (very) superficially a flower.

As to so many sun-loving mountain herbs deforestation of summits leads to a great increase of their numbers. On Mt. Diëng, which was forested in Junghuhn's time, *G. quadrifaria* must there have been rather rare, but nowadays it even invades unpaved roads and is behaving as a weed resisting being trodden down.

In East Java on the hill Gending Waluh, on Mt. Idjèn, a second gentian was once found, *G. cephalodes* (Flora of Java 2: 440), with leaves crowded in a small basal rosette in the centre of which a bunch of several flowers.

3. **Swertia javanica** Bl.—Flora of Java 2:**441**—Mt. Gedé.

An erect, perennial herb, £-iJ m high, often branched, entirely glabrous. Leaves 5-15 cm long, 1-2 cm wide, distinctly 3-nerved. Corolla lobes possessing a nectary above which are found two green spots and a purple venation. Corolla about equal in length to the petals.

In Java from Mt. Pangrango eastwards to Mts Tjeremai, Slamat, Ardjuno & Jang, in grasslands and shrubberies, at 2000-3100 m. Also in Sumatra (Mt. Kerintji) and Central Celebes (Mt. Latimodjong).

Flowering time is from May to July. The flowers last several days and are protandrous. Pollination is by bumble-bees or selfing.

Swertias are resembling *Gentiana*, but their corolla is split almost to the base and the lobes have one or more nectaries actually producing honey.

4. Swertia coerulescens (Zoll.) Gilg—The subglabrate form of Mt. Papandajan—Flora of Java 2: 441—Mt. Papandajan. **12222.**

Similar to the former but more slender with thinner stems, narrower leaves, and somewhat smaller flowers, the calyx shorter than the corolla and in the typical form from East Java the plant distinctly densely short-hairy. The form on Mt. Papandajan is, however, subglabrous with hairs only on the margin of the leaves and the sepals while sometimes the corolla is not much longer than the calyx. This then approaches so-called "hunger formfc" of Mt. Gedé, which are quite glabrous. It might therefore be concluded that *S. coerulescens* more or less fades into *S. javanica* towards West Java.

In West Java on Mt. Papandajan, eastwards on Mts Ardjuno & Tengger, at 2000-3100 m.

5. **Swertia oxyphylla** (Miq.) Gilg—Flora of Java 2: 440—Mt. Sumbing. Loogen. Mt. Idjèn. 12109.

Differs from both preceding species by the purple corolla distinctly exceeding the calyx, the row of fimbriate appendages above the nectary gland, and properly 1 -nerved leaves. In habit and narrow leaves it resembles *S. coerulescens.*

In Java on Mts Sumbing, Merbabu, Lawu, Tengger, Sméru & Idjèn, in similar places, at 2100-3200 m. Also in Bali (G. Agung), Lombok (Rindjani) and Timor (Mt. Tatamailau).

The rather conferted leaves persist hanging like a dried skirt (tunica) round the stem, a peculiar feature also found in *Anaphalis javanica* and *A. viscida* (10-1 & 2) and to some degree in ***Eupborbiajavanica* (19-4).**

GERANIACEAE

6. **Geranium potentilloides DC.** var. **ardjunense** (Z. & M.) Carolin—Flora of Java 1: 243 (as *G. ardjunense)*—Mt. Ardjuno. **11861.**

A perennial herb, with strong taproot, and one or more erect to prostrate stems 20-90 cm long. Stalks 1 -flowered, with 2 bracteoles at the top. Sepals finally 7-8 mm long, petals c. 7 mm.

In Java from Mt. Merbabu eastwards to Mt. Tengger, in shrubberies, between rocks and in tjemara forest, at 2400-3150 m. Also in N. Sumatra (Atjeh), SW. Celebes (Mt. Bonthain) and Timor.

The genuine species occurs in the Antarctic Is., New Zealand, SE. Australia and the eastern half of New Guinea (up to 4250 m), the variety being a race reaching the most western extension of the range.

7. **Geranium homeanum** Turcz.—Flora of Java 1: 243 (as *G. nepa/ense)—Klttik* Pass(Mt. Tengger). 11907.

Superficially like the former, but (almost) all pedicels bearing 2 flowers and hence 4 thin bracteoles. Sepals finally 4 mm long, petals 3-4 mm.

In Java only on Mt. Tengger at Klètak Pass, Ngadiwono etc., locally not rare on roadsides, talus, and in light tjemara forest, at 1500-2000 m. Also known from SE. Australia and **New Zealand.**

PLATE 20

EXPLANATION OF PLATE 21

GESNERIACEAE

1. **Agalmyla parasitica** (Lamk) O.K.—Leaf large, reaching lower right corner of plate—Flora of Java 2: 525—Tjibodas (Mt. Gedé).

A fleshy, coarse, herbaceous, hardly branched plant climbing with its roots on the base of tree trunks, initially from the soil, but by decay of its lower parts sometimes becoming epiphytic, clinging to the bark up to several metres long. Leaves pendent, hairy, in more or less two rows, on long petioles, their blade 15-30 cm long, 6-11 cm wide, the other leaf of each pair very small and narrow, 1-2$ cm long, or absent. Flowers gorgeous. The 4-valved capsule (not drawn) is linear, straw-coloured and 20-45 cm long. The minute seeds are numerous and end at both ends into a hair.

In Java in high, primary rain-forest, rarely in old secondary forest, mainly in the western half, more scattered in the eastern half where rain-forest is more local (Mts Diëng, Muriah, Telemojo, Ungaran, Wilis, and even near Ranu Darungan on the SE. slope of Mt. Sméru), at 750-1900 m. Also in Malaya and Sumatra.

One might think that honey-birds would be responsible for visiting and possibly pollinating the scarlet flowers but nothing of the kind is observed. The seed seems well adapted for wind dispersal, but wind is extremely rare and feeble in the depth of the forest to which this plant is confined and dispersal distance will be consequently restricted within the forest.

2. **Cyrtandra picta** Bl.—Flora of Java 2: 531—Tjibodas (Mt. Gedé).

An ascending-erect, rather coarse, terrestrial herb, 30-60 cm high. Leaves rather variable in shape, 12-15 cm l°ng» 5'8 cm wide. Fruit (not drawn) an oblong berry with fine seeds.

In Java mainly in the western half in damp rain-forest and secondary growths, common and often locally gregarious, along streams, in moist humus, and between litter, from Udjon Kulon eastwards; in East Java confined to wet slopes of the high volcanoes, on Mts Lawu, Dorowati, Tengger & Ranu Darungan on SE. Sméru, at c. 100-2400 m. Also in Sumatra.

The flowers may be sometimes porcelain-white.

3. Didymocarpus asperifolia (Bl.) Bakh. f.—Drawn tilted for 90 degrees—Flora of Java 2: 521—Tjibodas (Mt. Gedé).

A hispidulous erect herb, 1-1J m high. Leaves 7-30 long, 3-15 cm wide. Capsule (not drawn) linear, 8-10 cm long, opening with 2 valves; seeds without appendages.

In Java from Mt. Salak eastwards to the Priangan Mts, in the eastern half rare, e.g. on Mt. Ungaran, in rain-forest, along trails, on slopes, sometimes remaining in secondary growth after forest is cut, scattered, at 250-1500 m. Also in Sumatra.

4. **Aeschynanthus horsfieldii** R.Br.—In natural poise—Flora of Java 2:5 24—Tjibodas (Mt. Gedé).

Mostly a terrestrial herb, sometimes epiphytic, with rather rigid stems, i-i m long. Leaves fleshy, varying from ovate-oblong to ovate-lanceolate, 4-9 cm long, 1-4 cm wide. Fruit (not drawn) a linear capsule, 13-20 cm long, dehiscing with 2 bow-shaped valves, exposing the many small seeds which are all provided with a single rather thick hair at both ends.

In Java from Mt. Halimun (above Nirmala) eastwards to the Priangan Mts, but also more rare in Central Java, e.g. on Mts Tjeremai, Telemojo & Lawu, in shaded forest; on Mt. Lawu a common epiphyte in oak forest; frequent on ridges and stony localities, at 1000-2400 m.

5. **Aeschynanthus longiflorus** (Bl.) DC.—In natural poise—Flora of Java 2: 5 24—Tjibodas (Mt. Gedé).

An epiphytic herb, attached with the roots to sometimes thin branches, mostly in the lower stratum of the forest, rather stiff and not exactly pendent, 50-80 cm long. Leaves fleshy, 5-16 cm long, 2-6 cm wide. Capsules linear, 30-50 cm long opening with 2 snake-like curved valves, seeds at both ends with a single very long and thin hair.

Only in West Java, eastwards to the Priangan Mts, in shaded rain-forest, at 500-1500 m. Also in Sumatra and Sarawak.

The stamens are exserted from the corolla and open a day before the stigma becomes exserted; this protandry points to cross-pollination. Observation did not show birds or insects visiting the plants. And with this flower colour one would not expect pollination by nocturnal birds or insects.

6. **Aeschynanthus radicans** Jack—In natural poise—Flora of Java 2: 5 24—Tjibodas (Mt. Gedé).

Mostly an epiphytic herb, more rarely terrestrial and creeping on rocks and in mossy forest and on humus in elfin wood, on stony ridges, sometimes hanging down in large garlands of more than 3 m length. Vegetative parts and flowers glabrous or hairy. Leaves fleshy, variable in shape, 2-7 cm long, {-3 cm wide. **Calyx ij~3i** cm long. Corolla 4±-7& cm long. Capsule (not drawn) 20-36 cm long, linear. Seeds small, at both ends with a single hair.

Throughout Java, the most common species of this genus, in rain-forest, but also rarely in secondary terrain, at 50-1750 m. Also in Sumatra, Malaya, Borneo, Bali, and probably elsewhere.

The larger flowered form here depicted is often distinguished as *Aeschynanthus pu/cber (BL)* G. Don, but in the Flora of Java it is probably correctly considered one of the forms of a variable widely distributed species.

One of the two hairs on the seed is inserted on an excrescence resembling a so-called elaiosome which may serve as food to ants which in this way disperse the seed, in addition to the normal wind dispersal.

Though very common, and long observed, I have never seen birds or insects visiting the flowers.

The calyx of this plant is already large and mature but then still closed and filled with a slightly slimy water exuded by glands inside the calyx. In this fluid the corolla is at that stage still a tiny point; during its development the corolla enlarges and the calyx mouth opens and finally the corolla becomes twice as long as the calyx. This postponed development of the corolla in "waterbuds" is found mostly in this family *Gesneriaceae* **and in certain members of the *Verbenaceae* and *Bignoniaceae*,** and is comparable to the growth of the inflorescence in certain species of *Commelinaceae* (9-3). Similarly also seed growth lags frequently behind the growth of the pericarp in tropical trees, the reason why they are so often empty in the herbarium. No experiments have yet been performed to check whether this peculiar development serves for a special aim compulsory for the development of the floral parts. It may be a caprice of nature, so frequent in the plant kingdom, but seldom recognized, by which I mean that plants possess many characters which are beyond any usefulness and unnecessary to survive and multiply. The idea that all characters of plants must have a use in order to survive is a whim of the human mind or idiosyncrazy.

PLATE 21

EXPLANATION OF PLATE 22

GRAMINEAE

In grasses a fertile stem or culm bears at the top a panicle or spike, consisting of many small units, the spikelets. The flowers or fruits contained in the latter are protected by scale-like structures called glumes, which often bear a long needle called the awn.

1. **Isachne pangerangensis** Zoll. & Mor.—Flora of Java 3: **581.**

Culm 3-80 cm high. Leaves more or less densely set with long pale patent hairs, 1-15 cm long, 2-10 mm wide. Spikelets with only 2 flowers; no awn.

In Java common in various often sterile habitats, at 1200-3000 m. Also in Sumatra, Bali, Lombok, and Timor.

2. **Helictotrichon junghuhnii** (Buse) Henr.—Flora of Java 3: 523—Mt. Papandajan. 11681.

Culm glabrous, to 60-150 cm high, habit of oats. Leaves 12-7 5 cm long, 4-1 o mm wide. Spikelets 15-21 mm long; the glumes in two rows, imbricating, with strong nerves; awn 16-23 mm> the lower part twisted, the upper part straight.

In Java from Mt. Papandajan to Mt. Idjèn, in grassland, at 1800-2800 m. Also in the northern half of Sumatra.

3. **Pennisetum alopecuroides** (L.) Spreng.—Flora of Java 3: 575.

Densely tufted plant, 35-80 cm high. Leaves 1-3 mm wide, the top often dried and brownish. The long stiff hairs in the spike emerge in a bunch at the base of each spikelet.

In East Java in sunny dry places or in thin tjemara forest, at 1750-2400 m. Burma to S. China, Formosa, Polynesia & E. Australia; also Luzon (300-2300 m).—A characteristic plant of frost holes; also a sand-binder in sand seas.

4. Coelachne infirma Buse—Flora of Java 3:582.

Tender, tufted plant to 30 cm high, often rooting at the lower nodes. Leaves with a fringe of hairs between sheath and blade. Outer glumes half as long as the spikelet; no hairs or awns'.—In West & Central Java and Mt. Ardjuno, in moist places, often in great numbers, at 1000-2100 m. Also in Sumatra, Luzon, Celebes and E. New Guinea.

5. **Agrostis infirma** Buse—Flora of Java 3:5 24.

Densely tufted plant 15-80 cm high, glabrous. Leaves 3-40 cm long, 1-6 mm wide. Glumes with a distinct keel and a long acute top, but mostly no awn.

In Java rather common on all open, sunny summits and plateaux, at 1700-3200 m. Also in the northern half of Sumatra, N. Borneo (Mt. Kinabalu), Celebes (Mt. Latimodjong), Timor (Mt. Tatamailau), and perhaps in New Guinea.

6. **Brachypodium sylvaticum** (Huds.) P.B.—Flora of Java

Laxly growing plant, 40-140 cm high. Leaves 9-20 cm long, 2-8 mm wide, the higher ones mostly smaller. Spikelets subsessile, 2-4 cm long, the glumes in two rows, imbricating, the awn shorter than the glume.—In Java from Mt. Papandajan eastwards, in grasslands, at 1800-3200 m. Eurasia to Japan, Africa, Ceylon, also in Atjeh, Bali, Lombok, SW. Celebes (Mt. Bonthain), Ceram, and Luzon.

7. **Deyeuxia australis** (Z. & M.) Jansen—Flora of Java 3: 5*5-

Often forming large tufts, 10-80 cm high, glabrous. Leaves 4-30 cm long, 1-8 mm wide. Spikelets like those of no. 5, but between the glumes a long awn-like structure is found, called the rachilla.—In Java in grassland, at 1500-3300 m. Also in Sumatra, Bali, Lombok, Sumbawa, Timor, SW. Celebes (Mt. Bonthain), and Mindanao.

8. **Bromus insignia** Buse—Flora of Java 3:517.

Robust, 70-175 cm high. Leaves 20-40 cm long, 3-10 mm wide. Spikelets in a lax panicle slightly resembling those of no. 6, but looser, coarser, and distinctly stalked.—On Mt. Papandajan in West, further in Central & East Java, in glades and grassland, at 1900-2800 m. Also in Timor (Mt. Tatamailau), N. Borneo (Mt. Kinabalu), Ceram, New Guinea.

9. **Microlaena stipoides** (Labill.) R.Br.—Flora of Java 3: 529.

In tufts, 25-90 cm high. Leaves 4-25 cm long, 2-5 mm wide; between the blade and the sheath there is mostly a distinct pale rim with some long hairs. Spikelets stalked, with 3 flowers, with a tuft of short hairs at the base, the outer glumes slender with an awn as long as the spikelet.

In West Java on Mt. Papandajan, then from Mt. Diëng eastwards, in grassland, at 2000-2600 m. Hawaii to New Zealand & Australia, also in New Guinea, Luzon, and Timor (Mt. Tatamailau).

10. **Muehlenbergia huegelii** Trin.—Flora of Java 3:539.

Laxly tufted, often rooting at the lower nodes, 30-100 cm high, glabrous. Leaf blade 34-14 cm long, 3-7 mm wide. Glumes pale at base; awn long and soft, at top somewhat different, paler and thinner.—In Java from Mt. Patuha eastwards to Mt. Jang, in somewhat shaded places, at 1300-2300 m. India to Formosa and Japan, also Lombok (Mt. Rindjani).—The plant smells strongly of maggi; the anthers are bright orange.

11. **Danthonia penicillata** (Labill.) Beauv.—Flora of Java 3: 525 (as *D.pilosa)*—Mt. Papandajan. 11679.

Densely tufted, 30-50 cm high. Leaves 5-15 cm long, i£-2j mm wide, glabrous; often part of them withered and brown. Lower glumes nearly as long as the spikelet, awnless; higher glumes with an awn about as long as the spikelet.

In West Java on Mt. Papandajan, in East on Mts Lawu, Ardjuno & Jang, in grassland, locally abundant, at 2400-3000 m. New Zealand, Tasmania, Australia, also in New Guinea, SW. Celebes (Mt. Bonthain), and Lombok.

12. **Festuca nubigena** Jungh.—Flora of Java 3:516.

Plant in dense tufts, 50-75 cm high. Leaves rolled up and narrow, 12-35 cm long, in all 1-2 mm wide, part of the leaves dead and dull brown. Spikelet 7£-10 mm, with 3-5 flowers, lower glumes unequal, the shorter one more than half as long as the longer one.—In West Java from Mt. Papandajan eastwards to Mt. Jang, often dominant in tussock grassland, at 2300-3370 m. Also in Sumatra, Lombok and New Guinea.

13. **Tripogon exiguus** Buse—Flora of Java 3:5 34.

Densely tufted plant, 15-40 cm high. Leaves crowded at the base of the naked culms, to 30 cm long, 1-2 mm wide. Spike dense, dark, ± flat by distichous spikelets. Awns shorter than the spikelets.

In Java from Mt. Pangerango to Mt. Idjèn, in West Java very rare and local, in open places, at 2100-3100 m» seldom found as low as 1030 m on bare lavastreams. N. India to S. China and Formosa, also in Bali and Lombok.

14. **Festuca leptopogon** Stapf—Flora of Java 3:516.

Lax, tufted, 75-125 cm high. Leaves flat, 10-25 cm lon£> 3-8 mm wide. Spikelets 8-10 mm long, with 3-4 flowers, lower glumes unequal, the shorter one less than half as long as the longer one.—In Java from Mt. Papandajan to Mt. Idjèn, rare in grassland and forest borders, never gregarious, at 1650-2100 m. N. India to S. China and Formosa, also in Sumatra, Timor, SW. Celebes (Mt. Bonthain), and Luzon.

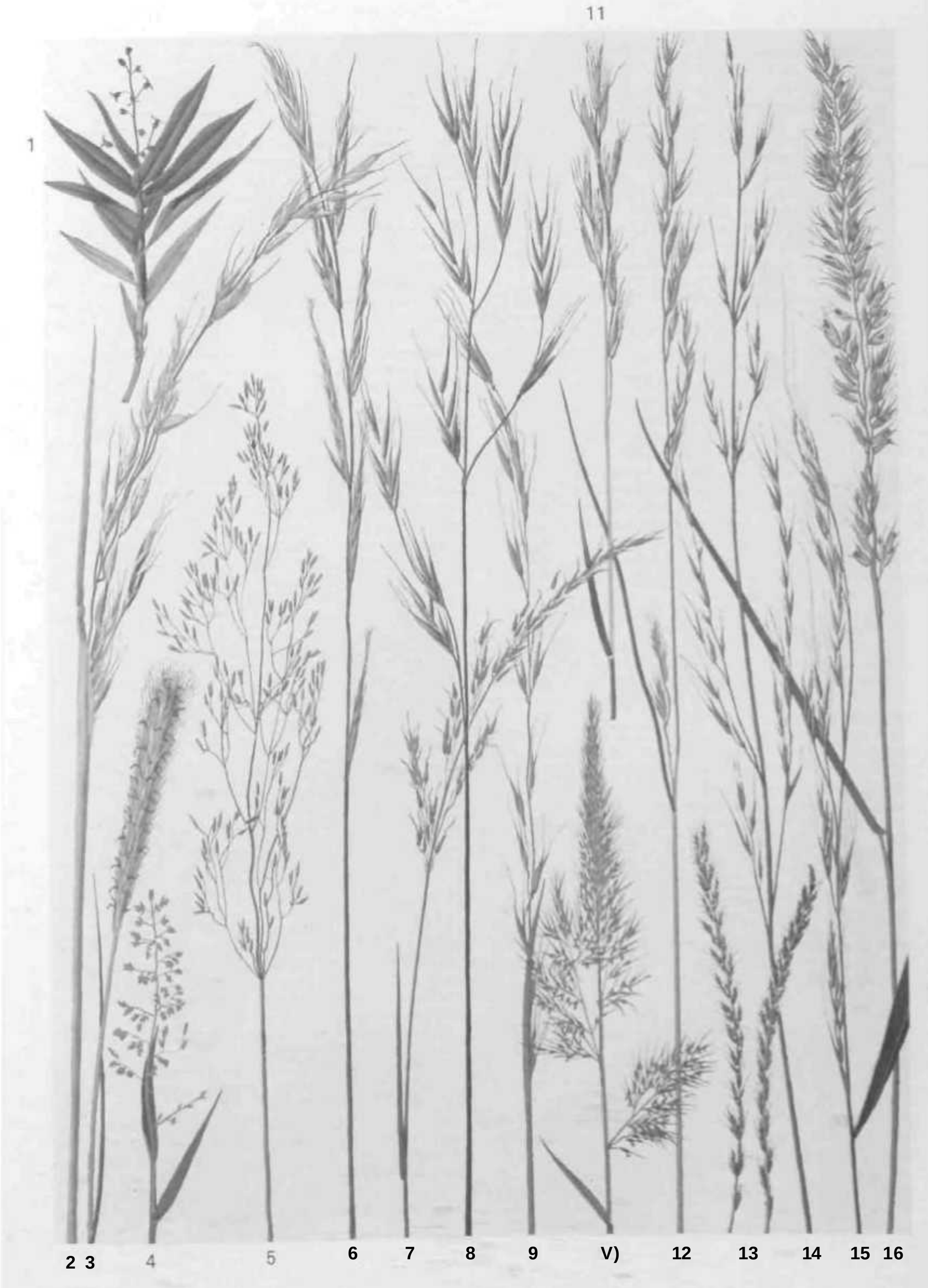
15. **Streblochaete longiarista** (A. Rich.) Pilger—The characteristic hair-like paint-brush formed by the spirally contorted-intertwined fine awns on top of the panicle is too fine to be well reproduced—Flora of Java 3:518—Tosari.

Tufted plant, 75-100 cm high. Leaves 7^-20 cm long, 4-12 mm wide. Spikelets 18-21 mm long. Awns of different culms very characteristically intertwined and easily attached to clothes and fur and thus dispersed (Beumée, 1931).

In Java on Mts Tjeremai, Ardjuno, Tengger, Raung & Idjèn, in light shade, locally abundant, at 1500-2200 m. E. Africa, Mascarenes, also in Luzon (Mt. Pulog) & Lombok (Mt. Rindjani).

16. **Hierochloe horsfieldii** (Kunth) Maxim.—Flora of Java 3 : 529—Mt. Papandajan. Mt. Tengger. 11934.

Culms to 50-120 cm high. Leaves 12^-30 cm long, 3-10 mm wide. Spike dense, spikelets 5i-6J mm; glumes broad; awn short and soft.—In Java from Mt. Papandajan east to Mt. Idjèn, in grassland and open tjemara forest, at 2100-3300 m, sometimes dominant, e.g. on the southern summit slope of Mt. **Tjeremai.**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EXPLANATION OF PLATE 23

HALORAGACEAE

i. **Gunnera macrophylla** Bl.—A very small specimen. Upper part of inflorescence buds of cf flowers above open ones, lower part of inflorescence female flowers in lightgreen spikes above darkgreen fruit spikes—Flora of Java i: 267 —Tjibeureum (Mt.Gedé).

A vigorous rhizomatous herb with long, rooting runners. Stem short, ascending, coarse, the leaves conferted, very long-stalked, glossy and strongly veined, 10-50 by 10-50 cm. Flowers without petals in a coarse, terminal, spike-like panicle, the basal ones female, the apical ones male.

In Java on Mt. Gedé near Tjibeureum and on Mts Diëng & Merbabu, in reed-marshes, near waterfalls and seepage, and along brooks, 1000-2850 m, locally common, but rare in general. Also in Sumatra, N. Borneo (Mt. Kinabalu), the Philippines, Sangihe, NE. Celebes, New Guinea (to 3300 m), and the Solomons.

A most interesting plant. The stem and petiole bases have small slime-producing glands. Besides, the thick base of each of the equitant petiole bases have 3 warts, one central and two lateral lower, immediately below which an adventitious root emerges. The warts contain tissue which is infested by colonies of one-celled blue-green algae of the genus *Nostoc.* Similarly as in the roots of *Cycas* this is a peaceful symbiosis of two plants; it is supposed that the algae are capable of fixing nitrogen into a nutrient for the host plant. Whether *Nostoc* is compulsory for the life of *Gunnera* is not yet proved.

On the island of Sangihe it is believed that the flowering of *Gunnera* means that an eruption is imminent of the dangerous active volcano Mt. Awu on which the plant is not rare in the summit area; this is obviously by confusing the large amount of produced yellow pollen with the production of sulphur as a forebode of volcanic activity.

2. **Haloragis micrantha** (Thunb.) R.Br. ex Sieb. & Zucc—Flora of Java 1: 266—Mt. Papandajan.

Very delicate prostrate branched herb with rooting stems, mostly tufted, on open muddy plains only 5-30 cm long and bright red, in brooks floating and longer with weaker red tinge. Leaves 3-10 mm long, 1^-4 mm wide. Inflorescences terminal and pointing upwards.

In Java only known from the tegals of Mt. Papandajan, where not at all rare in grassland, dry and moist, at 2000-2600 m. Also known from a few mountain tops in the Archipelago, ranging from Japan to New Zealand, also in N. Borneo (Mt. Kinabalu), the Philippines, Celebes, and New Guinea.

3. **Laurembergia** coccinea (Bl.) Kanitz—Only with male flowers—Flora of Java 1: 266—Mt. Papandajan.

Delicate creeping herb, more or less reddish tinged, 5-30 cm long, often tufted. Leaves 4-10 mm long, 2-6 mm wide. Flowers unisexual, the male ones 3-7 mm stalked, the female ones on very short stalks.

In Java only on Mts Gedé, Patuha, Papandajan & Diëng, in moist open places, marshy plains, and along small streams, at 1600-3020 m. Southernmost tip of India (Nilgiri & Pulney Hills) and Ceylon, also in Sumatra.

HAMAMELIDACEAE

4. **Altingia excelsa** Noroña—a. Twig with inflorescence of young fruit, b. with male flowers emerging—Flora of Java 1: 646—Tjibodas (Mt. Gedé).

Giant tree to 60 m tall, with cylindrical bole to i± m diameter with small buttresses and light grey smooth bark. Leaves 7-16 by 3-7CIH, aromatic when crushed. Inflorescence initially enclosed by scales; basal 1-3 heads female, higher 6-10 ones racemose and male, the latter very rich in stamens, and shed after anthesis.

In West Java eastwards to Garut in the Priangan Mts, in primary forest, at (5 5o-)7oo-i7oo m. SE. Asia, also in Malaya and Sumatra.

Rasamala is one of the finest forest frame trees of Java, its crown emergent beyond the closed canopy. Competing only with the conifers *Podocarpus imbricatus* (13-2) and *Podocarpus neriifolius(iyi)* in majestic size. The wood is dark brown, heavy, and beautiful. In fissures of the wood a scented resin collects, which in Java is sometimes used as a substitute for benzoin. Small harmless bees may build colonies in these resinous parts. Single specimens in the open branch very low above the ground, like can be seen in the Tjibodas mountain garden. Probably formerly also dominant down to 600-700 m, but at present most forests below 1500 m have been depleted of *rasamala,* often leaving a canopy of *Castanopsls* and *Lithocarpus* species. The Forestry Service frequently uses this valuable timber species for reafforestation.

The mistletoe *Viscum liquidambaricolum* Hayata (Flora of Java 2: 76), a drooping yellow-brown hemiparasite, occurs exclusively on *rasamala;* at Tjibodas a smaller mistletoe, *Korthalsellajaponica* (30-6) is also frequent on *rasamala.*

Overmature trees—possibly 3-5 centuries old—have mosses, lichens, mistletoes and epiphytes in the crown, which gradually decreases in size because the branches break off. Eventually, fungi attack the huge trunks which, standing like mouldering columns, slowly decompose and disintegrate.

5. **Distylium stellare** O.K.—Twig with female flowers in upper axil, male flowers in lower axils, dehisced fruits and one gall—Flora of Java 1: 646—Mt. Papandajan. 12231.

A tree to 12 m, on rocky slopes and on crests, attaining to 45 m in level fertile soil. Leaves stiff, leathery, 3-18 cm long, iJ-6 cm wide, mostly with remote hard teeth, sometimes entire. Flowers unisexual, in spikes, without a corolla: male ones with 3-5 stamens, bright red, the female ones densely hairy with 2 bright red styles. Fruit a woody capsule, with 2 cells each with one seed. The fruit wall splitting into two layers.

In Java from Mt. Gedé eastwards to Mt. Jang, in mixed forest, at 1000-2700 m. SE. Asia, also in Malaya, Sumatra, and Flores.

Seedlings are easily recognizable by the remotely coarsely toothed leaf tops. In sterile state the tree is recognizable by the long-persistent large brown baggy galls mostly present on the twigs, caused by Aphids.

Also used in mixed reafforestation, and on Mt. Diëng as wayside tree.

HYPERICACEAE

6. **Hypericum leschenaultii** Choisy—Twig with flower and 2 buds, dehisced fruit separate—Flora of Java 1: 382—Mt. Gedé.

An erect shrub 1-4 m tall, with showy flowers. Leaves 2^-74 cm long, 1J-4 cm wide, glaucous beneath, the young sprouts often somewhat reddish tinged.

In Java from Mt. Salak to Mt. Idjèn, in grassy plains, forest edges, slopes along watercourses, crevices and brushwood, at 1500-3500 m. Also in Sumatra, Bali, Lombok, Sumbawa, Flores, and SW. Celebes.

A jewel of the Javanese mountain flora. In the Tengger sand sea and other sterile exposed places (Mt. Jang) the plants may be very densely branched and almost bare in the dry season. A rare instance of a plant which without further domestication is suitable as an ornamental plant. It can easily be grown in mountain gardens in Java.

7. **Hypericum japonicum** Murr.—Flora of Java 1: 382—Mt. Papandajan.

A delicate herb, ascending or erect, rooting and growing in tufts, 4-45 cm long. Leaves J-2 cm long, J-i J cm wide. Petals long-persistent.

All over Java, but mainly in West, in moist open places, along watercourses, in marshes, on talus, in marshy grasslands and even as a weed in tea estates, at 1000-2400 m, descending along watercourses as low as 200 m. Ceylon and S. India through SE. Asia and China to Japan and Korea and throughout Malesia and Australia to Tasmania, New Zealand and Hawaii.

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EXPLANATION OF PLATE 24

JUGLANDACEAE

1. **Engelhardia spicata** Bl.—Infructesccnce—Flora of Java 2:15 8—Tjibodas (Mt. Gedé).

An often lofty, sometimes majestic tree to 15-30 (-36) m tall, the trunk to 1 £ m diameter. Leaves pinnate, 20-50 cm long, the leaflets 8-16 cm long, 3-6 cm wide. Catkins while in flower (not drawn) mostly with a single female axis which is to grow out later, and at the base a few male axes which are later shed. Fruiting catkins 25-50 cm long, the hairy nuts fused with the base of a 3-lobed bract 3-5 cm long. The catkins are shed as a whole.

In Java common at 1000-2200 m, rarely lower, especially in Central and East, where it is an early invader of the tjemara forest, grassland and savanna woodland. Locally, e.g. on the W. side of Mt. Jang, it may form pure stands. In SE. Asia, throughout W. Malesia, and the Lesser Sunda Is.

The Sundanese name *ki hudjan* (rain tree) alludes to the drooping inflorescences; *sawa* or *donglu* with various prefixes and variations in Javanese.

The timber has little resistance and is not valued.

JUNCACEAE

2. **Juncus prismatocarpus** R.Br.—Two stem tops, right in flower, left in fruit—Flora of Java 3: 451—Mt. Papandajan.

A perennial herb with several, mostly erect stems but no creeping rhizome, 30-70 cm high. Stems compressed, pithy, bearing several leaves with a well-developed, grass-like blade 5-20 cm long. Flowers insignificant, in a lax corymb of heads.

In Java from Mt. Patuha eastwards to Mt. Diëng, in stagnant water, lake and stream banks and other marshy land, at 1000-2600 m. From SE. and E. Asia to Australia and New Zealand, also in N. Sumatra, Malaya (Cameron Highlands), the Philippines, and New Guinea (up to 3225 m).

3. **Juncus effusus** L.—a. Rootstock with culm bases and a young shoot, b. apical part of a flowering culm—Flora of Java 3: 451—Tjibeureum (Mt. Gedé). 123 31.

A densely tufted erect herb with strong rhizome. Culms tough, terete, 40-120 cm high, inside with uninterrupted white pith, at the base enveloped by glossy brown sheaths; without proper leaves.

In Java known from Mt. Gedé & the Priangan Mts to Mt. Jang, in stagnant water, marshes, lake shores and by ditches, not rarely in dense groups, at 1600-2500 m. Largely a northern hemisphere species, rare in Australia; also in N. Sumatra, N. Borneo (Mt. Kinabalu), the Philippines and New Guinea.

The dried stems can be used for making mats.

LABIATAE (continued on Plate 25; see also Plate 30-2)

4. **Achyrospermum densiflorum** Bl.—Flora of Java 2: 624—Mégamendung (Mt. Gedé). 12213.

Ascending herb, often rooting at the base, 15-60 cm long. Leaves 6-8 cm long, 2J-4 cm wide. Inflorescence 4-7 cm long. Calyx red-purple or pink, rarely pale green, corolla generally purple or pink, rarely white.

In Java mainly in the western part, in forests and in shady places, at 600-2000 m, sometimes descending to 15 o m. In SE. Asia, also in Sumatra, the Philippines, Lombok, and Sumbawa.

5. **Coleus galeatus** (Poir.) Benth.—Flora of Java 2: 637—Mt. Papandajan. 122 51 or 11251.

A herb J-ij m tall, erect or ascending. Leaves very herbaceous, 7-20 cm long, 3-10 cm wide. Fruiting calyx 9-14 mm long, very oblique, lateral teeth distinctly shorter than the 2 narrow lower teeth, posterior calyx lobe decurrent.

All over Java, in moist forests, at 100-2400 m, especially in West Java above 600 m. Also known from Sumatra, Borneo, Bali, the Philippines, the Moluccas (?), and New Guinea.

6. **Elsholtzia pubescens** Benth.—Flora of Java 2: 632—Mt. Ardjuno.

Erect herb, 1-2J m high, mostly richly branched, often woody at the base, very aromatic when crushed. Leaves 6-8 cm long, 2 £-3 cm wide. Flowers in dense spikes, in candelabra-like panicles together. Flowers sweet honey-scented.

In Java from Mt. Tangkuban Prahu eastwards to Mt. Idjèn, on grassy plains and slopes, forest edges and in sunny thickets, frequent in tjemara forest, at 1000-2900 m. Also known from SW. Celebes (Mt. Bonthain), Bali, Lombok and Timor.

On the huge pyrogenous plains of Mt. Jang in immense stands, often together with *Euphorbia* (19-4) and the fern *Pteridium* (bracken) in tjemara savannas: obviously rather fire-resistant. Also a pioneer on lavastreams on Mt. Idjèn and in Bali. The stands swarm with small harmless bees and if lucky one can locate and harvest honey-combs in those places.

7. **Scutellaria discolor** Benth.—Flora of Java 2: 620—Mégamendung (Mt. Gedé).

Perennial herb, 10-100 cm high, variable. Leaves 4-11 cm long, 2J-10 cm wide. Flowers along the main axis of the inflorescence mostly *not* opposite, or in clusters, light blue or nearly white. Main inflorescence axis bearing no or but a few glandular hairs; bracts mostly shorter than the pedicels that they subtend.

Throughout Java, in forests, shady roadsides, at 200-2400 m. Also known from SE. Asia, Sumatra, Bawean, the Lesser Sunda Is., Ceram and New Guinea (once).

Compare the far more beautiful var. *cyrtopoda* (25-8).

I'LATE 24

LA BI AT A E (continued; see also Plate 30-2)

1. **Satureia umbrosa** (Bieb.) Scheele—Flora of Java 2: 630 (as var. *repens(D.* Don) Briq.)—Mt. Ardjuno. 11882.

Perennial erect or ascending herb, up to 1 m long. Leaves thinly to densely hairy on both faces, gland-dotted beneath, up to 4i cm long, 3 cm wide.

In Java from Mt. Patuha eastwards to Mt. Idjèn, in grasslands, at 1200-3200 m. From the Caucasus to Japan, SE. Asia and Malesia, also on Mt. Kerintji (Sumatra), Bali & Lombok, Luzon, and New Guinea (Lake Habbema).

2. Plectranthus javanicus (Bl.) Benth.—Flora of Java 2: 636 —Mt. Tengger. 11929.

Erect, perennial herb, j-2 m high, mostly strongly branched, fetid when bruised, not aromatic, often somewhat red-tinged. Leaves 2-5 (-8) cm long, 1-2 J(- 5) cm wide.

In Java from Mt. Gedé eastwards to Mt. Idjèn, in forest edges, secondary growths, grassland, also in tjemara forest, at c. 1000-2500 m. Also in the northern half of Sumatra, the Lesser Sunda Is. (Bali, Lombok, Sumbawa, Flores & Timor), and Luzon.

3. **Mesona** palustrisBl.—Flora of Java 2: 638—Mt. Ardjuno. **11828.**

Erect or slightly ascending, soft white-hairy herb. Stem terete, 30-60 cm high, often branched at the base. Leaves 3-8 cm long, 1J-3 £ cm wide.

In West Java very rare (base of Mt. Salak at Tjiomas, Tjiampéa, G. Bunder) and Batudjadjar (near Bandung), further only from Mt. Ungaran eastwards to Mt. Idjèn, in grassy places, along roadsides, in sparse tjemara forest, not on marshy soil, at c. 1000-2700 m. SE. Asia, also in Luzon, Celebes and the Lesser Sunda Is. Bali, Lombok & Sumbawa.

It is most peculiar that the four localities under everwet conditions in West Java are at low altitude, viz. 300, 250, 500 and 600 m respectively, one said to be found in a rice-field area.

4. Plectranthus teysmannii Miq.—Flora of Java 2: 636—Mt. Papandajan.

Erect, usually little-branched herb, }-iJ m high. Flowers graceful, with purple dots. Leaves somewhat bullate, stiffen, 2 £-5 cm long, 1 £~3£ cm wide.

In Java from Mts Tilu & Papandajan eastwards to Mt. Idjèn, in grasslands, forest edges, and in tjemara forest, never in marshy places, at 1400-2700 m. Also in SE. Asia (where described under various names), in South & Central Celebes, and the Lesser Sunda Is. Bali, Lombok, Sumbawa & Flores **(down to 1000 m).**

5. **Melissa axillaris** Bakh. f.—Flora of Java 2: 629 *(M. parvifiora* Benth., non Salisb.)—Mt. Papandajan.

An erect, often branched herb, J-iJ m high, not aromatic. Stem 4-sided. Leaves 2-7 cm long, 1-3 cm wide.

In Java from Mts Patuha & Papandajan eastwards to Mt. Lawu, in forest edges, along trails, in elfin and tjemara forest, at 1500-2700 m. India to Japan and China, also in Sumatra (Gajo Lands & Mt. Kerintji).

6. Stachys oblongifolia Benth.—Flora of Java 2: 624 (as *S. melissaefolia* Benth.)—Rantja Gede, near Kertasari. 11657.

An erect or ascending, rarely branched herb, 30-60 cm high, with a 4-sided stem. Leaves hairy, 4-6 cm long and \\-*i*\ cm wide.

In Java only in Rantja Gedé, near Kertasari (Talun, near Papandajan), 01? damp soil between high grass and herbs on marshy soil of a nearly overgrown swamp glade, locally common at c. 1700 m. Otherwise only known from SE. Asia.

I have dispersed the black nuts of this extremely rare plant in various places on Tegal Alun Alun on Mt. Papandajan in Oct. 1939 because the plant was threatened to be smothered by the advancing forest. In 19401 could not (yet?) find positive results.

7. **Paraphlomis oblongifolia** (Bl.) Prain-Flora of Java 2: 619 —Telaga Warna, Puntjak (Mt. Gede). 11701.

An erect, rather coarse, soft-hairy herb, £-1 m high, with 4-sided stem. Leaves thin, 15-20 cm long, 6-8 cm wide.

Only in West Java, possibly also on the south slope of Mt. Slamat in Central Java, in rain-forest and in forest edges at 900-1800 m. Also in Sumatra and N. Celebes.

8. Scutellaria discolor Benth. var. **cyrtopoda** (Miq.) Adelb.—Flora of Java 2: 620—Near Sméru homestead.

An erect, little branched herb, J-J m high. Leaves similar to the species (24-7) but flowers more showy; the stem densely glandular hairy, and large bracts under the flowers.

In Java from Mt. Malabar (Priangan) eastwards to Mt. Jang, in shady places, sometimes moist, in mixed and tjemara forest, **at 1600-3200 m.**

9. **Leucas** marrubioides Desf.—Flora of Java 2: 622 (as *L. javanica* Benth. f. *montana* (Zoll.) Back.)—Tosari (Mt. Tengger).

An erect, soft-hairy, perennial herb, \-\ m high. Leaves 2^-5 cm long, 1 £-3 **i** cm wide.

In Java only found in the eastern part on Mts Lawu, Ardjuno, Tengger & Jang, in grasslands and tjemara forest at 2000-2800 m. Also in Ceylon and S. India.

10. **Pogostemon menthoides** Bl.—Flora of Java 2: 632—Above Tjibodas (Mt. Gedé).

An erect, rather inconspicuous herb, 30-80 cm high, when dried turning blackish. Leaves 2-8 cm long, 1-5 cm wide.

In Java from Mt. Gedé eastwards to Mt. Idjèn, in rain-forest, elfin forest, and also in tjemara forest, always in shade, at 1200-2200 m. Also in Bali, N. Borneo (Mt. Kinabalu), and Luzon.

PLATE 25

LAURACEAE

1. **Lindera bibracteata** (Bl.) Boerl.—With unripe fruit—Flora of Java i: 134—Puntjak (Mt. Gedé). 11704.

A small tree, 8-15 m tall, mostly low-branched. Leaves 4-15 cm long, 2-4 cm wide, glaucous beneath. Ripe fruit somewhat. larger, glossy pitch-black, ellipsoid, c. 10-11 mm long, 7 mm diameter.

In Java eastwards as far as Mt. Diëng, on ridges and summits, in elfin and mossy forest, at 1000-2800 m. Also in Sumatra (to lower altitude), Malaya and Borneo.

Trees of the laurel family of which there are some 70 species in Java (!), are inconspicuous but together take up quite some volume of the lower storey of the rain-forest canopy together with the *Fagaceae* (oaks and chestnuts) which are predominant in the proper canopy. Junghuhn and Miquel called this middle mountain forest aptly the "lauro-fagaceous" type.

2. Litsea cubeba (Lour.) Pers.—Fruit immature—Flora of Java 1: 126—Mt. Gedé.

A shrub or tree, up to 10 m tall, with pale green foliage, becoming blackish when dried for the herbarium. Leaves 7-15 cm long, 1I-3 cm wide, when crushed strongly scenting of lemon by an aromatic oil contained in small pellucid gland-dots in the leaves; the wood also aromatic. A "bud" (in this genus) really consists of 4 imbricating bracts concealing 4 sessile flowers and is hence a head-like inflorescence. There are consequently 4 fruits together. The stamens open with upcurved valves as usual in the family. Mature fruits are black.

In Java eastwards to Mt. Ardjuno, in the rain-forest, elfin woods and ridge forest, sometimes common near solfataras, but most common in thickets and secondary forest, readily invading clearings, and easily dominating fired areas, at 700-2900 m. In SE. Asia to Formosa, also in Sumatra (500-3100 m), Malaya, Borneo and Morotai.

Ki lèmoh (Sundanese) is a common treelet which occurs often gregariously. It grows rapidly and flowers and fruits at a young age, as is usual and adequate for second growth plants. An oil is sometimes made of the leaves reminding of citronella *(seréh)* oil and used as a substitute. Sticks made of the stems are supposed to be a repellent to snakes for their bearer.

3. **Litsea diversifolia** Bl.—Flora of Java 1: 128—Mt. Papandajan. 12232.

A shrub or treelet, up to 12 m tall. Leaves 5-15 cm long, 3-6 cm wide, glaucous beneath. Flowers fragrant. Fruiting receptacle cup-shaped with on top the red berry (finally black?).

All over Java, in low forest, mostly on ridges and spurs and in mossy forest, at 700-2500 m. Also in Sumatra, Bali and Sumbawa.

LEGUMINOSAE (continued on Plate 27; see also Plate 30-3)

4. **Albizia lophantha** (Willd.) Benth.—a. In bud and flower, b. a pod, c. fungus gall—Flora of Java 1:55 2—Mt. Idjèn-Merapi(4a). 12116. Mt. Papandajan (4b, 4c). 11670.

A smallish, short-lived, rapid-growing tree or shrub, up to 15 m; trunk to 30 cm diameter. Leaf pinnae 6-14 pairs.

In Java from Mt. Gedé eastwards to Mt. Idjèn, in open low forest, elfin or mossy, on ridges, in grassland, also in tjemara forest, coming rather close to craters, mostly at 1800-3100 m, descending rarely to 1100 m but only on mountains which highest peaks attain 2500 m altitude. On some volcanoes dominant in a girdle below the active summit, e.g. on Mts Tjeremai, Slamat & Idjèn-Merapi above lake Kawah-Idjèn, at 2500-3000 m. Also known from West Central Sumatra (Mt. Merapi), Bali, Lombok, and Flores. Strange enough also in the Swan R. area in SW. Australia.

Kemlandingan gunung (Javanese) is a singularly interesting and instructive plant, not only because of its peculiar distribution or because its altitudinal restriction revealed the mass elevation effect (see the text), but also because of its ecology. Normally it occurs sparsely in the elfin forest; it becomes abundant when this forest is destroyed by volcanism or fire. Its rather large seeds are—as in so many *Leguminosae,* e.g. *Acacias*—hard-shelled; this does not mean that they are thick-shelled, but that their seed coat is not well impregnable by water, thus retarding germination. Consequently when seed is shed the major part of it remains for years unchanged in the litter, as a valuable "seed reserve". If the seed coat cracks through the heat of ground fire or is impregnated by acids from solfatara or otherwise, germination follows. Hence, in fired places simultaneous germination follows, resulting into single-dominant groves. At young age to about 5-6 years the trees set abundantly fruit, but then fall into gradual decay, in part caused by the figured rust fungus *Uromycladium tepperianum.* Javanese who collect the young pod for vegetable (substitute for *petéh)* then set fire again to the stand to raise a new crop.

What the reason is that *A. lophantha* does occur abundantly on Mt. Gedé proper and not on Mt. Pangrango—two three-thousanders which lie only a few kilometers apart and are separated by a saddle at 2600 m—is probably due to the fact that it prefers stony, open places and is distinctly shade-intolerant. But one would have expected it in the small aloon-aloon (plain) on summit of Pangrango. It shares this peculiar absence from Mt. Pangrango with *Gaultheria fragrantissima* **(17-1) and *Myricaj'aranica($2-)).***

5. Desmodium **repandum** (Vahl) DC.—Flora of Java 1: 604—Tjibodas (Mt. Gedé).'

Little-branched, erect or ascending herb, up to 2 m high. Terminal leaflets 4-10 cm long, 2-7 cm wide. Inflorescence with hooked hairs, adhering. Flowers pretty, only few open at the same time; pod constricted between the joints.

All over Java, in forest, along trails, in thickets, also in tjemara forest, at 700-2000 m. In Africa, SE. Asia and all through the Archipelago.

6. **Dolichos falcatus** Willd.—Flora of Java 1: 644—Mt. Ardjuno. 11827.

A twining herb, 1-3 m long. Terminal leaflet 4-10 cm long, 3-7 cm wide.

In Java from Mt. Slamat eastwards in grasslands and thickets, mainly between 1000-2000 m, but on Mt. Idjèn-Merapi descending to 600 m, near Weleri (Semarang) at 250-300 m, and once found near Petjaron, W. of Panarukan, in Besuki Residency, winding on *Spinifex* on the seashore! In the Lesser Sunda Is. and Saleyer also at low altitude between 50 and 400 m (in Wetar on the beach), as in the Philippines. Obviously drought allows to descend; this unexplained phenomenon is found in some other plants. In Ceylon and India through SE. Asia, also in the Sula Is.

As in many other papilionaceous plants the flower colour fades with age.

7. **Dumasia villosa** DC.—Flora of Java 1: 624—Mt. Ardjuno. **11883.**

A twining herb, 1-4 m long. Leaflets 2-7 cm long, 1J-5 cm wide. Seeds glossy black.

In Java from Mt. Gedé eastwards to Mt. Idjèn, in forest edges and thickets, at 850-2500 m. East Africa and Madagascar to SE. Asia, S. China and Malesia, also in Sumatra, Luzon, SW. Celebes (Mt. Bonthain), Bali, Lombok, Timor, and New Guinea. Apparently not in Malaya.

I'I.ATE 26

EXPLANATION OF PLATE 27

LEGUMiNOSAE (continued; see also Plate 30-3)

1. **Euchresta** horsfieldii (Lesch.) Benn.—Part of a leaf, inflorescence, and 2 berry-like pods—Flora of Java 1: 619—Tjibodas(Mt.Gedé).

Perennial, erect, sparingly branched shrub $-i£ m high, woody at the base. The creamy flowers in terminal racemes 4-12 cm long. Each leaf consists of 5, rarely of 3 rather fleshy leaflets which are **8-20** cm long and 3-8 cm wide. The pod, comparable to the bean in this family, is a peculiar dark-blue 1-seeded berry, a most unusual feature.

In Java from Mt. Gedé eastwards to Mt. Tengger, in the depth of the rain-forest, very local and always in one or few individual plants, at 1300-2400 m. In SE. Asia, also in Sumatra and Bali, a distinct race in the Philippines and Formosa.

The fruit and seeds are bitter and used medicinally for various purposes. They would also act as an aphrodisiacum. They contain the alcaloid cytisine, and this is the reason that K. Heyne doubted the real value of this plant in the latter respect; it is known *aspalakija* or *pranadjiwa* in Javanese. It may be that the use as an aphrodisiacum is suggested by belief in the doctrine of signature (S 1936), by which the useful qualities are reflected by the appearance: the soft blue pods resemble testis.

2. Lespedeza junghuhniana Bakh. f.—Flora of Java 1: 613—Mt. Ardjuno. 11876.

An erect, very beautiful, profusely branched semi-shrub 1-2 m high. Leaflets 1 £-4 cm long, f-i \ cm wide. Pod elliptic, 12-15 mm long, 5-6 mm wide.

In Java known from Mt. Sumbing eastwards to Mt. Idjèn, in grasslands and forest edges, also in tjemara forest, often very common in savanna-like stands, at 1000-2800 m. Also known from Bali, Lombok and Timor.

This species occurs almost certainly in SE. Asia but a revision is needed to settle this question.

3. **Lespedeza juncea** (Linn, f.) Pers. ssp. **sericea** (Thunb.) Steen.—Flora of Java 1: 613—Mt. Idjèn. 12057.

An often copiously branched, broom-shaped semi-shrub, to 1 m high; twigs very tough. Corolla whitish.

In Java on Mt. Idjèn, in grasslands, at 1120-2400 m. In SE. Asia to Japan, Formosa and E. Australia, also in Luzon, Sumba, Flores, Timor, and East New Guinea.

4. Parochetus communis D. Don—Flora of Java 1: j 87—Mt. Papandajan.

Creeping herb, the flower stalks varying from 4-15 cm. Leaflets 1-3 cm long and wide. The flowers change colour during anthesis; the various stages have been depicted.

In Java from Mt. Papandajan eastwards to Mt. Idjèn, in marshy grasslands and along streams and roadsides, sometimes in rather dry tjemara forest, at 1800-3200 m. In East Africa and Asia, also in Bali.

5. **Shuteria vestita** W. & A.—Flora of Java 1: 625—Mt. Ardjuno. 11825.

A twining or creeping herb, 1-4 m long. Leaflets 2-6 cm long, 1 £-5 cm wide, often pale-blotched.

In Java from Mt. Gedé eastwards to Mt. Idjèn, in forest edges, thickets, talus, in shrubberies, and marshes, at 1000-2500 m. In SE. Asia, also in Sumatra, Bali, Lombok, Flores, Timor, SW. Celebes (Mt. Bonthain), and New Guinea.

6. **Smithia ciliata** Royle—Flora of Java 1: 600—Mt. Idjèn. **12020.**

A tiny annual, erect or ascending, often branched herb, 10-80 cm long. Leaflets £-iJ cm long, 14-3 mm wide. Flowers pale blue, opening at about 8 a.m.

In Java only known from Mt. Idjèn, in sunny, sandy or grassy places, also on grassy old lavastreams (redjèngans), locally sometimes numerous, at 950-2200 m. SE. Asia to Formosa, also in Luzon, SW. Celebes (Mt. Bonthain), Bali, Lombok and Timor.

LENTIBULARIACEAE

7. **Utricularia striatula** J.E.Sm.—Roots and leaves drawn against the background of moss—Flora of Java 2: 517—Sèlokaton (Mt. Diëng). Loogen.

A very delicate, unbranched herb, up to 10 cm high. The long-petioled leaves are in a rosette at the base of the stem and are minute and round, measuring only 2-4 mm diameter. The stem itself has only a few minute, narrow bracts below the flowers. The spurred flowers vary from white to purple or blue and have a yellow palate. The minute obovoid seeds have, on the thicker half, excrescences bearing a whorl of hooks at the apex.

In Java from Mt. Salak eastwards to Mt. Diëng, in East Java e.g. on Mt. Kelud and Mt. Dorowati, mostly in moss, near waterfalls, in stream beds, on dripping cliffs, on seepage, mossy rocks and other wet places, but also on mossy tree trunks in forest, e.g. on the ridge of Mt. Dorowati together with *Corybas* (36-6) up to 3 m above the soil, at 800-2000 m, rarely at low altitude outside Java. From India to China, throughout the Archipelago, an evasive plant, rare, but probably more common that now supposed.

The tiny roots carry a minute, transparent, globular bladder which acts as a trap for tiny insects which are digested by means of an enzyme which disintegrates proteins. Other insectivorous plants in this work are *Nepenthes* **(33-5)** and *Drosera* **(14-18).**

L 1 LI ACEAE (continued on Plate **28)**

8. Disporum cantoniense (Lour.) Merr.—Flora of Java 3: 94 (as *D. Mnense)—T)ibod2iS* (Mt. Gedé).

An erect, overhanging herb, with a strong rhizome, the lower part of the stem unbranched and leaves replaced by stem-clasping bracts, J-iJ m high. Leaves and branchings distichous hence in one plane, the leaves 6-15 cm long, iJ-6 cm wide. Flowers varying in colour, sometimes greenish-white or white. Tepals with a saccate base.

All over Java, both in high forest and in mossy scrub and elfin woods, at 800-2550 m. SE. Asia, also in Malaya, Sumatra and Bali.

In Sumatra a form (or separate species?: *D. calcaratum)* is found with spurred tepals. In the Philippines *D. lu^pniensis* Merr. has solitary axillary flowers.

1'l.ATE 27

EXPLANATION OF PLATE 28

LILIACEAE (continued)

1. **Dianella** ensifolia (L.) DC, sens. lat.—An inflorescence and to the left a bunch of fruits—Flora of Java 3: 87.

A perennial erect herb, £-1 m high, with a rhizome, the base of the unbranched stem with equitant grass-like leaves, the latter 20-80 cm long, £-3 cm wide, all with sheathing base; stem-leaves much smaller, passing into bracts, more or less distichous. Leaves on margin and underneath the midrib with minute prickles, hence rough at the touch. Tepals sometimes violet. Filaments thickened at the top. Berry globose, blue with 2-9 black seeds.

Common all over Java, but not gregarious, in forests and thickets, at 100-2000 m. Widely distributed from Madagascar and SE. Asia through the Malesian Archipelago.

A variable plant, described under several names. According to Backer the form with blue tepals and umbels racemosely collected would be a different species: *D. montana,* but to me it is at most a race.

2. **Dianella javanica** (Bl.) Kunth—Only an inflorescence, the lower portion in fruit—Flora of Java 3: 87—Mt. Gedé.

In habit like the former, but with very densely tufted smooth leaves, glaucous beneath, 20-40 cm long, 1-3 cm wide. Rootstock sometimes very thick and woody. Stem laterally compressed, sturdy, often branched. Inflorescence profusely branched. Flowers even sky-blue, very rarely white. Filaments thickened in the middle. Berry ellipsoid, with 9-20 seeds.

Only in West Java from Mt. Salak to the Priangan Mts, in elfin forest and brushwood, on ridges and spurs, especially in stony sterile localities near craters, on lavastreams, often close to solfatara, at 1500-2900 m. From the Malay Peninsula and N. Sumatra through the Archipelago to New Caledonia, also on not volcanic mountains.

3. **Ophiopogon** caulescens (Bl.) Backer—a. A small plant in bud, b. inflorescence in anthesis, c. in fruit—Flora of Java 3 : 95— Tjibodas(Mt. Gedé).

A herb with long rhizome, and often very long, thick adventitious, stiff, densely hairy roots, not seldom aerial on an elevated stem, resembling those of orchids (having a thin velamen), acting as stilt-roots. Leaves 15-65 cm long, J-iJ cm wide. Floral stalk 2-edged, leafless, flowers often secund, mostly purplish, sometimes white.

All over Java in the depth of the high forest, but also in elfin and mossy forest, rarely in secondary growth, not in tjemara forest, at 650-2000 m. Also in Sumatra.

The fruiting of this plant is most peculiar because after fertilization the wall of the ovary does not develop, but bursts and withers whereby the ovules become exposed and develop in the open into the depicted globular black-violet seeds which are covered by a fleshy seedcoat (sarcotesta), a remarkable secondary gymnospermy shared by *Peliosanthes* (no. 4). Up to 6 of these seeds develop from one flower.

It is a case where Corner's theory of "shift of function" well applies, that is that fruits or seed develop analogous structures of similar function, here palatability of the diaspores, irrelevant of morphological identity. See also the "fruit" of *Geniostoma* (no. 8 of this Plate)!

A closely related never flowering species of *Ophiopogon* is commonly used as a borderplant in gardens in Java.

4. Peliosanthes javanica (Bl.) Dietr.—a. Leaf, partly, b. infructescence—Flora of Java 3:95—Mt. Salak.

A coarse herb with a thick, woody, horizontal rhizome, the roots also very thick and hairy, similar to those of *Ophiopogon.* Leaves crowded in a rosette, 4-38 cm stalked, blade 7-27 cm long, 2-8 cm wide. Stalk of raceme leafless, 10-65 cm high, terete, erect with nodding top. Pedicels persistent. Flower greenish white, the segments connate at base 4J-6 mm long. Seeds developing as in *Ophiopogon* (see above), 0-3 per flower, also with a sarcotesta.

Only in West Java to the Priangan Mts, and in Nusa Kambangan, in the depth of high forest, rather rare, at 5-1700 m. SE. Asia, also in Sumatra and Borneo, possibly wider; there are more names than species in this genus.

5. Smilax zeylanica L.—Flora of Java 3:99.

Climbing shrub with very tough stems, 3-6 m long, sometimes spiny, not warty. As usual in the genus the leaf-sheath produces 2 tough simple tendrils at the base. Leaves 5-12 cm long, 1 £-4 cm wide, not glaucous. Flowers fragrant.

All over Java, in primary and secondary forests, preferably in forest edges and sunny places, at 50-1600 m. Very widely distributed from SE. Asia through Malesia, possibly even in Madagascar; variable, described under many names.

On Mt. Diëng in grassland I found a specimen which, in absence of support, had developed nolens volens as an erect shrub 1 m high.

LOGANIACEAE (see also Plate 30-1)

6. **Fagraea elliptica** Roxb.—A single leaf and an inflorescence —Flora of Java 2: 211.

A sizeable tree, up to 45 m tall, but often smaller, the trunk up to 1 & m diameter. I noted roots with thick corky bark. Leaves decussate, 8-24 cm long, 2-15 cm wide; twigs with dense leaf-scars. Inflorescences terminal on the twigs. Flowers fragrant. Berries globose, J-J cm diameter, orange to brick-red.

In West Java, in various sorts of localities, but only under everwet climatic conditions, in forest, thickets but also in grass wastes, from sea-level to 1800 m. Throughout the Archipelago but not in Central & East Java, the Lesser Sunda Is. and the Philippines, clearly avoiding areas with a seasonal climate.

7. **Fagraea blumei** G. Don—Flora of Java 2: 211—Nirmala. De Voogd.

A coarse, woody plant. Leaves decussate, 7-20 cm long, 3-13 cm wide. Flowers very coarse, the lobes of the corolla twisted-imbricate. Ripe berry dull green, under the transparent skin is a sticky, waxy substance (van Die c.s., 1957).

All over Java, in forests, 50-2200 m. All over the Archipelago except in Celebes, the Moluccas and New Guinea.

A most interesting plant. The flowers open at sunset, by which the margins of the lobes first detach themselves (see bud in picture) standing out as the blades of a turbine, and after some 5-10 minutes the limb spreads very suddenly. At night they emit a disagreeable smell resembling that of sour milk caused by diacetyl (Derx, 1950). Probably the flowers are visited by bats. According to Burck they are protandrous. They last two days, discolouring the second day (see picture).

The plant is variously reported as: a tree up to 26 m, or a scandent or erect, epiphytic or terrestrial shrub, or a climber. In my experience it is a hemi-epiphyte, that is, a plant which is only epiphytic in its youth stage. Its seed germinates on a host tree somewhere in the axil of a main branch. Here the shrub develops, clasping the stem of the host with its roots, some of which reach the soil. This access to more nutrients leads to accelerated growth both in length and thickness of the root(s) which connects the epiphyte with the soil leading to a stem adjoint to that of the host tree. This is well-known from many species of *Fiats* and of *Wight'ta* (51-5). I have observed it once in *Vactinium laurifolium* (17-6) on a roadside tree near Tretes. The New Zealand montane rain-forest abounds with similar hemi-epiphytes. When the host tree decays, the hemi-epiphyte remains standing as a slender, sometimes high tree.

The collecting of the plant at various stages of its development accounts for the variation of reports on its habit by collectors. I have never seen it truly terrestrial.

8. Geniostoma rupestre Forst.—The orange fruit is the double seed-cake after the two green valves have been shed—Flora of Java 2: 207—Tjibodas (Mt. Gedé).

A shrub or small tree up to 10 m tall. Leaves 5-16 cm long, 2-5 cm wide. Inflorescences sometimes also on old wood below the leaves. At maturity the two blackish valves of the capsule detach at base and top and drop, exposing the many small dark seeds embedded in an orange fruit pulp.

Throughout Java in the undergrowth of the forest, also in elfin and mossy forest on ridges, at 900-2800 m. All through the Archipelago (but not in Malaya) and distributed towards Queensland and the West Pacific islands as far as Samoa and the Marianas. A variable species!

PLATE 28

LORANTHACEAE (see also Plate 30-4/6)

1. **Macrosolen avenis (Bl.) Danser—Flora of Java 2: 70—Mt. Papandajan. 12229.**

A parasitic shrub, }-im diameter; actually a "hemiparasite" because, though absolutely depending on a host plant, capable of assimilating carbohydrates with its green leaves. Leaves variable in size and shape, 4-10 cm long, 1J-4 cm wide. Corolla in various shades of red to orange-red. All floral stages are represented in the picture, but whether the spots on the ripest fruit I could find are a natural feature I do not know; it could be a discolouring by a fungus.

In West Java only as far as the Priangan Mts, parasitizing on all kinds of trees and shrubs, even the conifers of *Podocarpus* (13-1 & 2), at 1600-2400 m. Burma, also in Malaya and Sumatra.

The tubular-flowered mistletoes have a club-shaped bud. Honey-birds press the inflated apex of ripe buds with their beak, which then open suddenly (one can do this also by pressing them lightly between two fingers). Then they insert their long narrow beak and suck the honey, with which the tube is sometimes half-filled, with their specialized tongue. In nature the flowers are always erect.

It is well-known that birds eagerly seak the mistletoe berries which have hardly time to ripen fully, like those of *Polygonum cbinense* (41-7). They pass the intestine very rapidly and the birds have a special technique to get rid of them, rubbing the very sticky kernels off on branches. There they germinate by forming a haustorium and enter the tissue of the host plant. The stem of the mistletoe often branches at the base and these runners attach themselves again by haustoria, a sort of small sucker. When heavily infested, branches and even trees may succumb. Especially isolated treelets are most heavily infested, among them *Citrus*, kapok, etc. Regularly cutting away the parasite is the only remedy.

Common vernacular names for mistletoe are *binalu api, dalu* with prefixes, Malay, *kemaduan*, Javanese, *mangandeu*/\ Sundanese.

2. **Scurruia montana Danser—Flora of Java 2: 74—Mt. Ardjuno. 11838.**

Hemiparasitic shrub, c. 1 m diameter. Leaves 3-12 cm long, 1 £-7 cm wide, brown-felty (as usual in this genus). Flowers 4-merous, the tube splitting on one side.

East Java (Mts Ardjuno, Tengger, Jang & Idjèn) and Bali, almost exclusively parasitizing on *Casuarina* (8-9), exceptionally on *Ericaceae*, at 1450-2900 m. Also once in W. Sumatra (Mt. Merapi).

SCHISANDRACEAE (see also Plate 2-10)

3. **Kadsura scandens (Bl.) Bl.—a. Twig part with male buds and flower, b. female flowers on knob of thick twig, c. full-grown fruit, d. full-grown leaf—Flora of Java 1: 99—Mt. Papandajan. 12250. Tjibodas. 11710.**

A coarse liana, 5-25 m long. Leaves completely entire, 7-17 cm long, 2&-14 cm wide. Flowers of two kinds on one plant, male and female, the first with many crowded stamens; the latter with many crowded ovaries, each developing into a juicy fruit.

All over Java, in the depth of the primary forest, not in tjemara forest, from sea-level to 2400 m. Also in Malaya, Sumatra and Bali.

The completely ripe fruit is well edible with a sour, somewhat aromatic taste.

4. **Schisandra axillaris (Bl.) Hook. f. & Th.—A male flower and a fruit—Flora of Java 1:100—Tosari.**

A rather thin woody climber, 5-10 m long. Leaves elongate, 5-13 cm long, 2-5 cm wide. Each male flower with many stamens on a globose, fleshy receptacle, each female flower with many separate ovaries ditto; both sexes on one plant. In fruit the female receptacle lengthens somewhat, carrying the globular berries, but less elongate than in the other species (2-10).

Throughout Java, in forest and forest edges, at 1000-2400 m. SE. Asia (?), also in Sumatra and Bali.

Schisandra is in sterile state and bud stage very similar to *Kadsura*, especially *S. elongata*, but the leaves have remote teeth, sometimes very obvious, sometimes minute.

5. **Talauma candollii Bl.—a. Twig with flower, b. a maturing fruit, c. a ripe fruit, showing the seeds and one carpel still lingering on—Flora of Java 1:97—Tjibodas (Mt. Gedé).**

A shrub or tree, 2-5 m tall. Leaves 18-45 cm long, 5-17 cm wide. Sepals 3, petals 6, rarely 9, fleshy, 4-8 cm long. Stamens and carpels numerous; latter crowded, separating from the receptacle in the cavities of which the 2 orange seeds of each carpel remain attached after the pericarp is thrown off.

All over Java, in the rain-forest, ascending from low altitude to 1800 m. S. Burma, SW. Cambodia, Peninsular Thailand, also in Sumatra and Malaya.

After the seeds with their orange sarcotesta are exposed they later dangle out on a thin thread which is often mistaken for their funicle. These threads really consist of a number of spirally wall-thickenings torn out of the vessels of their placentation, caused by movements through wind and weight of the seed.

This beautiful species occurs also in cultivation, both in Malesia and in other places in the tropics.

MELASTOMATACEAE (continued on Plate 31)

6. **Kibessia azurea Bl.—Twig with flower and young fruit, left below a separate mature fruit—Flora of Java 1: 371 (as *Pternandraazurea)*—Poeraseda(SW. of Bogor). 11735.**

Alow-branched tree, 5-21 m tall, the trunk to 45 cm diameter. Leaves curvinerved (as usual in this family), 5-14 cm long, 2-6 cm wide; the flush dark blue-violet. Fruit a berry provided with many dredge-shaped warty appendages.

Only in West Java, as far as the Priangan Mts, in the rain-forest, at 17 5 -13 00 m. Also in Sumatra and Borneo.

Flowering on a tree is simultaneous and lasts only a few days; hence after anthesis the ground below a tree is strewn with the (blue) petals, as in *Memecylon* of the same family, and in several *Rosaceae* (cherries, apples, pears, etc.).

Not seldom peculiar densely soft-setose, green, globular galls are developed, measuring some 1J cm diameter, in sessile pairs on the nodes just below each leaf pair. They are caused by gall-gnats and were in the past mistaken for fruits.

A Sundanese name for this tree is *ki beusi*, from which Blume coined the generic name *Kibessia. Ki befujsi* alludes to iron-hard wood, but this is in confusion with *Rhodamnia cinerea*, a Myrtaceous tree with equally opposite curvinerved leaves and very hard wood. Our tree has inferior wood; a good Sundanese name is *ipis kulit.*

The genus *Kibessia* is very well distinct from *Pternandra* by the peculiar calyptrate, circumscissile-dehiscing calyx; in *Pternandra* the calyx is minutely lobed from the beginning. The leaves are in both genera very similar.

PLATE 29

LOGANiACEAE(see also Plate 28-6/8)

1. **Buddieja asiatica** Lour.—Flora of Java 2: 212—Mt. Ardjuno.

Shrub, 1-5 m tall, very variable in hairiness, leaf size and shape. Leaves 9-20 cm long, 1-5 cm wide, underneath whitish or yellowish felty. Inflorescences 4-25 cm long, sometimes united to panicles.

All over Java, in mixed and tjemara forests, in thickets, forest edges and riversides, gravelly riverbeds, talus, at 600-2900 m, sometimes descending to 150 m along rivers. A pioneer on lavastreams and invading grassland after fire. From West Pakistan to S. China & Formosa and the Marianas, throughout the Archipelago.

LABIATAE (continued from Plate 25)

2. **Plectranthus petraeus** Adelb.—Leafy top and top of panicle—Flora of Java 2: 636—Mt. Idjèn, near Sempol. 12008.

Erect, coarse, very aromatic, densely white-felty herb, i-ijm high. Leaves 4-10 cm long, 3-6 cm wide. Spikes arranged in large, terminal panicles.

Only known from Mt. Idjèn, on grassy, sunny and hot rocky old lavastreams (redjèngans), with pioneering tjemara, at 1100-1400 m.

LEGUMINOSAE (continued from Plate 27)

3. **Pithecellobium clypearia** (Jack) Benth.—Part of a leaf and across it part of inflorescence with some pods—Flora of Java 1: 5 51— Tjibodas (Mt. Gedè). 12913.

A tree, 3-20 m tall, with sharp-angular twigs. Leaves with 4-15(-20) pairs of pinnae, which in turn have 8-26 pairs of opposite trapezium-shaped leaflets j-3 cm long and J-iJ cm wide, fine-hairy beneath. Flowers fragrant. Pods curled up, circinnate, c. 1 cm wide, inside orange, opening with 2 valves, containing 2-10 black seeds.

All over Java, in forests, from sea-level to 2000 m. Also known from SE. Asia and Malesia.

One of the very few leguminous trees ascending to 2000 m in the Malesian tropics, the others being a *Sophora* and *Aibi^ia* (26-4). In the mountains the leaflets are smaller than lower down, but this decrease in size is gradual.

LORANTHACEAE(see also Plate 29-1/2)

4. **Dendrophthoe magna** Danser—a. Twig with adult leaves, b. flush, c. older twig with buds and flowers, the one on the right just open—Flora of Java 2: 72—Mègamendung (Mt. Gedè). 12205.

A strongly branched, enormous woody parasite which can grow to 5 m diameter, with a woody stem of 5 cm through. Leaves 8-13 cm long, 3-4^ cm wide. Inflorescences solitary in the axils of old leaves or fascicled (as depicted) on defoliated nodes below the leaves. Flowers supported by large bracts, 5-merous, slit on one side.

Only in West Java, restricted as far as known to the northern spurs of Mt. Gedè, viz. Geger Bintang, G. Limo, G. Telaga, and other peaklets around Puntjak Pass, at c. 1400-1800 m. Also on Mt. Kinabalu (Sabah).

Parasitizes on *Castanopsis acuminatissima (riung anak)* and possibly also on *Lithocarpus* species (oaks). Always in high trees, but traceable on the forest bottom by the fallen corollas.

5. **Korthalsella dacrydii** (Ridl.) Danser—3 plants on a twig of *Podocarpus imbricates* (13-2)—Flora of Java 2: 75—Tjibodas (Mt. Gedè). 11494.

A miniature mistletoe, little-branched, up to 10 cm long. Leaves are represented by opposite, tiny scales. Flowers minute, greenish, 1/5 mm diameter, male and female on one plant. Berry equally minute, 1 mm, 1-seeded.

In Java from Mt. Gedè eastwards as far as Mt. Kawi, always on *Podocarpus imbricates,* at 1400-2000 m. Also known from Malaya, Atjeh, SE. Borneo, and Timor. In one place in Atjeh, and in Malaya, a parasite on an other conifer, viz. *Dacrydium elatum.*

A most evasive plant, most localities known from a careful scrutiny of herbarium specimens of *Podocarpus* by Wasscher (1941) but not observed by collectors of *Podocarpus.* In fact I discovered this plant while in search in the herbarium for pollen of *Podocarpus* on a specimen from Tjibodas, where almost all trees seem to carry it. It causes no galls like the following species and is hard to spot in the field. Its extremely small size makes its pollination and seed dispersal difficult to understand. Its stem emerges always in the axil of the coniferous leaf.

6. **Korthalsella japonica** (Thunb.) Engl.—Sprouting from the gall-like thickening of a branch of *Altingia exce/sa* (23-4)—Flora of Java 2: 75—Tjibodas (Mt. Gedè). 11698.

Sometimes densely branched small mistletoe, 5-10 cm long, rarely to 20 cm. Internodes flattened in one plane. Leaves minute scales collected in a sort of collar at each node. Berry minute, pale to reddish.

In Java rarely collected, but an evasive plant easily overlooked and mostly found by accident; on the spurs of Mt. Gedè, in Priangan, and on Mt. Gilipetung (Djokja), at 1000-1800 m. Extremely widely distributed from Abyssinia and Madagascar through SE. & E. Asia and Malesia to E. Australia and Lord Howe I.; in N. Sumatra (up to 3000 m), Malaya, N. Borneo (Mt. Kinabalu) and the Philippines.

On various host trees, in Java on *Symplocos* (52-4), *Eurya* (52-6), *Schima* (52-7) and *Altingia* (23-4), in Atjeh also on *Ternstroemia* and *Ericaceae,* in India mainly on *Quercus.* The large cultivated *Altingia* in front of the guest-house at Tjibodas is heavily infested and this curious parasite can easily be observed there. Its reaction with the host plant causes a gall-like swelling of the twig of the latter.

MORACEAE (continued on Plate 32)

7. **Madura cochinchinensis** (Lour.) Corner—Flora of Java 2: 17—Tjibodas (Mt. Gedè). 11713.

A wild-branching, tough, thorny climber to 5-10 m high, with latex. Leaves 2-9 cm long, 1-3 J cm wide. Flowers (and later the fleshy fruits) many, male and female, in short-stalked heads.

All over Java, in thickets and secondary forest, from the lowland up to 1500 m. S. to E. Asia, all over Malesia.

The thorns are to be understood as modified branches, as they sometimes carry leaves.

OLEACEAE (see also Plate 33-6)

8. **Ligustrum glomeratum** Bl.—Flora of Java 2: 215—Mt. Idjèn. 11992.

Shrub or tree, 5-15 m high. Leaves to 4-10 cm long, 2-4 cm wide. The white flowers have 2 stamens and are sweet-scented. Fruit (drupe) up to 8 mm long, fleshy, dark purplish, tasting bitter sweet, with 1-3 seeds.

All over Java, in forests, most commonly in secondary growths and thickets, but also in elfin and mossy forest on ridges, and invading grasslands, from the lowland up to 2600 m. SE. Asia and all through Malesia. A variable species, sometimes cultivated as an ornamental.

1'LATE 30

EXPLANATION OF PLATE 31

MELASTOMATACEAE (continued from Plate 29)

1. **Astronia spectabilis** Bl.—Flora of Java 1: 371—Tjibodas.

Tree, 10-30 m tall, trunk to i£ m through! Leaves 8-25 cm long, 4-11 cm wide, densely brown(-scaly) beneath. Calyx 5-7 mm long, not ribbed, and not constricted below the top, distinctly 5-lobed, densely brown(-scaly). Petals white, 6-7 mm long. Filaments 4 mm long. Fruits over 1 cm diameter, their pericarp withering and leaving the vessels of both endo- and exocarp as a cup of erect fibres surrounding the very numerous needle-thin, erect seeds packed as matches in a round box.

All over Java, in mixed mountain forest, common, also commonly invading tjemara forest in East Java and Bali, and sometimes locally dominant (Mt. Tjeremai, Slamat, Mt. Abang in Bali), at 1300-2500 m. Also known from Lombok and SW. Celebes (Mt. Bonthain).

The Sundanese name is *ki harèndong*, a sort of family name given with various suffixes and prefixes to many climbing members of this family.

2. **Creochiton bibracteata** (Bl.) Bl.—Flowering twig with 1 open pink flower, a bud and 2 immature, developing fruits, natural poise—Flora of Java 1: 362—Puntjak Pass. 11541.

Long liana, by its roots attached to trunks; patent branches short, hanging, 1-2 m long, brown-hoarish-hairy as is the flush. Leaves 5-12 cm long, 3 J-6 cm wide.

Endemic in West Java, on Mts Salak and lower northern spurs of Gedé, but also in Priangan Mts (e.g. Mt. Papandajan), in forest and forest borders, a very beautiful but obviously rare climber.

3. **Medinilla laurifolia** (Bl.) BL—Perpendicular twig with one smallish even darkgreen leaf, one large pink flower and 2 pale green hanging immature fruits, natural poise—Flora of Java 1: 368—Tjibodas.

Shrub \-*i*\ m through, mostly epiphytic, sometimes on rocks, the twigs with thickened nodes and often warty, round to bluntly 4-angular. Leaves opposite, besides the main rib with 2 lengthwise nerves near the margin, 6-15 cm long, 2-7 cm wide. Inflorescence few-flowered and not paniculate, 4-6 cm long, the axes pale pink. Flowers 5-merous.

Mainly in West Java, but also scattered eastwards as far as Mt. Merapi in Central Java, in high forest, but especially common in lower, more open elfin and mossy forest, on ridges, at 800-2400 m. Also in Sumatra and S. Celebes.

4. Medinilla speciosa (Bl.) Bl.—a. Large leaves (in part) from underside with red nerves on thick twig ending at b. where also part of inflorescence with purple berries below the smallish pink flowers; natural poise—Flora of Java 1: 367—Tjibodas.

A shrub, 1^-3 m tall, sometimes epiphytic, on tree trunk bases, sometimes said to be more or less climbing. Twigs with corky bark, angular or winged below the nodes. Leaves very large, mostly in whorls of 3-4, more or less sessile, often somewhat V-like folded, 12-32 cm long, 5-13 cm wide; main nerves green or red beneath. Panicles drooping, 5-18 cm stalked, 10-40 cm long in all, main branches mostly in whorls. Flowers 4-5-merous. Fruit finally almost black.

All over Java, eastwards obviously as far as Mt. Tengger, in high rain-forest, a magnificent plant, mostly solitary or in a few specimens, at 700-2200 m. Also in Malaya, Sumatra, (? Borneo), Bali, Lombok and Ceram.

It has peculiar dense axillary bushes of dry fibrous erect hair-like scales on the stem-nodes, in consistency somewhat resembling those found on *Saurauia* and *Me las to ma*, but here confined to the nodes. Whether these are morphologically roots or mere enatia is unknown to me. They are found also in certain other species of *Medinilla.* A specialized function seems uncertain. Naturally they collect detritus and these nodes are often found saturated with water.

5. **Medinilla alpestris** (Jack) BL—Flora of Java 1: 369—Above Puntjak Pass towards Mt. Geger Bintang (Mt. Gedé). 12638.

An erect shrub, 2-6 m high, mostly terrestrial, but obviously sometimes epiphytic. Leaves sessile, sometimes their bases stem-clasping, 5-25 cm long, 3-12 cm wide, those of a pair equal to very unequal higher up.

Common in Java, especially in West, scattered eastwards, at least as far as Mt. Tarub (Lamongan) between Mts Tengger and Jang, in rain-forest, at 600-2500 m. Also in Sumatra and Bali.

Sometimes confused with a closely allied, but different species which seems to be confined to Mt. Salak, *M. verrucosa,* but readily distinguished from it by a sharp-quadrangular stem and even the flush completely glabrous, without scales.

6. **Melastoma trachyphyllum** Bakh. f.—Flora of Java 1:359—Kandangbadak (Mt. Gedé).

An erect terrestrial shrub, 2-4 m high. Leaves above rough as sandpaper, 5-14 cm long, 2-6 cm wide. Pedicels covered with small triangular brown scales. Sepals scaly on both sides. Petals white (sometimes purple?), mostly with a red margin, 2-2$ cm long. Stamens distinctly unequal; prolongation of the connective 2-4(-io) mm.

All over Java, eastwards as far as Mt. Idjèn, in forest edges and thickets, and in elfin wood on ridges, at 1000-2500 m, usually above 1500 m. Also in Sumatra and Lombok.

Some details have been cited in order to avoid confusion with two other rather common Javanese species which are rather similar in habit.

7. **Sarcopyramis napalensis** Wall. var. **javanica** (Z. & M.) Hochr.—Left before the buds there is a young square fruit seen from above—Flora of Java 1: 361—Mt. Salak.

Erect or ascending annual herb, somewhat fleshy, 5-30 cm high. Leaves 14-5 cm long, 1-3 cm wide, of a pair mostly different in size. Flowers 4-merous, petals 10-17 by 7-12 mm, easily falling off, the 4 calyx lobes linear, feathery incised. Ovary and fruit crowned by a 4-angular bowl.

In West Java from Nirmala eastwards to Mt. Salak, never found on Mt. Gedé, in moist places in forest and forest edges, preferably along rocky shaded streams, at 1000-1600 m. SE. Asia, also in Malaya, Sumatra and E. Borneo (Kutei).

8. Sonerila heterophylla Jack—Flora of Java 1: 362—Mégamendung (above Bogor towards Mt. Gedé).

Erect or ascending herb, 10-50 cm long, rather densely hairy. The leaves of a pair very different in size, the larger being at least 10 times as long as the smaller, in the upper half coarsely toothed, 5-8 cm long, 1^-3 cm wide. Flowers 3-merous, with 2-5 in axillary bundles. Capsule dehiscent with 6 small triangular apical valves.

Mostly in West Java, scattered eastwards as far as Mt. Ungaran, in the depth of the forest, at 1000-1600 m. Also in Sumatra (down to 8 50 m) and Malaya.

9. **Sonerila tenuifolia** Bl.—Flora of Java 1: 362.

Erect, thin, slender herb, 5-90 cm high, mainly branched in the upper half, younger parts reddish, older ones often woody with grey bark. Leaves of a pair little different in size, 2-8 cm long, 1-3 cm wide, serrate, mostly on both sides with scattered bristly hairs, often purple beneath. Capsule dehiscent with 3 apical slits.

In West Java as far as the Priangan Mts, in low light forest, particularly on ridges and slopes, in elfin and mossy forest, often common, at 1000-2300 m. Also in Sumatra, Malaya, **and** N. Borneo (Mt. Kinabalu & Sarawak).

PLATE 31

EXPLANATION OF PLATE 32

MORACEAE (continued from Plate 30-7)

1. **Ficus sinuata** Thunb. ssp. cuspidata (Bl.) Corner—Lateral twig in natural poise—Flora of Java 2:25.

A slender treelet up to 6 m long, mostly epiphytic and with its roots clasping the trunk of the host tree. Branches drooping, the figs axillary or behind the leaves. Leaves distichous, 4-18 cm long, 1-4^ cm wide, the young ones white, often long-acuminate at top. Figs finally red. Plant with latex as all fig species.

In West and Central Java, eastwards to Mt. Lawu, in rain-forest, at 700-2000 m. Also in Malaya & Sumatra.

This is a montane subspecies of a species ranging from SE. Asia to Celebes.

The leaves have a peculiar prolonged cuspidate apex—though this may vary in this species and be hardly present in other subspecies—a so-called driptip ("Träufelspitze") where a drop of water may linger when the rest of the leaf has already dried up after rains. As such driptip leaves are rather restricted to certain species in the very wet tropical and tropical-montane forests romantic visiting botanists have invented theories about a supposed specialized function which they "a priori" should possess. Resident botanists are more conservative in their opinion, observing that only certain species have them, and that the majority of the elfin and mossy forest trees in the same biotope have blunt leaves. They observe also that the length of the tip may be variable, as in this species where it measures from 6 mm (that is: no driptip) to 50 mm. Excessive length growth of leaves under gloomy very wet conditions is a common experience in greenhouse cultivation. In other instances it may be an inherited specific character, without a specialized function. I have always wondered why such teleological speculation was not applied to human races of which some have a sunken nose-bridge and a flat nose and others both features prominent.

2. **Ficus** disticha BL—Flora of Java 2: 21—Mt. Salak. 11525.

A large root-climber to over 20 m long, old stems to 5 cm through. Leaves leathery, distichous, 2-7 cm long, 1-3^ cm wide, variable in shape. Figs axillary or on the twig behind the leaves, 8-11 cm wide.

Only in West Java as far as the Priangan Mts, creeping or climbing in the forest, often in rocky places, in elfin and mossy forest on ridges and along watersides, fruiting on slender free-hanging shoots, at 1100-1900 m, rarely lower. Burma, in Malesia common, as far east as the Philippines and Ternate, in Sarawak also in lowland peat-swamp forest.

3. **Ficus deltoidea** Jack var. **lutescens** (Desf.) Corner—a. & b. Two different forms—Flora of Java 2:28.

A terrestrial shrub or small tree, or an epiphytic root-climbing shrub, up to 7 m, often smaller and epiphytic, clasping the support by roots. The thickish leaves on one plant may be of two kinds, lanceolate and obovate, with different venation, even on one twig, 3-10 cm long, 2$-6 cm wide. Always a few black glands in nerve axils on the yellowish undersurface. Figs 8-12 mm, of various shape.

In Java from Mt. Pulasari to the Priangan Mts, in the depth of the high rain-forest, but more common in lower elfin and mossy forest on ridges, and rocks, sometimes gregarious in thickets surrounding solfatara, hot springs and mudwells in very acid soil (Mt. Salak!), at 800-2400 m, rarely 400 m (Udjon Kulon). Also in Sumatra and Borneo.

One of the varieties of a very variable species ranging from Lower Thailand over the Greater Sunda Is. and descending to sea-level.

The thick leaves may secrete abundant water through their hydathodes (drip) recognizable as grey spots (chalk) after evaporation.

This variety is often cultivated as an indoor plant in temperate countries.

4. Ficus punctata Thunb.—A branched twig with small elliptic leaves and in front a halved hanging fig with drops of latex on the cut—Flora of Java 2: 21—Tjibodas (Mt. Gedé).

A very large shrub climbing with roots and appressed to the support, 10-20 m long, the stem to 6 cm diameter. Leaves 1J-4J cm long, £-2$ cm wide, varying in shape, underneath with small hairy pits. Figs roughly resembling a peach, from knobs on the old wood, 5-11 cm long, 4-8 cm wide, making a sharp contrast to the small leaves.

All over Java, rather common, in humid forest, but also in villages and orchards, at (400-)800-1800 m. From Lower Thailand ranging eastwards to Celebes.

MYRICACEAE

5. **Myrica javanica** Bl.—A male flowering twig, at base with 2 fruiting racemes of a female tree—Flora of Java 2: 2—Mt. Gedé.

Dioecious tree, mostly gnarly, to 25 m tall and trunk to 33 cm diameter, often merely 2-3 m tall. Young twigs glabrous with minute sessile yellow glands at the underside of the leaves. Leaves obovate, 5-12 cm long, 2^-7 cm wide, aromatic when crushed. Flowers in catkins. Fruit a warty 1 -seeded drupe, tasty and aromatic when ripe.

In Java from Mt. Salak eastwards to Mt. Jang, on ridges and peaks, near craters, a pioneer on lavastreams, etc., sometimes dominating in the elfin forest, at 1000-3300 m. Throughout Malesia, but not found in Malaya and the Lesser Sunda Is. east of Lombok.—Used for reafforesting montane grassland. As a roadside tree near Trètès.

MYRSiNACEAE(see also Plate 33-2)

6. **Ardisia fuliginosa** Bl.—Flowering twig and bunch of fruit —Flora of Java 2:197—Tjibodas (Mt. Gedé).

Shrub or treelet, 2-5 m high. Leaves 8-24 cm long, 2&-10 cm wide, the flush rusty-hairy; fruit a 1 -seeded drupe as is usual in the genus.

All over Java, in rain-forest undergrowth, at 50-1750 m. Also in Sumatra, Borneo, Celebes and Lombok.

7. **Ardisia javanica** DC.—Flowering twig and below a bunch of blackish-red drupes—Flora of Java 2: 199.

Slender, lax shrub, 2-5 m high. Leaves 4 J-9 cm long, 1 £-4 cm wide. Corolla whitish or pink.

All over Java in the rain-forest undergrowth, in elfin and mossy forest, on ridges, at 900-2300 m. Also in Sumatra, Borneo and the Lesser Sunda Is. eastwards to Flores.

As is common in this genus the lateral twigs are conical-thickened inserted at the base.

8. Ardisia villosa Roxb.—Flora of Java 2: 197.

A small shrub J-i J m high. Leaves 10-16 cm long, 24-5 cm wide. Calyx about as long as the corolla, hairy.

All over Java (but rare in East), in the undergrowth of rain-forest, more common in lower elfin and mossy forest on ridges and slopes, also in secondary thickets, mainly above 1000, to 1850 m, but sometimes lower, even 100 m in bamboo groves in Nusa Kambangan. SE. Asia, also in Sumatra, Malaya, and rare in Borneo.

In this species the leaves have obvious red-brown dots (glands in the leaf tissue, as in all species of the genus, but mostly only observable in transparent light).

9. **Myrsine avenis** (Bl.) DC.—Female specimen—Flora of Java 2: 203—Mt. Salak crater.

A small tree, 4-8 m tall, rarely a thick tree to 15 m. Leaves leathery, hard, with no venation visible or very obscurely so, 3±-io cm long, 1-5 cm wide. Flowers male or female, on different trees. Flowers and fruit largely behind the leaves on the twigs, clustered on accrescent woody knobs. Fruit a 1-seeded drupe.

All over Java, especially in the elfin and mossy forest on ridges and slopes, often gregarious, dominant or co-dominant with *Vaccinium varingiaefolium* (17-8), *Myrica* (no. 5 of this Plate), and *Leptospermum* (33-4), at (1300-) 1800-3000 m, e.g. on Mts Gedé, Papandajan & Jang, and not shunning the poisonous craters and sulfurous mudwells, close to the solfatara of Mt. Salak, together with *Ficus deltoidea* (no. 4 of this Plate). From Malaya and Sumatra eastwards to the Philippines, Celebes and Flores, possibly wider.

In transparent light the leaves show white, short streaks **and** dots which are glands in the leaf tissue, as usual in this genus.

I'l.ATK 32

EXPLANATION OF PLATE 33

MENISPERMACEAE

i. **Stephania capitata** (Bl.) Walp.—Flora of Java i: 159—Tjibodas (Mt. Gedé).

A slender, entirely glabrous climber, twining to the left with striate stems 2-15 m long, the roots tuberous, fusiform. Leaves peltately attached, 6-17 cm long, 2j-io cm wide. Flowers unisexual in racemosely arranged heads with a fleshy receptacle, the male heads 8-10 mm diameter, the female heads 12-15 mm- Fruits rather long-stalked, 8-10 mm long, glabrous, red.

All over Java, in primary and secondary forests, from the lowlands to 1600 m. Also in Sumatra, Malaya, Borneo, and Bali.

MYRSiNACEAE(see also Plate 32-6/9)

2. **Maesa latifolia** (Bl.) DC, sens, lat.—Flora of Java 2:195—Tjibodas (Mt. Gedé).

An erect shrub, 2-5 m high, of very modest appearance. Twigs brownish, with lenticels. Leaves variable, 3-16 cm long, 1-8 cm wide.

Throughout Java, in the forest, especially in little shade, along streams, in thickets and secondary forest, at 300-1600 m. Also in Sumatra and probably wider.

Ki piit (Sundanese) is often cultivated in hedges *(pagers)* as the young shoots are an estimated vegetable.

MYRTACEAE

3. **Eugenia operculata** Roxb.—Flora of Java 1: 336 (as *Cleistocalyx operculata)*—Tjibodas(Mt. Gedé). 12282.

Tree 10-25 m tall. Leaves 9-17 cm long, 4-6\ cm wide. Calyx tube top-shaped, c. 4 mm long, the apical part falling off as a whole, also the petals connate to a caducous cap. Stamens 7-10 mm long. Fruit a globose, red *djambu.*

All over Java, in high forest on dry soil, but also in the lowland in permanent freshwater swamp-forest, up to 1600 m. From SE. Asia throughout Malesia to Australia.

It is most unusual that the same tree species inhabits two such different habitats, mountain forest and lowland freshwater swamp. From Bogor one can easily observe both habitats, viz. at Tjibodas on Mt. Gedé and east of Tjibinung in the swamp forest at Tjitjadas, which is kept permanently flooded by a freshwater well; there it forms a forest together with ***Elaeocarpus macrocerus* (Turcz.) Merr., *Horsfieldia glabra* (Bl.) Warb., *Glochidion glomerulatum* (Miq.) Boerl., *Ficus microcarpa*** L. f., and *Ilex cymosa* Bl. (S 1934).

I agree with Henderson that *Cleistocalyx* is a mere section of the large genus *Eugenia, djambu* in Malay.

4. **Leptospermum flavescens** J.E.Sm.—Flora of Java 1: 346—Mt. Gedé.

Usually a shrub or tree, mostly crooked and gnarled, strongly branched, the crown generally umbrella-shaped, in poor localities dwarfed to even less than 50 cm. Twigs triangular, silky hairy. Wood very hard, often contorted, bark grey, flaky. Leaves ij-3i cm long, £-j cm wide, aromatic when crushed. Flowers fragrant. Fruit hard, dry, greyish, obconical-cupular, 5-7 mm, opening at the wide apex with slits just wide enough to let pass the numerous, minute linear seeds.

Only in West Java on Mts Salak, Gedé, Malabar, Tjikuraj & Papandajan, in elfin and mossy forest, on summits and ridges, often co-dominant or dominant (Mt. Sèla on Mt. Gedé), near to craters and pioneering on ash-slopes and lavastreams, at 1700-3000 m (1200 m, Mt. Salak crater). Southern SE. Asia throughout Malesia to Australia; in the Lesser Sunda Is. only in Flores. Not in New Guinea. In many places outside Java, e.g. Malaya, Banka, Billiton and Borneo on sandy podsolic soils also at very low altitude. In the Toba-Batak region a characteristic pioneer in successional stages of thickets and shrubberies. On all high peaks and highlands with acid bedrock (granite, sandstone, quartzite) e.g. on the massifs of the Gajo Lands in N. Sumatra, Mts Tahan in Malaya, Kinabalu in N. Borneo and Latimodjong in Central Celebes, up to 3600 m.

In poor localities specimens of only 20 cm may already flower and fruit profusely. On Mt. Gedé flowering mainly in May-June, on Mt. Singalang seen in January; it blossoms abundantly and the trees then look from a distance as covered by snow.

NEPENTHACEAE

5. **Nepenthes gymnamphora** Nees—a. Ground rosette with pitchers in various stages, b. a male inflorescence, c. a female inflorescence in fruit—Flora of Java 1: 167—Pondok Walanda, Mégamendung, above Bogor. 12215.

An unbranched woody climbing plant, forming small pitcher-bearing leaf-rosettes at the base of the stem and here and there on the stem; the apical part with "normal" leaves which are sessile, with a semi-amplexicaul base and more or less parallel edges, 10-35 cm long, 2-6 cm wide, the midrib continuing in a tendril which may in its turn end in a pitcher; the pitcher with a transversely ridged rim and a lid, whether or not provided with two lengthwise fringes. These pitchers are somewhat different in shape and colours from those depicted here. Male and female flowers on different plants, in dense terminal racemes. Pods dehiscing, with very many tiny, linear seeds.

In Java confined to rain-forest, in the depth of high forest, but also on forest borders, on ridges, in elfin and mossy forest, often in stony and barren places, sometimes near solfatara. From Mt. Halimun (Nirmala) eastwards to Mts Diëng, Telemojo & Lawu, further east only in three spots: Mt. Dorowati, Mt. Lamongan and Ranu Darungan (SE. Sméru), at 900-2400 m. Also in Sumatra.

The plant climbs with the tendrils which may fasten with 1-2 loops round branches. The wood of the stem is very tough and when the bark is (easily) peeled off it can serve as a substitute for rattan. Some native names are *sorok radja mantri* or *pakit soro* in Sundanese *an&gantongsemar* in Javanese.

The basal part of the pitcher is provided with glands which produce water, slime and a protein-digesting enzyme. Small animals, ants, beetles, etc. which fall over the rim into the pitcher, cannot climb out because of the extremely smooth pruinose inside of the upper part of the pitcher and thus fall a victim to the plant. The pitchers are often halfway filled with water and contain much detritus besides the non-digested chitin remains of the shells of insects.

Nepenthes is ecologically most interesting as it is a sure indicator of an everwet climate; in East Java it is hence restricted to three local everwet spots (it may potentially occur also locally on the wet south slopes of Mts Jang, Raung & Idjèn) mentioned above, where it is associated with *Gleichenia* and *Hymenophyllaceae* which are of equal climatic significance.

OLEACEAE (see also Plate 30-8)

6. **Jasminum multiflorum** (Burm. f.) Andr., sens. lat.—Flora of Java 2: 218—Tjibodas (Mt. Gedé). 11714.

A woody climber, 2-10 m long. Leaves glabrous or hairy, 4-13 cm long, 2-6 cm wide. Calyx teeth 5-8, 2-12 mm long. Corolla tube 2-3 cm long, the 7-9 lobes 1J-2 cm long. Berry containing 2 seeds (as in our picture) or 1.

All over Java, a very common, variable plant, occurring in glades in primary and secondary forest, everwet or seasonal, in thickets and even in teak-forest, ascending from sea-level to 1600 m. SE. Asia through Malesia to Queensland.

The flowers expand in the afternoon, and drop in the early morning, spontaneously or at a slight touch.

Sometimes this species is cultivated as a garden ornamental. In tropical America here and there naturalized.

PLATE 33

EXPLANATION OF PLATE 34

ORCHIDACEAE (continued on Plates 35 to 40)

A very considerable portion of the 700-odd species recorded from Java occur in the mountains, predominantly in the cloud belt between 1000 and 2400 m where moss is abundant. Consequently, they are scarcer in East Java, save in very humid spots e.g. on Mt. Dorowati, Mt. Lamongan, and some other "wet islands". The majority of the species live on tree trunks and branches, together with ferns and moss, as *epiphytes*; a single large tree may carry dozens of species. F.W. Went (1940) has found that these do not occur in a completely random way, but there are preferences to the host tree, so that one can speak of associations. He also found that in less rainy periods fleshy leaves and pseudobulbs shrink, but are capable of absorbing atmospheric water.

Quite some epiphytes may, in absence of trees, grow well on rocks, lavastreams, and near waterfalls, provided the situation is suitable everwet, e.g. on Mt. Lamongan; on Bur ni Tèlong in the Gajo Lands they form magnificent rock gardens.

The roots and rhizomes of all orchids live in symbiosis with mycorrhizal fungi providing transition of water and nutrients absorbed from humus, soil and litter. Some have become so lazy that they entirely depend on the fungus and have no green leaves; such *saprophytes* are found in 34-3 and 37-4.1 have given a key to these saprophytes (1931).

The general Malayan name for orchid is *anggrèk;* in Sarawak & Sabah it is *bunga last, lau* being a corruption of the explorer's name (Sir Hugh) Low, who was obviously fond of collecting them.

Fortunately there are only very few commercial orchids in the mountain flora, safeguarding their existence (see 36-6, 37-2, 38-1, 39-3, etc.).

1. **Bulbophyllum obtusipetalum** J.J.S.—Flora of Java 3: 379—Tjibodas(Mt. Gedé).

Epiphytic. Leaves 15-24 cm long, 3-4* cm wide. Rhizome creeping, branched, the stems 2-4 cm spaced. Racemes mostly in pairs, 19-26 cm long. Flowers scented.

In Java common at Tjibodas, on Mt. Papandajan, and Andung (Kedu) in Central Java, in humid forest, at 1000-1600 m. Also in Sumatra.

2. **Caladenia carnea** R.Br.—Flora of Java 3: 255—Mt. Salak.

Terrestrial, delicate herb; stem soft hairy. Leaf erect, linear, 5-15 cm long, 3-nerved, violet underneath. Inflorescence purple-red tinged and specked.

In Java from Mt. Salak eastwards to Mt. Ardjuno, in grasslands, at 1400-2300 m. Australia, Tasmania, New Caledonia, also in Timor, Lombok, Bali and SW. Celebes (Mt. Bonthain). The other species of this genus all in Australia and New Zealand.

3. Cystorchis **aphylla** Ridl.—Flora of Java 3: 276—Tjibodas (Mt. Gedé).

Terrestrial, saprophytic, with a much-branched fleshy rhizome. Stem fleshy to 16 cm long, with scales only, bearing up to 20 flowers.

Mainly in West Java, rare in Central and East Java (Mt. Lamongan), at 1000-1700 m. Also in S. Sumatra, Malaya, Borneo, and the Philippines.

4. **Liparis pallida** (Bl.) Lindl.—Flora of Java 3: 307—Mt. Jang. 1**1944.**

Epiphytic. Pseudobulbs densely together, long-ovate, compressed, to 16 cm long, bearing one fleshy leaf jointed at the base, up to 30 cm long and 3 £-5 \ cm wide. Inflorescence to 30 cm long. At the end of flowering the large bracts become patent.

Throughout Java, in rain-forests, at 1000-2200 m. Also known from Sumatra and the Philippines.

5. **Macodes javanica** (Bl.) Hook. f.—Veins are in nature white-silvery, not golden-yellowish—Flora of Java 3: 275—Tjibodas (Mt. Gedé).

Terrestrial. Stem ascending, rooting at the base, fleshy, glabrous. Leaves 4-8 cm long, 24-5 cm wide. Inflorescence on a pale brown stalk with patent glandular hairs, up to 30 cm long in all, with up to c. 40 flowers. Contrary to most orchid species, the ovary is here not twisted and the flower therefore in its original position.

In West Java in forest, at 1000-1400 m.

Possibly better to be regarded as variety *argenteo-reticulata* **J.J.S. of *M.petola* Lindl.**

6. Nephelaphyllum tenuiflorum Bl.—Flora of Java 3: 291—Puntjak Pass(Mt. Gedé).

Terrestrial, with creeping rootstock, rooting at the nodes; stem fleshy, grey-purple, ascending, 15-20 cm long, with one leaf, 7J-8J cm long, 2 £-4$ cm wide. Flowers 5-8, lax.

In Java in forest, mainly in elfin and mossy forest on ridges, (? 2 50-) 1000-1800 m. Annam and Thailand, also in Sumatra, Malaya, and Borneo.

7. **Thelymitra javanica** Bl.—Flora of Java 3: 254—Mt. Papandajan.

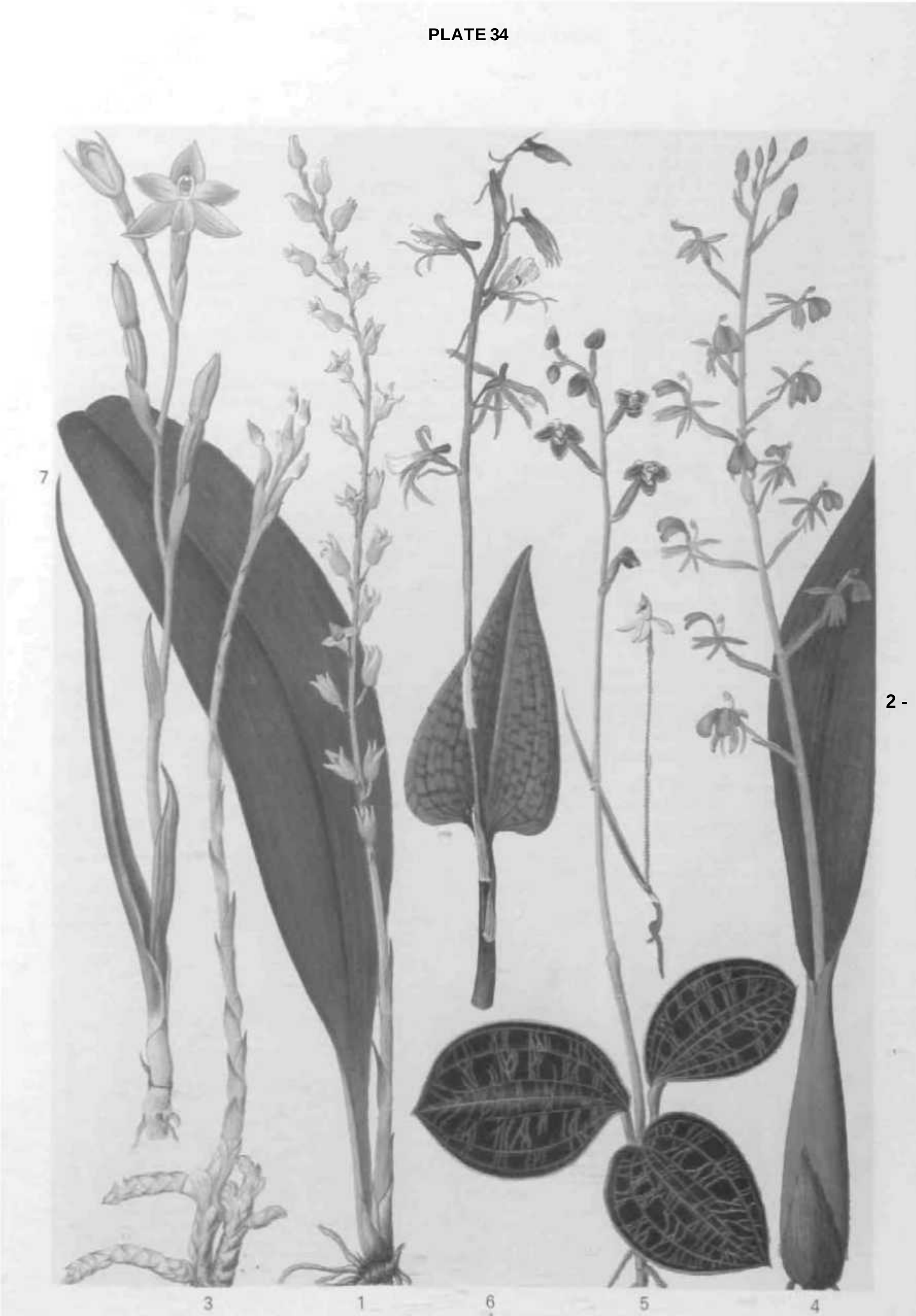
Terrestrial, with an elongate tuber. Stem 10-40 cm high, with one linear leaf, V-shaped in section, 5-16 cm long.

In Java from Mt. Gedé eastwards to Mt. Idjèn, in grassland and other sunny open places, mostly solitary but sometimes in dense groups, at 2000-3150 m. Also in Lombok and Luzon.

The flowers are very sensitive, closing in the daytime when the sun disappears, reacting rather to temperature than to light. On cold cloudy days they remain closed, but in a warm room they open.

The other species of this genus are almost all in Australasia.

PLATE 34



EXPLANATION OF PLATE 35

ORCHIDACEAE (continued)

1. **Calanthe** speciosa (Bl.) Lindl.—Only apex of inflorescence —Flora of Java 3: 328—Puntjak Pass (Mt. Gedé).

A coarse terrestrial orchid. Leaves 5-6, basal and plicate, 15-25 cm stalked, the blade 80-100 cm long and 8-14 cm wide, with 7-9 larger nerves. Inflorescence on one of the basal nodes, apart from the leaves on the pseudo-stem, 50-60 cm long, densely many-flowered, the floral bracts caducous. On older flowers the spur turns black, the reason of which is unknown to me; this unusual colour might be caused by a fungus developing on honey.

All over Java, in forests and in elfin wood on ridges, at 1100-1800 m. Also in Sumatra and probably in Malaya.

2. **Ceratochilus biglandulosus** Bl.—Flora of Java 3: 445—Tjibodas (Mt. Gedé).

An unbranched very small epiphyte, unbranched, its stem only 1-8 cm long, often curved, the roots very thick; plant often with a purplish tinge. Leaves fleshy, in two rows, densely set, i-ijcm long, J cm wide. Flowers solitary, always one in bloom on a plant. Lip with green tip and a black spot near it.

All over Java, mainly in West, in forest, at 1000-2000 m. Also in Sumatra.

3. **Ceratostylis anceps** Bl.—Two stems, left in flower, right in fruit—Flora of Java 3:311—Tjibodas (Mt. Gedé).

Epiphyte, rootstock lengthened, hanging, branched, to 60 cm long, with two rows of bracts. Stems 3-5 cm apart, double-edged, 10-16 cm long. Leaves thick and stiff, 6-12 cm long, i-2£ cm wide.

All over Java, in forests, sometimes on moist boulders, at 1000-2000 m.

4. Coelogyne miniata Lindl.—Flora of Java 3: 281—Tjibodas (Mt. Gedé).

Epiphyte, seldom on rocks, with strongly branched, brown rootstock and long roots. Pseudobulbs 6-10 cm apart, with 2 leaves, the latter erect, 6-12 cm long, 1-5 cm wide. Inflorescences not hanging, 8-11 cm long, lax, few-flowered; about all flowers open at the same time.

All over Java, rather common, in forest, at 1000-2400 m. Also in Bali (and ? Sumatra).

5. **Cryptostylis arachnites (Bl.)** Hassk.—Inflorescence only—Flora of Java 3: 257—Tjibodas (Mt. Gedé).

Erect, terrestrial, unbranched plant, 20-60 cm high. Leaves erect, **radical** on the short vertical rootstock which is provided with long thick roots. Leaves 2-12 cm stalked, rather dark green with darker veins, 8-16 cm long, 4-7 cm wide.

All over Java, more common in West than in East (Mt. Andjasmoro), in rain-forests, often in moist places, locally common on ridges, at 1000-2000 m altitude. SE. Asia, also in Sumatra, Malaya, Bali, Sarawak, Batjan and the Philippines (down to 500 m).

The intensity of the flower colour is rather variable in different specimens and alters with the age of the flower; in Malaya said to be greenish with red.

In plants of this genus, of which the aspect of the species is very homogeneous, it has been found that similarly as in *Ophrys* species, male wasps are attracted by scent and shape of the lip which they mistake for females of their kind; they copulate with it affecting at the same time pollination. In four Australian species of *Cryptostylis* this curious way of fecundation is performed by an ichneumoid wasp. No observations are made on the Malesian species in this respect.

6. **Pristiglottis pubescens** (Bl.) Cretz. & J.J.S.—Flora of Java 3: 277—Tjibodas (Mt. Gedé).

Terrestrial with rooting ascendent stems 15-25 cm long. Leaves ovate, 2-4 cm long, 1-2 cm wide. Inflorescence with 2-5 flowers, snow-white.

In West Java in forest, at 1100-1500 m. Also in Sumatra.

7. **Dendrochilum aurantiacum** Bl.—Flora of Java 3: 286—Tjibodas (Mt. Gedé).

An epiphyte with long and much-branched rootstock. Pseudobulbs 2-6 cm spaced. Leaves 7-12 cm long, if-2 cm wide. Flowers scented.

All over Java, especially in West, rare in East (Mt. Andjasmoro), in forest, often on ridges and in mossy forest, common, at 1000-1700 m. Also in Sumatra.

8. **Phreatia secunda** (Bl.) Lindl.—Flora of Java 3: 323—Tjibodas (Mt. Gedé).

Epiphyte without pseudobulbs, very rarely terrestrial on moist rocks. Leaves 6-11 equitant in two rows, thick, fleshy, slightly compressed and channelled, 2-8 cm long, 4-9 mm wide.

All over Java, in forests, at 50-1500 m. Also in Peninsular Thailand, Malaya, Sumatra, Borneo, and the Philippines.

9. **Schoenorchis juncifolia** Bl.—Flora of Java 3: 441—Tjibodas (Mt. Gedé).

Pendulous epiphyte, richly branched and up to 1 m long. Leaves in two rows, rather stiff, round on section (linear-terete), often violet tinged, 8-16 cm long.

All over Java, in mixed forest and tjemara forest, common in ridge forest, at 1500-2800 m. Also in Lombok and Flores.

10. **Spiranthes sinensis** (Pers.) Ames—Inflorescence only—Flora of Java 3: 265—Tjibodas (Mt. Gedé).

Terrestrial, 12-45 cm high, roots rope-like, fleshy, in a bundle in the soil. Mostly one stem, well-developed leaves only at the base, 3-12 cm long, 3-9 mm wide. Flowers arranged in a spiral round the stem and opening in that order, in various shades of pink, very rarely white.

AU over Java (mainly in West), in grass fields, often alone but also in groups, at 1000-1750 m, very rare in the lowlands (at Bekasi east of Djakarta on swinging bogs!). Widely distributed from Siberia and Afghanistan to New Zealand and Australia, throughout Malesia.

PLATE 35

EXPLANATION OF PLATE 36

ORCHIDACEAE (continued)

1. **Appendicula ramosa** Bl.—Only unbranched end drawn—Flora of Java 3: 315—Tjibodas (Mt. Gedé).

Epiphyte with much-branched hanging rooting stems to 60 cm long. Leaves in two rows, inflorescence very short. Inner tepals almost round; the lip with two flat corky ribs.

In West Java in rain-forest, elfin and mossy forest, at 1200-2000 m. Also in Sumatra, Sumbawa and Celebes.

2. **Bulbophyllum cernuum (Bl.)** Lindl.—Flora of Java 3: 388.

A small epiphyte with creeping rootstock producing pseudobulbs in a row, each provided with one leaf and one flower on a thread-like stalk 4-8 cm long. Leaves 3-5 cm long, 4-8 mm wide.

In West Java, in forests, particularly in dwarfed ridge forest, also on rocks, at 700-1800 m.

3. **Bulbophyllum bakhuizenii** Steen., nom. nov.—Flora of Java 3: 382 (as *B. multiflorum* (Breda) Krzl., 1896, non Ridl. 1885; based on *Odontochilus multiflora* Breda, Gen. Sp. Orch. Asclep. descr., tab. fig. 2.1828).

Epiphyte with creeping rooting rootstock. Pseudobulbs elongate, more or less compressed and furrowed, 2-3\ cm long, \-\ cm thick. Leaves 3^-8 cm long, 1-2 cm wide.

West Java, in forest, at 500-1400 m. Also in Central Sumatra (Harau Gorge).

Similar to *B. triflorum* (Breda) Hassk. which has, however, small, ellipsoid, smooth pseudobulbs 1-1} cm long, }-i cm thick, dark-orange tipped tepals of which the median is shorter than the 2 laterals, and smaller leaves 2-3^ cm long and J-i J cm wide.

The epithet is dedicated to Dr. R.C. Bakhuizen van den Brink Jr, from whose wide knowledge Malesian botany, the Rijksherbarium and I personally have had so much profit.

4. **Bulbophyllum uniflorum** (Bl.) Hassk.—One flower only—Flora of Java 3: 375—Tjibodas.

Epiphyte with long creeping rootstock. Pseudobulbs 4-5 cm apart, erect, linear, elliptic on section. Flowers on stalk c. 6-9 cm long, solitary or two together. Leaves firm, 3 cm stalked, 12-20 cm long, 4-7 cm wide.

In West Java in forests, rarely on rocks, at 1250-1450 m. Also in Sumatra and Malaya.

In Malaya Holttum distinguishes some colour varieties.

5. **Coelogyne longifolia** Lindl.—Top of inflorescence with one flower—Flora of Java 3: 281.

Epiphyte with vigorous creeping rootstock with short nodes. Pseudobulbs c. 3 cm apart, 4-angular, 5-10 cm long, with 2 stalked leaves, 15-40 cm long, 2-6 cm wide, with 5 nerves at underside. Inflorescence up to 60 cm long, from the top of a pseudobulb, erect with drooping top, lasting long but few flowers open at the same time.

All over Java in forests, 1400-2200 m. Also in Sumatra.

6. **Corybas carinatus** (J.J.S.) Schltr—a. In flower, frontal and lateral view, b. in fruit—Flora of Java 3: 256—Mt. **Salak VII**-III. 12396.

Terrestrial; related to *C. mucronatus* (37-2), but veins in the leaves not white, the odd outer tepal less curved, more spathulate, with 5-7 keeled veins and differently coloured lip.

In West Java on Mts Salak and Geger Bintang (a spur of Mt. Pangrango), in mossy brushwood, on ridges, locally common, **at 1800-2000 m.**

This tiny botanical jewel rests with its leaf mostly on moss; when in fruit the stem, and particularly the flower stalk is lengthened which will probably be of advantage for dispersal of the tiny seeds. See also *Myrmechisi^d-ii)^* another moss dweller. The same is found in *Lecanorchis* and in some *Burmanniaceae.*

7. **Dendrobium hasseltii** (Bl.) Lindl.—Flower bunches only—Flora of Java 3: 366—Tjibodas.

Epiphyte, the stem leafy all over, mostly slender and somewhat zigzag, 15-80 cm long. Leaves 3J-7 cm long, j-i cm wide. Flowers in a short raceme, looking all sides, on defoliate parts of the stem, dark purple with an orange blotch and coarse chin.

All over Java, common, mainly on ridges and in mossy forest, also in tjemara forest, 1500-3000 m. Also in Sumatra.

On Mt. Gedé a white-flowered form has been found, of course also with the orange blotch on the lip.

On Mt. Kerintji (Sumatra) dwarfed forms occur with the stem only 8 cm long and the leaves only 1 £ cm long and £ cm wide.

8. **Dendrobium kuhlii** (Bl.) Lindl.—One flower only—Flora of Java 3: 366—Mt. Gedé.

Epiphyte, in stem and leaves very similar to the preceding species but the chin much narrower and curved. Flowers much lighter coloured with dark veins.

In Java on Mt. Gedé and probably the Priangan Mts, in similar places as the preceding and often occurring together with it, but much more rare, at 1500-2500 m. Also in Sumatra.

9. **Dendrobium mutabile** (Bl.) Lindl.—Only a bunch of flowers—Flora of Java 3: 368—Tjibodas.

Epiphyte, the stems crowded together, elongated, drooping, somewhat thickened in the middle, 20-100 cm long. Leaves 5-9 cm long, 1A-2J cm wide, often violet tinged underneath. Racemes on leafless nodes near the stem tops. Flowers scentless, whitish to more or less violet.

In the western half of Java in forests, rather common, at 500-1800 m, also on rocks of lavastreams of Mt. Guntur. Also on Krakatao and ? S. Sumatra.

10. **Eria erecta** (Bl.) Lindl.—Flora of Java 3:341.

A coarse epiphyte. Stem elongated, rather thick, particularly towards the slightly zigzag bended top, 40-45 cm long. Leaves at the top of the stem 5-7, 8-20 cm long, 2-3£ cm wide. Inflorescences c. 4, at the higher nodes, dense, rich-flowered, much shorter than the leaves, woolly. Lip not movable, lateral lobes small, connate in front of the central lobe.

All over Java, in forests, at 1000-2300 m.

11. **Goodyera reticulata** (Bl.) Bl.—Flora of Java 3: 271.

A terrestrial orchid, 15-30 cm high, from a creeping basal part with c. 7 leaves; these velutinous dark green with silvery nerves, 3-8 cm long, 1 £-3 & cm wide.

All over Java, in humid rain-forest, at 15 00-1800 m. Also in Bali and Sumbawa.

12. **Myrmechis gracilis** Bl.—Flora of Java 3: 268.

Terrestrial, or on mossy tree bases. Stem ascending, rooting, 10-20 cm long. Leaves $-3 cm long, }-i} cm wide, with undulate margin. Inflorescence 3-4 cm long, hairy, with (i-)2-3 flowers that open but little.

Rather common in West Java, rare in Central (Mts Tjeremai, Diëng 8c Ungaran) and East (Mts Smèru & Idjèn), in forest, particularly mossy on summits and ridges, at 1600-3000 m. Also in Sumatra, Bali, the Philippines, and Japan.

The stalk of the fruit lengthens to **10** cm.

13. **Nervilia punctata** (Bl.) Schltr—Plant in flower—Flora of Java 3: 261—Tjibodas.

Terrestrial with a small subterranean tuber and along-stalked heart- to kidney-shaped leaf, 4J-6 cm through, with 7 veins. Flower and leaf appearing alternately. Stem lengthened in fruit.

All over Java in forests, at 25-1500 m. Also in Sumatra, Malaya, and Peninsular Thailand.

14. **Taeniophyllum glandulosum** Bl.—Flora of Java 3: 448.

Inconspicuous leafless epiphyte, with green strap-shaped roots 2|-io(-i7) cm long, clinging to the bark. Stems thread-like, inflorescence distinctly stalked, zigzag, scaly, warty. Flowers in two rows, tepals for 1/3 part connate, pale green; lip with a long acicular recurved point, the spur inside with a gland.

All over Java, in elfin and mossy forest, at 2200-2700 m.

['LATE 34

ORCHIDACEAE (continued)

1. **Bulbophyllum ovalifolium** (Bl.) Lindl.—Flora of Java 3: 389—Taman Hidup (Mt. Jang). 1195 2.

Delicate epiphyte with a creeping rootstock on which the pseudobulbs sit in a row, each about 13 by 8 mm long and 4-8 mm thick, with one ovate to lanceolate, blunt leaf 2-3 cm long and £-| cm wide. Flower solitary.

All over Java, in forests, at 1500-2500 m.

2. **Corybas mucronatus** (Bl.) Schltr—Lateral and frontal view —Flora of Java 3: 256—Mt. Geger Bintang (Mt. Gedé).

Delicate orchid with a small globose tuber in the earth, the single leaf resting on moss. Flower solitary, the median sepal erect, large, hollow, spathulate, curved over the lip, obtuse with a small tip, its midrib strongly keeled with on both sides 4-5 lengthwise nerves, with 9 wine-red lengthwise lines. Lip simple, strongly curved, the margin fimbriate. Stalk under the fruit lengthened to 10 cm.

In West Java, only on Mt. Gedé-Pang rango, at about 1500 m, particularly on ridges (Geger Bintang, above Tjibeureum), among moss, sometimes against mossy tree bases. Also in Malaya.

This remarkable genus of delicate orchids was in the past considered to be richest developed in New Zealand, but has since appeared to be widespread through Malesia to the Himalayas, but with by far the majority of species in New Guinea, and scarce west of this island. Most species occur above 1000 m, but there are several records from only a few hundred metres above sea-level.

3. **Dendrobium cymbidioides** (Bl.) Lindl.—Flora of Java 3: 356—Tjibodas (Mt. Gedé).

Epiphyte with a short creeping rootstock; pseudobulbs with blunt angles, 2J-5 cm long, green-yellow. Leaves two, stiff-leathery, 4-14 cm long, 1£-4 cm wide. Inflorescence sprouting from between the leaves, 6-20 cm long. Flowers 4-7, laxly arranged, fleshy, the ovary (which seems to be the stalk of the flower) longer than the sepals.

In Java eastwards to Mt. Lawu, in rain-forests, especially in elfin and mossy forest on ridges, rarely on rocks, at 1500-2500 m. Also in Malaya and Sumatra.

4. **Galeola javanica (Bl.)** Benth. & Hook, f.—In flower and with 2 fruits—Flora of Java 3: 260—Tjibodas (Mt. Gedé).

Plant to 70 cm high, with thick tuberous roots on a vertical rootstock in the soil. The plant is saprophytic, which means that it has no green substance in leaves or stem to produce its own carbohydrates, but is dependent for nutrients on a fungus which lives partly in its root tissue and partly in the humus and provides for these. The leaves are reduced to bracts. The flowers open scarcely. Fruit fleshy, meat-coloured.

In West Java in the depth of the forest, once found on Mt. Dorowati in riverine tall bamboo-rich forest, at 700-1500 m. S. Thailand, also in Sumatra, Malaya, Borneo (and ? Minahassa).

The genus is a peculiarly variable one; some species are climbing and may reach 5-10 m length; these may be saprophytic and possess a huge fleshy rhizome, but there are also climbing species with green leaves.

5. **Herminium lanceum** (Sw.) J. Vuyk—Plant cut in two parts—Flora of Java 3: 248—Mt. Papandajan.

Terrestrial, 15-40 cm high. Leaves 2-4, some small, some large, 8-13 cm long, £-i£ cm wide.

In Java from Mt. Papandajan eastwards, mainly in grassland on open slopes and in plains, at 1000-2400 m. SE. Asia to Japan, also in Bali, Lombok, Sumbawa, Timor, Alor, Luzon, SW. Celebes (Mt. Bonthain).

6. **Paphiopedilum javanicum** (Lindl. & Paxt.) Pfitz.—Leaves and flower—Flora of Java 3: 247—Rarahan, near Tjibodas (Mt. Gedé).

Terrestrial orchid with short rootstock and very thick roots. Leaves 6-8, crowded at the base of the stem in 2 rows, 10-16 cm long, 2-4 cm wide, above pale green with darker spots, below with a bluish or glaucous shade. Stem purple, hairy. Flowers 1, rarely 2, thin stalk 20-60 cm long. Pod erect, elongate, 5-10 cm.

In Java from Mt. Karang in Banten to Mt. Andjasmoro in East, in light forest and elfin scrub on ridges, locally numerous, at 750-2000 m. Also in Sumatra, N. Borneo (Mt. Kinabalu) and Flores.

-. **Pristiglottis hasseltii** (Bl.) Cretz. & J.J. Smith—Flora of Java 3: 278—De Voogd.

Terrestrial. Stem 10-20 cm high, with mostly 2 flowers. Leaves more than two times as long as wide, 2-3 J cm long, i-i J cm wide. Lip of the flower with a very narrow claw with green teeth on both sides.

In West Java in rain-forest, particularly on ridges and in mossy elfin wood, at 1400-1500 m.

In S. Sumatra a var. *sumatrana.*

IM..VI E 37

EXPLANATION OF PLATE 38

ORCHIDACEAE (continued)

1. **Calanthe ceciliae** Rchb. f.—Inflorescence only—Flora of Java 3: 330—G. Bèsèr, N. of Sindanglaja (N. Gedé).

Terrestrial, with 4-5 long-stalked (10-30 cm) leaves crowded at the base, 30-50 cm long, 6-15 cm wide, drooping, widely wavy. Inflorescence ½-1 m high with persistent bracts.

In West Java, in the depth of the forest, at 1000-2200 m. Also in Sumatra and Malaya.

2. **Cymbidium lancifolium** Hook.—Part of leaf and inflorescence—Flora of Java 3: 395—Rarahan near Tjibodas (Mt. Gedé).

Terrestrial, 30-50 cm high, sprouting from a creeping rootstock. Leaves crowded at the base, long-petioled **(8-18** cm), lanceolate, 15-25 cm long, 2J-4 cm wide. Inflorescences to 5 together, erect, 15-30 cm long. Flowers pale purple as depicted, but sometimes the basic colour is pale green instead of pink, with 2 purple stripes and a purple lip. Lip versatile.

In West and Central Java in forests, especially in elfin wood or mossy scrub on ridges, at 900-1500 m. SE. Asia to China and Japan, also in Sumatra and Malaya.

3. **Disperis javanica** J.J.S.—Flora of Java 3: 254—These flowers from Mt. Diëng. Loogen.

Terrestrial, with an ovoid tuber. Stem 5-15 cm high, with one patent, sessile, half-amplexicaul leaf with cordate base, 1-1 Jem long.

Restricted to Central & East Java, a very rare plant, only found at Selokaton (Pekalongan) on talus above a tea estate, near Djogorogo on Nit. Lawu in lalang field, above Kediri on Mt. Wilis, and on Mt. Ringgit, flowering as is usual for orchids in the rainy season, between Nov. and March, always in a few specimens, at 900-1200 m.

It is more fully described by Loogen (1938).

4. **Oberonia similis** (Bl.) Lindl.—Flora of Java 3: 298—Mt. Pendil, near Djampit(Mt. Idjèn). 12129.

· Hanging epiphyte, 7-15 cm long, in fruit lengthened to 30 cm, often several stems together. Leaves about 5, fleshy, in 2 rows, 5-16 cm long, J-i cm wide at the base; base obliquely articulated; top acute. Stalks of the spike with narrow, pale appressed, thin empty bracts. Inner tepals elongate; lip ±: 4-angular, as long as wide, not fimbriate, 3-lobed, the central lobe with 2 short acute lobes.

All over Java, in forest, at 600-1500 m.

5. **Phaius flavus** (Bl.) Lindl.—Top of inflorescence and leaf top—Flora of Java 3: 326—Tjibodas.

A coarse terrestrial orchid. Stem with c. 5-8 large leaves. Stem short-tuber-like thickened. Leaf sheaths tubular, clasping each other to form a false stem c. 60 cm long. Leaves in two rows, 30-50 cm long, 7-11 cm wide, wavy with lengthwise folds and 5-7 main nerves, often pale yellow spotted. Inflorescence emerging apart from the false stem on the rootstock but near it, 30-90 cm high. Flowers becoming blue-black in drying, also the leaves nigrescent.

All over Java, in the depth of the rain-forst, at 900-2600 m. Himalaya, also in Sumatra, Malaya and the Philippines.

On Mt. Gedé is a form with white flowers, the outer tepals greenish tinged and the lip with brown veins.

6. **Habenaria angustata** (Bl.) O.K.—Flora of Java 3: 248 (as *Platanthera angustata)*—Kandangbadak (Mt. Gedé).

Terrestrial, 65-75 cm high; no tubers, but fleshy roots. Leaves c. 4, ovate to cordate, the radical ones 10-15 cm long, 5-7 cm wide. Flowers green, fragrant, the lip simple, narrow, 11-12 by 3 mm; spur hanging, cylindrical.

In West & Central Java in forests, especially in mossy **and** elfin wood on ridges, at 1500-2800 m. Also in Sumatra, Borneo and Luzon.

I prefer to follow Ames and Holttum in combining the genus *Platanthera* with *Habenaria.*

7. **Pholidota globosa** (Bl.) Lindl.—Small part of a plant—Flora of Java 3: 286—Tjibodas (Mt. Gedé).

Epiphyte but sometimes on rocks. Pseudobulbs very many on the branched rhizome which produces abundant long stiff roots, globose, each with 2 erect leaves 8-16 cm long, f-ij cm wide. Inflorescence on very young twigs, terminal, in the young stage the flowers concealed below very densely set imbricate, equitant shiny-straw-coloured bracts, concealing the axis of the spike, which are readily caducous when the flowers develop. Inflorescences finally 10-15 cm long, drooping towards the apex.

All over Java, in rain-forest, especially its elfin and mossy facies on ridges and slopes, at 1400-2750 m, common. Also in Sumatra, Malaya, Borneo and Bali.

8. **Plocoglottis javanica** Bl.—Top of inflorescence—Flora of Java 3: 325—G. Bèsèr, near Patjèt(Mt. Gedé).

Terrestrial with creeping, branched, fleshy rootstock. Leaves spaced, on a stalk as long as the blade (20-35 cm), the latter 20-30 cm long, 6-10 cm wide, sometimes with yellow spots, with c. 7 main nerves. Inflorescence separate from the leaf on the rootstock, erect, stalk grey-violet spotted.

In West Java common in rain-forest, at 350-1400 m. Also in Sumatra, Malaya and Peninsular Thailand.

PLATE 38

EXPLANATION OF PLATE 39

ORCHIDACEAE (continued)

1. **Bulbophyllum purpurascens** T. & **B.**—Flora of Java 3: 380—Mt. Gedé. De Voogd.

Epiphyte with creeping rootstock. Pseudobulbs 2-24 cm apart, ovate to globose, small, with one obtuse stiffly fleshy leaf 5-9 cm long, 2£-3$ cm wide, often purplish underneath. Stalk of inflorescence **54-17** cm long, with 12-19 flowers. Outer lateral tepals twisted, the outer margins facing each other, much larger than the median one; inner tepals not fimbriate.

In West & Central Java, in forest, at 200-1000 m. Also known from Krakatoa, Banka, Sumatra, Malaya, Borneo and Peninsular Thailand.

2. **Dendrobium jacobsonii** J.J.S.—Flora of Java 3: 366—Trètès(Mt. Ardjuno). 11891.

Epiphyte, the stems zigzag, 15-50 cm long, the stems sometimes branched and upcurved if hanging, only the apical portion with leaves. Leaves half-amplexicaulous, 1-2 cm long, £-1 cm wide, twisted and glossy. Flowers evenly cinnabar-red.

In East Java only on Mts Lawu, Wilis, Ardjuno, Kawi & Sméru, in tjemara forest, at 2000-2900 m.

Plants tran ferred by Docters van Leeuwen from Mt. Lawu to Kandangbadak on Mt. Pangrango, at 2500 m, grew excellently on a *Cupressus* tree, planted there over a century ago in the forest by Teysmann.

Specimens cultivated by Docters van Leeuwen at Bandung at 600 m were smaller, the flowers sometimes no more than 2, and paler.

3. **Diglyphosa latifolia** Bl.—Flora of Java 3: 289—G. Bèsèr near Pat jèt (Mt. Gedé). 11770.

A robust, erect, terrestrial orchid with a creeping, fleshy, terete, dark violet rootstock, i£ cm thick. Leaves single, with 7-9 veins, green with indistinct dark spots, their violet stalk 20-3 5 cm. Inflorescences emerging from the rootstock near but apart from **the** leaves, 25-40 cm high, the fetid flowers very dense and numerous.

All over Java (but in East Java rare: Mts Jang & Idjèn), in the depth of the rain-forest, at 1000-1900 m. Also in Sumatra and Malaya.

4. Goodyera bifida (Bl.) BL—Flora of Java 3: 272—Mt. Papanda jan. 12266.

Terrestrial and erect with ascending, rooting, fleshy stem, 15-25 cm high. Leaves c. 7, green, 3-7 *cm* long, 2-3 £ cm wide. Flowers facing the same side, white to flesh-coloured; the tepals bending together, c. 1J cm long.

All over Java, in the depth of the forest, also in mossy forest, rarely on rocks in streams, common, sometimes locally gregarious, at 700-2850 m. Also in Sumatra, **Malaya,** Bali, Timor and SW. Celebes (Mt. Bonthain).

5. **Stigmatodactylus javanicus** Schltr & J.J.S.—Flora of Java 3: 255—Taman Hidup (Mt. Jang). 11942.

Very delicate, erect, terrestrial orchid, 8-12 cm high, with a small globose glassy subterranean tuber, with one minute cordate leaf. Flowers 1-3.

Only in Java, and only twice found, in the depth of high forest, near Tjibodas (Mt. Gedé) and at Taman Hidup (Mt. Jang), on humus, at 1800-1900 m.

Apparently very rare, but easily overlooked. Flowers found in May and November.

6. **Malaxis oculata** (Rchb. f.) O.K.—Flora of Java 3: 297—Tjibodas. 11780.

Terrestrial and erect, 25-35 cm high. Leaves c. 5, spaced, 3-5-nerved, 5-9 cm long, 3-4 cm wide, the margin somewhat wavy, above with a coppery hue, beneath grey-green with purple.

In West Java in the depth of the rain-forest, at 600-1400 m. Also in ? Sumatra.

7. **Microtis unifolia** (Forst. f.) Rchb. f.—Flora of Java 3: 254—Mt. Papandajan. Tengger. 11926.

Terrestrial, 10-40 cm high, with a globose tuber and a single hollow onion-like leaf, round on section, sheathing the lower part of the stem, 20-30 cm long, exceeding the flowers.

In West Java only on Mt. Papandajan, in Central & East Java more common, in grassland and light tjemara forest, at 1300-3200 m. New Zealand, New Caledonia, Tasmania, and Australia, also in Bali, Lombok, Timor, SW. Celebes (Mt. Bonthain), Luzon, Formosa and the Ryu Kyu **Is.**

8. Anoectochilus flavescens Bl.—Flora of Java 3: 267 (as *Odontochilusflavescens)*—Mt. Papandajan. 12270.

Terrestrial, stem ascending, purplish tinged. Leaves 4-6 cm long, 2-2J cm wide, dark green. Inflorescence hairy, to 12-flowered.

In West Java in the depth of the high rain-forest, locally sometimes not rare, at 1450-2000 m.

I have followed Holttum and Seidenfaden in not keeping *Odontochilus* apart from *Anoectochilus.*

9. **Phreatia tjibodasana** J.J.S.—Flora of Java 3: 323—Mt. Ardjuno. 11877.

Epiphyte. Pseudobulbs conferted, each with one leaf, 7^-9 cm long, 1-1 \ cm wide, with a 2-dentate top. Inflorescence very thin, 10-15 cm long.

All over Java, on roadside trees, in forest edges and in the forest, at 1500-2500 m. Possibly also in Sumatra.

10. **Podochilus serpyllifolius (Bl.)** Lindl.**—Small part** of **a** plant—Flora of Java 3: 313—Telaga Warna near Puntjak Pass (Mt.Gedé). 12279.

Slender epiphyte, the stem thread-like, creeping, branched. Branches with leaves in two rows, the flowers developing in the apical part, **very** small.

In Java on trees and rocks in the rain-forest, sometimes coating tree trunks, at 700-1500 m. Also in Sumatra and the Philippines.

The genus *Podochilus* is closely related to *Appendicula* (see 36-1) and differs only in technical details, but in habit its species are all usually much finer and more delicate than those of *Appendicula.*

I'].ATI- V)

ORCHIDACEAE (continued)

1. **Calanthe flava** (Bl.) Hassk.—Only the top of the inflorescence—Flora of Java 3: 330—Mt. Papandajan.

A tall terrestrial plant, the leafless stem ending in the raceme of yellow flowers J-iJ m high, emerging from a rosette of 3-5 large, thin, lengthwise plicate leaves with 5 major nerves, leaf stalk 10-25 cm> blade 20-40 cm long, 6-12 cm wide. Racemes 8-25 cm long, with persistent bracts. Labellum warty at the base, of 3 equally long lobes, the central one 2-fid; spur rather short, slightly greenish.

All over Java, in rain-forest, at 700-2200 m. Also in Sumatra (common) and Bali.

In Java a red-flowered variety occurs.

2. **Habenaria** tosariensis J.J.S.—Flora of Java 3: 251—Mt. Ardjuno. 11869.

An erect terrestrial herb, 20-80 cm high, with a vertical rhizome and about 7 leaves, 5-14 cm long, i£-2£ cm wide. Three outer floral segments c. 1 cm long, as well as two inner ones. Lip c. 1 £ cm long, deeply divided into 3 equally long lobes, the central one simple and narrow, the two lateral ones each comb-like divided into 6-7 linear fringes. Spur club-shaped, i£ cm long.

In Java from Mt. Sumbing eastwards to Mt. Jang, not uncommon in glades and on grassy slopes and in tjemara forest, **at 2000-2800 m.**

Flowers are very fragrant, especially at dusk.

Not seldom growing together with an allied similar species, *H. multipartite* Krzl. which has much larger flowers (outer sepals 2-2\ cm, lip halves with 9-10 fringes).

3. **Erythrodes humilis** (Bl.) J.J.S.—Beyond anthesis—Flora of Java 3: 276—Tjibodas (Mt. Gedé).

A terrestrial orchid, some 25-40 cm high, from a creeping stem-base. Leaves rather glaucous, 4-6 cm long, 2-4 cm wide, with 2 curved nerves besides the main rib.

Only in West Java, in forest, and among bamboos, at 200-1450 m. Also in Sumatra, Borneo and ? Malaya.

The identity is slightly uncertain.

OROBANCHACEAE

4. **Aeginetia** indica L.—The two flower stalks are much longer than drawn here—Flora of Java 2: 516—Above Trêtês (Mt. Ardjuno). 11893.

A somewhat fleshy plant without chlorophyll, with a rhizome, parasitizing on roots of other plants, only with bracts at the base of the rigid flower stalks. The tubular corolla longer than the slit spathaceous calyx and distinctly curved. Fruit an ellipsoid berry, 1 £-2 cm long, with numerous minute seeds.

In Java from Plosokerep (Indramaju) and Tjibeber eastwards to Mt. Tengger, in grasslands, dry rice-fields *(humas)* and once in devastated teak-forest, at 800-1800 m, but in Plosokerep at only 10 m. SE. Asia to China and Japan, also in Malaya, Borneo, the Philippines, Flores and New Guinea, outside Java also reported from low altitude.

Largely parasitizing on grasses, e.g. *alang-alang* (lalang, *Imperata), Pogonatherum pankeum, glagah (Sacchar urn spontaneum),* in SE. Asia also on *Zingiberaceae.* From the Philippines sugar-cane is recorded as a host, but in **Java the** species parasitizing on sugar-cane is accepted by Bakhuizen van den Brink Sr to be a different species.

PANDANACEAE

5. **Freycinetia javanica** Bl.—A female plant—Flora of Java 3: 201—Mt. Halimun (SW. of Bogor).

A branched shrubby plant, up to 15 m long, climbing with adhesive roots, the flowering branches pendulous. Stem also with pendulous aerial roots often concealed by the leaves. Leaves in spiral rows round the stem, equitant, stiff, shortly aculeate towards the top, 12-25 cm l°ng, x"3 en* wide. Spathes and fleshy bracts coloured yellow; spathes said to be somewhat fragrant. Flowers in spikes. Fruit spikes 5-7 cm long, with numerous berry-like fruits.

In West and Central Java, in forest, often covering tree trunks, in elfin wood on narrow ridges sometimes smothering the vegetation in dense masses, at 700-1800 m. Also in Sumatra, Malaya and Borneo.

In Malaya the colour is said to be of an undefinable salmon-orange-pink, in Java I saw it always yolk-yellow. Spikes 3-5, but sometimes (as depicted) only 3, with two fleshy solid yellow barren appendages replacing the two others.

There are no data on pollination, it seems to vary with the species. The red-flowered *F. funicularis* is visited by birds (bulbuls, *Pycnonotus* but *F. insignis* by bats which are attracted by the "bat-odour" and eat the fleshy parts. That bats do a lot of damage does in my opinion not disprove a priori their function as potential pollinators; bats also visit regularly the flower heads of *Parkia (petêh),* performing pollination and doing damage. As in most instances experiments are needed to support field observations.

PLANTAGINACEAE

6. **Plantago major** L.—From left to right: fruiting spike, flower spike in bud, leaf, spike in flower—Flora of Java 2: 446.

Perennial herb with erect rootstock. Leaves in a basal rosette, variable in shape and size, from broad-ovate to lanceolate, entire to coarsely dentate, 1-25 cm stalked, 3-22 cm long, 1-12 cm wide. Flowers in leafless unbranched stalked spikes 6-80 cm long. Fruit a capsule, opening with a lid; seeds 4-20, the seed-coats jellify in wet weather.

All over Java in rocky or marshy, often ill-drained places, in grassland, along streams, also invading estates, from the lowland to 3300 m, common above 700 m. A cosmopolitan species, not yet found in Borneo and New Guinea, abundant in Sumatra.

A very variable plant, described under many names, obviously indigenous in Malesia, profiting from man's opening up land. Large experimental studies by Turrill have shown that variability is very largely influenced by variability of environment and to a huge degree not genetically defined.

POLYGONACEAE (see also Plate 41-7/11)

7. **Rumex brownii** Campd.—Left: part of an inflorescence, upper half in flower, lower with fruit, right: a lower full-grown leaf—Flora of Java 1: 220—Klêtak Pass (Mt. Tengger). **11904.**

An erect, branched, perennial herb, up to 60 cm high, with a taproot and many basal sprouts; the root may become a very large, branched lignotuber. Flowers in panicles of spikes. The inner 3 tepals after anthesis enlarged, triangular-acuminate, tightly enclosing the three-angled fruit with an uncinate tip **and** with 4-6 hooks on their margins, without a thickening (boss) on their midrib.

In Java only on Mt. Tengger, on grassy roadsides, at 1300-1500 m. Australia, Timor, and East New Guinea.

The only other native *Rumex (R. nepalensis)* occurs curiously also in one place only, namely on Mt. Jang; it is much coarser, has large leaves of different shape, tepals which are not uncinate at apex, but with a boss.

Teysmann imported *R. alpinus* from the European Alps to near the Kandangbadak hut, above Tjibodas; it grows there in profusion just as in Switzerland, around homesteads; a nitrophile plant.

PLATE *)

PIPERACEAE

1. **Peperomia laevifolia** (Bl.) Miq.—Flora of Java i: 174.

A rather delicate, sparingly branched, rather fleshy herb, 10-50 cm high, erect or ascending, often rooting at the base. The noded stem is often zigzag. Leaves variable in size and shape, mostly glaucous beneath, 14-7 cm long, 1-3 cm wide. The minute flowers in spikes, those and stem mostly tinged reddish.

Throughout Java and Malesia, in shady moist places, mostly in rain-forest, terrestrial, but often on rocks, fallen dead trees and on the base of living tree trunks, also in mossy forest, seldom epiphytic, up to 2800 m.

2. **Peperomia tetraphylla** (Forst. f.) Hook. & Arn.—Flora of Java 1: 174—Tjibodas (Mt. Gedé).

A delicate herb, erect to ascending, often tufted and rooting at the nodes, widely branched, 5-20 cm long. Leaves 3-nerved, succulent, in whorls of four and with proportionally thickish terminal flower spikes. Leaves 1-1J by J-i cm.—In Java from Mt. Gedé eastwards to Mt. Idjèn in rain- and mossy forest, always epiphytic, at 1000-2300 m. Tropics and subtropics of both hemispheres, also in Sumatra (to 2900 m), the Lesser Sunda Is., SW. Celebes (Mt. Bonthain), the Philippines and New Guinea.

3. **Piper sulcatum** Bl.—Flora of Java 1: 172—Tjibodas.

Erect, terrestrial herb, j-iJ m high. Leaves 7-13 cm long, 3-8 cm wide. Flowers in rather thickish spikes, sometimes male and female on different plants, 3-10 cm long.

Throughout Java, in humid forest, locally often gregarious on the forest bottom, at 700-2500 m. Also throughout Sumatra (down to 450 m).

When dried the plants become dark, blackish brown, the reason why it was also described as *P. nigrescens.*

PITTOSPORACEAE

4. Pittosporum moluccanum (Lamk) Miq.—Flowering twig, a bunch of fruits—Flora of Java 1: 280—Mt. Suket (W. Idjèn).

A smallish tree, 4-15 m high, rarely a shrub. Leaves often crowded towards the twig-ends, very variable in size and shape, 5-15 cm long, 2J-5 J cm wide. Flowers fragrant, either male or female, with in each the other sex suppressed or sterile. Capsules variable in shape, ellipsoid to roundish, (1-)2-4 cm long, (1-) 1 \-z cm wide, a vivid orange-red, opening with 2 valves in which the hard, black seeds are embedded in 2 rows held together by **a** very sticky resin, with a strong aromatic smell of turpentine. Small trees loaded with the beautiful fruit are quite a sight.

In Central and especially East Java (very rare in West), in tjemara and in rain-forest, on ridge crests, in elfin forest, also along rivers and in abandoned coffee estates, between 1000 and 2000 m, but sometimes descending to lower altitude. Also in Formosa, the Philippines, and E. Indonesia (Celebes, the Moluccas, Lesser Sunda Is.), clearly because of preference for a climate with a dry season.

POLYGALACEAE

5. Polygala venenosa Poir.—Flowers and fruits, some dehisced and exposing the red seeds—Flora of Java 1: 198.

Erect shrub, often unbranched, 1-3 m high, stem rather thick, fleshy and green. Leaves large and rather fleshy, 15-30 cm long, 4-10 cm wide. Axis of raceme rather sturdy, straight, reflexed, the scars rather closely set. Fruit generally with distinct wings.

All over Java, in the depth of primary and secondary forest, especially in deep moist humus, stream beds and riverine, at 50-1600 m. In the lowland such forest plants have become very rare and survive solely in refuges, such as botanical Nature Monuments (Dungus Iwul), Dèpok (destroyed now), water catchment areas or kramat groves (graveyards) and pemali (forbidden) places. Throughout the Malesian archipelago, but obviously not outside.

The seeds are almost entirely covered by a fleshy envelope, the caruncula, making them attractive to (?) birds.

6. **Polygala venenosa** Poir. ssp. **pulchra** (Hassk.) Steen., comb, now *(P. pulchra* Hassk. Flora 25: **II,** Beibl. **32. 1842)**—A single raceme with fruit and flower in natural poise—Flora of Java 1:198—Geger Bintang (Mt. Gedé).

A lax erect shrub, i-ij m high. Stem rather thin, not fleshy. Leaves 4-io(-i4) cm long, iJ-4(-5) cm wide. Rachis of the raceme thin, rather flexuous, with spaced scars, 5-10 cm long (outside Java often much longer). Fruits not winged.

In West and **Central Java,** in **forest on higher** stony, well-drained places, most common in light forest on slopes and ridges, at 1200-2000 m. Common in the Great Sunda Is.

Clearly an ecological race of the preceding, but in the majority of cases quite distinct, though without morphological characters valid for specific distinction in this lineage; admittedly transitions occur.

POLYGONACEAE (see also Plate 40-7)

7. **Polygonum chinense** L.—a. Flowering twig, b. fruit bunch, partly mature, c. fungus gall—Flora of Java 1: 223.

Herb, often woody at the base, generally strongly branched, sometimes climbing to 10 m and drooping; at higher elevations erect or prostrate and with small leaves. Ripe fruit black, triangular, enveloped by the swollen, dark blue, juicy perianth segments.—All over Java,plentifully in forest edges, jungles, on river banks, in tea and cinchona plantations, at 250-3350 m, rarely along riverbeds descending to the plains. In SE. & E. Asia and throughout Malesia.

The flowers are heterostylous and are obviously cross-pollinated. The berries are eagerly devoured by birds and deposited in often inaccessible places. Sometimes an ustilaginaceous fungus *(Liroa emodensis* (Blak.) Of., formerly called *Ustilago treubii)* causes the plant *to* form very beautiful, large, coral-shaped galls of pink colour (fig. c).

8. Polygonum nepalense Meissn.—Flora of Java 1: 222.

Erect or ascending annual herb, often branched from the base, 20-50 cm high. Leaves pellucid-dotted, variable in shape, 2-5 cm long, 1 £-2£ cm wide.

In Java from Mt. Gedé eastwards, in marshy grasslands, depleted forest, invading tea estates, locally sometimes numerous, at 1200-2300 m. N. Africa to SE. Asia and almost throughout the Archipelago, not in Malaya and Borneo.

9. **Polygonum paniculatum** Bl.—Flora of Java 1: 222.

A robust, erect herb, 2-4 m high. Stem with conspicuous nodes. Leaves 12-18 cm long, 5-8 cm wide.

In Java from Mt. Salak eastwards to Mt. Slamat, in muddy and other moist open places, below waterfalls, in thickets, and along forest edges, not in the forest, mostly gregarious, sometimes forming extensive pure stands (Tegal Bungbrun on Mt. Papandajan), at 1350-3000 m. Also known from SE. Asia, Malaya, and throughout Sumatra.

Bungbrun (tiwu b.) is the Sundanese name.—In the very young stage the leaves are included within the sheath at the node, which is a linear acute tubular, closed organ some 10 cm long; when the leaf expands the sheath is torn on one side and only its basal part of J-i £ cm high remains.

10. **Polygonum plebeium** R. Br.—Flora of Java 1:221.

Small prostrate or ascending herb, strongly branched and rooting, mat-forming, 5-25 cm long. Leaves 1-2 cm long, 1-2 mm wide, besides the midrib no lateral nerves visible.

In Central (Mt. Diëng) and East Java (Mts Tengger & Idjèn), in moist grassland or forming tufts on small dunes in the Sand Sea, at 1500-2400 m, rarely by a water course descending to 900 m, and in Lombok on the sandy beach of Segara Anak, locally common. Widely spread in the Old World, very rare in Malesia, only found in Java, Lombok & Luzon.

11. **Polygonum runcinatum** D. Don—Flora of Java 1: 222.

Annual herb, erect or ascending, mainly branched at the base, **J-im** long. In the basal leaves, the stalk only winged in the upper part, at the base with 2 auricles which in the higher leaves are connected with the blade, the latter ovate-triangular, often with 1-3 lobes on either side, generally hairy and with a pale V-shaped blotch.

In Java on Mt. Papandajan and from Mt. Slamat eastwards to Mt. Idjèn, in light forests, glades, forest edges, elfin and mossy forest, and sometimes on the edge of high estates, at 1300-2800 m. E. & SE. Asia, also in Sumatra, the Lesser Sunda Is. and New Guinea.

POTAMOGETONACEAE

12. Potamogeton octandrus Poir.—Flora of Java 3:9.

A slender aquatic, with floating elongate and linear submerged leaves. Flowers greenish, in spikes.

In Java mainly in Priangan (Kamodjan, Situ Lembang, G. Sembung, Rantja Bali, Pèngalèngan, Tjisokan Gorge), Petung Kriana & Diëng, on lake shores and in streams, at (6 50-) 1000-2100 m. All through the Old World, from **S.** Africa to **Japan and** Australia, but not elsewhere in Malesia.

PLATE 41

EXPLANATION OF PLATE 42

PRIMULACEAE

1. **Lysimachia montana** (Reinw.) Bakh. f.—Flora of Java 2 : 443_Tjibodas(Mt. Gedé).

Ascending or erect herb, up to £ m high. Leaves 3-10 cm long, 1 £-6 cm wide. Racemes terminal or subterminal, with 1-5 flowers, somewhat drooping. Corolla 6-16 mm long. Capsule shorter than the calyx.

In Java from Mt. Salak eastwards to Mt. Sméru (SW.-), in mainly light forest, elfin and mossy forest, glades and along trails, at 1000-2600 m. Indo-China, also in Sumatra and Flores.

2. Lysimachia japonica Thunb.—Flora of Java 2: 443—Mt. Tengger. 11906.

A creeping rooting herb, to 40 cm long. Leaves opposite, densely gland-dotted, 1&-3 cm long, 1-2J cm wide.

In Java from Mt. Gedé eastwards to Mt. Jang, in humid localities, along trails in rain-forest, along stream banks, in tjemara forest, sometimes in abandoned fields, rare, at 1000-2000 m. SE. & E. Asia, from Kashmir to Japan, also in Sumatra; a variety occurs in Formosa, Luzon and New Guinea. Introduced in Australia.

3. **Lysimachia laxa** Baudo—Flora of Java 2: 443—Mt. Ardjuno. 11826.

An erect branched herb with an angular stem up to 1 m high. Leaves 3-11 cm long, £-2 cm wide. Flowers on long petioles, solitary in the leaf axils.

In Java from Mt. Tjeremai eastwards to Mt. Jang, in grassland, along forest trails, also in tjemara forest, locally often common, at 1800-3000 m. Ceylon and SE. Asia, also in Sumatra, Bali, Lombok and Sumbawa.

4. Primula prolifera Wall.—Leaf and upper part of inflorescence—Flora of Java 2: 442.

A coarse lush herb, with a basal rosette of large leaves on a sturdy rootstock and a central flowering stem with up to 6 spaced whorls of flowers, up to **i}m** high. Leaves 25-50 cm long, 6-10 cm wide. Flower whorls successively coming into bloom, the lower fruiting while the upper still in bud. Calyx yellow-waxy to degree. Capsule 1-celled, with many fine seeds.

In Java only thusfar on Mts Pangrango, Papandajan, Sumbing & Jang, at rather moist places, preferably in marshy places near small streams, but invading mossy forest, sometimes coming down along steep trails, locally always common to gregarious, at 2050-3000 m. Sino-Himalaya, also in N. Sumatra (Gajo Lands: to 3250 m) and Central Sumatra (Mt. Kerintji and Bt. Daun).

The lowest locality of this beautiful striking plant is on Tegal Pandjang, Mt. Papandajan; it is rumoured that it would have been found descending on the bank of the stream draining this tegal at about 1600 m, but thusfar this is not corroborated. It occurs only on mountains which are at least 2650 m high, the elevation effect (see text) being 600 metres.

When Junghuhn gave a lyric description of its occurrence on Mt. Pangrango, calling it *P. imperialis,* he found it restricted to the small summit "tegal" with some scattered specimens in the surrounding light mossy forest down to some 50 metres below the summit. Much later a regularly used trail was made from the Kandangbadak hut on the saddle between Gedé top and Pangrango cone at 2450 m to the summit and along this worn out gully-like path seed rushed down with rains and plants are found in "rows" along it. It also occurs near Lebak Saät hut and grows there profusely.

It needs a sufficiently deep, moist soil, and is obviously for that reason not occurring in the stony elfin forest on Mt. Gedé proper. All my experiments in transplanting it (by young and by old plants and by seed) were unsuccessful.

The amount of wax on the calyx and pedicels is different and increases from west to east, the Jang population being most waxy. The four Javanese populations are distinguishable to the trained eye, each possessing its own facies, obviously the result of inbreeding.

In continental Asia this species is both homo- and heterostylous, that is some plants have flowers with short styles and high-inserted anthers, others have the reverse, necessitating cross pollination for setting seed. However, the specimens from Sumatra and Java are all homostylous as shown by Ernst, that is, they have only one kind of style length (as long as the tube) and high-inserted anthers (near the limb) and are capable of self-pollination.

This is of distinct biological interest, as it is clear that in dispersal homostylous plants are better adapted than heterostylous ones, because a single successful seed of the former can propagate in isolation in new territory and lead to establishment, whilst the latter cannot produce progeny under such conditions. Obviously our *Primula* could "escape" in the geological past from the continental population along Burmese ranges towards Sumatra because of this capacity. A most illustrative other example of this is also shown by the most widely spread species of the genus *Primula* on the northern hemisphere, covering the entire range of the genus, viz. *P. farinosa* in that the most isolated populations of it in Patagonia are (naturally) homostylous. It is peculiar that a small genetical difference of a few alleles may thus have a basic influence on plant distribution.

In spite of being high altitude plants these tropical subalpines are not hardy in temperate countries; they can stand the tropical occasional nightly frost but no frost periods.

PROTEACEAE

5. **Helicia serrata** (R.Br.) Bl.—a. Flowering twig, b. developing fruit, c. ripe fruit—Flora of Java 1: 275—Mt. Papandajan. 11668.

A tree to 30 m tall, the trunk to 50 cm diameter. Leaves 10-20 cm long, 5-8 cm wide. Fruit on one side always with a groove, but indehiscent.

In West & Central Java, eastwards to Mt. Lawu, at 1000-2650 m, in forest. Also in Sumatra, Malaya, Borneo.

The form here depicted is a mountain race or variety; it is a smallish tree to 8 m high with a dense crown, with stiff, leathery and almost entire-leaves. Thusfar it is only found in Sumatra and Java.

In drying the leaves become yellowish or olivaceous in colour, a sure sign that this plant belongs to alum-accumulators, similarly as *Symplocos* (52-4), *Eurya* (52-6), *Polyosma(jo-))9* etc.; alum compounds are used in tanning, and in dyeing tissues. Alum plants frequently have blue flowers, purple or blue flush and bluish fruit walls.

'LATE +2

EXPLANATION OF PLATE 43

RANUNCULACEAE

1. **Clematis lechenaultiana** DC.—One leaf, an inflorescence ending in a many-fimbriate fruit—Flora of Java i: 144.

A coarse woody climber to 6 m long. Leaves opposite, with 3 leaflets, the latter 7-11 cm long, 3-5 cm wide. Tepals thickish. Stamens and carpels numerous; in fruit each carpel (nut) is crowned by the very long, persistent, feathery-hairy style.

All over Java in forest borders, glades, thickets, elfin and mossy forest, at 1000-3000 m, rarely descending along rivers to 450 m. S. China to the Ryu Kyu Is., Formosa, also in Luzon, Sumatra, Bali and Lombok.

2. Clematis javana DC.—A leaf, on it an inflorescence with buds, open flowers and one fruit with red nuts and long feather}* styles—Flora of Java 1: 145—Mt. Idjèn. 12173.

A strongly branched woody climber at least to 5 m long, with opposite compound leaves, the stalks of the latter sometimes acting as a tendril in making a loop round a support. Leaflets 4-11 cm long, 2-7 cm wide. Tepals early caducous. Floral structure otherwise as in the preceding species.

All over Java from Padalarang near Bandung eastwards to Mt. Idjèn and Madura, in grassland and hedges, forest borders, light elfin and tjemara forest, mainly at 50-2800 m. Also in the Lesser Sunda Is., Ceram, the Philippines and New Guinea.

My collection here depicted belongs to a mountain race occurring in Central & East Java, Bali & Lombok at 1400-2800 m, described by Eichler as a separate species *C. multistriata.* The distinguishing vegetative characters are insufficient for specific distinction. To my synthetic approach to specific distinction it is even not certain that *C. javana* is distinct from the widely distributed polymorphous northern hemisphere *C. vitalba* on the specific level.

3. **Ranunculus blumei** Steud.—Stem top with one flower and one fruit—Flora of Java 1: 146—Tjibodas (Mt. Gedé).

A decumbent herb, often rooting at the nodes, to 80 cm long. Basal leaves with 3 leaflets or 3-parted, central lobe 3-44 cm long, 2-4 cm wide. Flower solitary.

All over Java from Mt. Gedé eastwards, in shaded places in forest, along trails and in marshy places near streams and in glades, also in tjemara forest, at 1100-3000 m, rarely descending along streams (outside Java) to 600-700 m and then often remaining sterile. Also in Sumatra, Bali, Lombok and SE. Celebes.

I have reluctantly accepted this name, as I strongly believe that Eichler's species concept is too finely knit and that this is a race of some wider distributed species of continental Asia, possibly *R. diffusus* DC.

4. Ranunculus javanicus Bl.—Apex of stem—Flora of Java 1: 146—Tjibodas.

Rather fleshy, decumbent herb sometimes over 1 m long, rooting at the base. Basal leaves up to 10 cm long and 7 cm wide, often cordate at the base; petiole to 3£ cm long, sheathing at the base.

In Java from Mt. Gedé eastwards to Mt. Jang, in marshy or wet places, on stream banks not rarely half-floating, sometimes gregarious below waterfalls, at 1800-3000 m. N. Thailand and possibly elsewhere in SE. Asia, also in Sumatra.

According to Docters van Leeuwen the flowers are proterogynous, but probably self-pollinated.

5. **Ranunculus sundaicus** (Back.) Eichl.—Stem leaf and part of inflorescence, one flower open, one wilting, two in fruit—Flora of Java 1: 146—Tjibodas (Mt. Gedé), a cultivated specimen.

A vigorous, erect or slightly ascending, stiffish, hairy herb, J-i J m high. Basal leaves with 3 leaflets, 7-8 cm long, 10-12 cm wide, on a long petiole (10-40 cm).

In Java common in the Priangan Mts, further only on Mt. Slamat, along stream sides, in moist grassland and glades, along forest trails, at 1000-1800 m. Also in Sumatra.

This species must certainly also occur in continental Asia ***{R.napaulensis* DC. ?).**

6. **Thalictrum javanicum** Bl.—Upper part in flower and fruit—Flora of Java 1: 143—Mt. Papandajan.

A graceful, erect, often profusely branched perennial erect herb, J-i \ m high. Lower leaves up to 4 times ternate compound with up to 80 leaflets. Tepals caducous when the flower opens.

In West Java only on Mt. Pangrango and Mt. Papandajan, from Mt. Tjeremai eastwards on all high or large volcanoes, in grassland, often in damp places, in elfin, mossy and tjemara forest, at 1800-3300 m. Ceylon, India, Himalayan tracts to Yunnan, also in Sumatra (Gajo Lands & Mt. Kerintji) and Bali (Mt. Agung).

The genus only represented by records from New Guinea, Ceram and Luzon which are all (depauperated) specimens relegated by Eichler to different species.

Through its similar habit *Thalictrum* is sometimes confused with *Boenninghausenia* (49-2) but that species has a corolla **and** calyx in anthesis and its leaves are very aromatic when crushed, with a smell of *Ruta.*

RHAMNACEAE

7. Rhamnus napalensis (Wall.) Laws.—**Flora of Java 2: 84**—Mt. Tengger. 11923.

An ascending, straggling or climbing woody branched plant, to 6 m long. Leaves distichous, thickish, 5-11 cm long, 2^-5 cm wide, when dried turning blackish.

Throughout Java, in forest edges, elfin forest, thickets, secondary and tjemara forests, at 1000-2300 m, but in other places in Malesia down to sea-level. SE. Asia and throughout the entire Archipelago.

PLATE 43

EXPLANATION OF PLATE 44

ROSACEAE (continued on Plates 45 and 46)

1. **Agrimonia eupatoria** L.—Flora of Java 1: 519—Mt. Ardjuno.

Erect perennial, aromatic, hairy herb, 30-50 cm high, sometimes to 1 m, sparsely branched. Leaves up to 15 cm long, the lower conferted, the higher ones remote, all glandular beneath. Top of the calyx with a whorl of hooked bristles, the fruit thereby adhering to fur and cloth.

In Java from Mt. Diëng eastwards to Mt. Tengger, in grassy places, along roadsides, also in tjemara forest, sometimes in fields, at (IIOO-)I6OO-25OO m. Europe and Asia, not known elsewhere in Malesia.

Certainly an indigenous plant, as usual quite similar to specimens from SE. Asia; the Indo-Javanese specimens might be separated from the genuine *A. eupatoria* as a distinct species *A. nepalensis* D. Don or as a subspecies.

2. Alchemilla villosa Jungh.—Flora of Java 1: 519—Mt. Papandajan.

A prostrate herb, the stems emerging from a vigorous rootstock. Leaves variable, from less than 1 cm diameter on the stems to 8 cm diameter in the rosette, old ones often bright red.

In Java from Mt. Papandajan eastwards to Mt. Idjèn, in grassy plains, sometimes marshy, in light forest, also tjemara forest, on banks of streamlets, even in the poorest places where dry-season frost and fire prevail, at 2000-3300 m. Not known anywhere else in Malesia, but possibly not different from *A. indica* Gardn.

3. **Potentilla indica** (Andr.) Wolf—Flora of Java 1: 517 (as ***Fragaria indica*)—Mt. Gedé.**

A prostrate herb with vigorous rootstock, emitting runners up to 60 cm length. Petiole 2-20 cm long. Leaflets 1^-4 cm long, 1-2 £ cm wide. Petals 4-9 mm long. At maturity the bottom of the flower is swollen into a globular juicy-spongy body set with small red nutlets, like a strawberry, but tasteless.

In Java from Mt. Gedé to Mt. Jang, in grassy places, along trails **and** river-banks, or as a weed invading tea estates, at 1000-2400 m. SE. & E. Asia, also in Luzon, Bali and Timor.

The "Indian strawberry" is also cultivated as an ornamental, both in the tropics in various Malesian islands, even down to sea-level, and in gardens in the temperate countries.

There are two forms, one with smooth and shiny nuts, the other with tuberculate and dull nuts. The indigenous plants in Java only possess the latter.

4. Neillia thyrsiflora D. Don—Flora of Java 1:511—Mt. Gedé. 12367.

Unarmed half-shrub, \-\\ m high, erect or leaning. Twigs flexuous, red. Leaves 5-11 cm long, 2-8 cm wide. Racemes often in leafy hairy panicles.

Only in West Java from Mt. Salak eastwards to Mt. Tjikurai, a fairly rare plant, in forest fringes and in mossy and elfin forest, at 1700-2800 m. SE. Asia, also in Sumatra.

On Mt. Gedé a form occurs with glabrous panicles, var. *fa/ ak*(B l) K bk **m.**

Somewhat resembling a *Rubus*, but different in having only a single ovary which later becomes a follicle that remains included in the floral cup; the latter bears long-stalked glands in the fruiting stage.

5. **Photinia integrifolia** Lindl.—A flowering twig with a small bunch of fruits—Flora of Java 1:513.

A shrub or small tree, often densely branched, 3-8 m tall. Leaves variable in shape, 4-14 cm long, 24-7 cm wide, entire, glabrous. Flowers in glabrous or hairy corymbs, with a rather disagreeable smell.

All over Java, in elfin and mossy forest, often on ridges and slopes, also in tjemara forest, not rare, at 1000-3200 m. SE. Asia, also in Sumatra, Lombok, Flores, Timor and SW. Celebes (Mt. Bonthain).

6. **Potentilla polyphylla** Lehm.—Flora of Java 1: 518 (as *P. mooniand)*—Valley of Tjiparugpug stream, on Tegal Aloon Aloon, Mt. Papandajan. 12238.

A perennial herb, with **a** thick rootstock, emitting several slack and little branched stems. Leaves 15-25 cm long, glossy silver-grey hairy.

In Java only known from the cited locality on Mt. Papandajan, in fairly humid soil among grasses, sedges and herbs, with scattered *Anaphalis javanica* (10-1) at 2500 m. SE. Asia, also **on** Mt. Kinabalu (N. Borneo).

Possibly the rarest mountain plant of Java. I found in 1929 only 3 large specimens in close proximity. A transplant to Mt. Gedé was unsuccessful. In 1939 I found that the specimens were rather smothered by the shade of the upgrowing *Anaphalis* succession. I wonder whether they have maintained themselves.

7. **Potentilla sundaica** (Bl.) O.K.—Flora of Java 1:518.

Perennial herb, 20-60 cm long, decumbent at the base, often rooting. Radical and lower cauline leaves pedate with 5 leaflets, smaller ones with 3; leaflets 1-3 cm long, |-i \ cm wide. No fleshy fruit.

In Java from Mt. Patuha eastwards to Mt. Diëng, in grassy places, along trails, in elfin forest, sometimes invading tea estates as a weed, **at 1200-2500** m. SE. Asia, **also** in N. Sumatra.

Flowering specimens with 3 leaflets may resemble *P. indica* (44-3) but the latter has solitary flowers and a coarsely dentate epicalyx.

('LATE 44

EXPLANATION OF PLATE 45

ROSACEAE (continued)

1. Rubus alpestris Bl.—Flora of Java i: 514—Mt. Papandajan.

Twigs climbing; the spines relatively short, more or less densely glandular-hairy, otherwise glabrous or hairy. Leaflets 5, higher ones 3, the terminal one 7-13 cm long, 3 £-4$ cm wide.

In Java from Mt. Gedé eastwards to Mt. Diëng, in forest edges and subalpine scrub at 1750-2900 m. Also known from SE. Asia, Sumatra, N. Borneo (Mt. Kinabalu) and SW. Celebes (Mt. Bonthain).

When fully ripe the fruits are juicy and tasty.

All species of *Rubus* are named *hareueus* in Sundanese, *grungung* in Javanese.

2. Rubus chrysophyllus Miq.—Flora of Java 1: 516—Mt. Papandajan.

Sturdy plant to 10 m long, yellow-brown hairy. Leaves bullate with conspicuously yellow-green venation, 7-22 cm long, 5-19 cm wide. Panicles vigorous.

All over Java in sunny places at forest edges, in light forest and subalpine scrub, near craters, at 1400-3000 m. Also in Sumatra, Lombok and the Philippines.

The orange fruits are the most delicious of all the Javanese species.

In the Philippines a small-leaved creeping form occurs, connected with intergrades with the normal-leaved one; this occurs also in Formosa under the name *R. calycinoides* Hayata.

3. Rubus fraxinifolius Poir.—Flora of Java 1: 514—Puntjak Pass (Mt. Gedé).

Erect shrub more or less climbing, spiny and glabrous. Twigs zigzag, like the leaf-rachises with scattered prickles. Leaflets mostly 5-9, rarely more or less, 4-16 cm long, 2-7 cm wide.

Almost all over Java, at least from Mt. Salak eastwards to Mt. Tengger, one of the most common species, in forest edges and other more or less open places, at 1500-2600 m, along water courses and in gorges sometimes descending to 600 m. In SE. Asia and the whole of Malesia as far as the Solomons.

Fruits inedible.

4. Rubus lineatus Bl.—Flora of Java 1:514—Mt. Gedé.

More or less climbing shrub 1-3 m long, little spiny. The closely parallel-nerved leaf silver-silky underneath is very characteristic. Terminal leaflets 6-15 cm long, 2-6 cm wide.

All over Java, at least from Mt. Gedé eastwards to Mt. Idjèn, in forest edges and subalpine scrub, at 1650-3200 m. SE. Asia, also known from Sumatra, the Lesser Sunda Is., S. Celebes, and N. Borneo (Mt. Kinabalu).

The berries are tasty.

5. Rubus niveus Thunb.—Largely in fruit, 3 pink flowers present—Flora of Java 1:515—Mt. Papandajan.

Shrub 1-2 m tall, erect or somewhat climbing, densely spiny. Leaves white-tomentose beneath; leaflets 7-11, the lateral ones 4-8 cm long, 2-4 cm wide. Fruits red, seemingly dark blue by their hair cover.

In West Java near Talun and on Mt. Papandajan, then from Mt. Diëng eastwards to Mt. Idjèn, in forest edges and in grassy wildernesses and jungles, also in tjemara forest, at 1000-3150 m, once collected near Agung village on Mt. Ringgit at only 600 m. SE. to E. Asia, also in the Lesser Sunda Is., Celebes and Luzon.

Cultivated in Tjibodas Mountain Garden (Mt. Gedé) and on Fraser Hill (Pahang) and running wild but not native in Malaya and on Mt. Gedé.

Fruits inedible.

6. Rubus pyrifolius J.E. Smith—Flora of Java 1: 516—Puntjak Pass(Mt. Gedé). 11699.

Climbing, spiny shrub, 3-10 m long. Leaves 4-16 cm long, 3-10 cm wide. Ovaries 3-10, of which 1-4 will develop to dark red fruits.

All over Java, in forest edges and open forest, at 1000-2200 m. SE. Asia, also in Sumatra, the Lesser Sunda Is., Celebes and the Philippines.

Fruit scarcely edible.

7. Rubus rosaefolius J.E. Smith—Flora of Java 1: 515—Tjibodas (Mt. Gedé).

Shrub, erect and more or less climbing, often surrounded by numerous suckers to far from the mother plant, whereby easy to propagate. Leaflets 5-9, 3-11 cm long, 2-5 cm wide.

All over Java, eastwards to Mt. Idjèn, in forest edges, jungles, shrubberies, secondary growths, etc., generally at 600-2200 m, but sometimes descending along watercourses to as low as 250 m, obviously by vegetative dispersal of plants or suckers detached by floods, as is known from other *Rubus* species. In Asia from India to S. Japan and Formosa, almost all over the Archipelago (but not native in Sumatra and Malaya, and Thailand) to the Solomons and Queensland.

The fruits are edible; their insipid taste can be considerably improved by the addition of sugar and is then reminiscent of strawberries. It is for this reason, the continuous flowering, the easy propagation and pretty growth in sunny gardens, and the occurrence of cultivars with double flowers, that this species is frequently cultivated and introduced in various countries, e.g. in S. Africa and Mauritius where it has run wild and established itself. This causes confusion to define its natural range.

In SE. Asia, Sumatra and once in Java (Pèngalèngan) there occurs another allied species, which is sometimes confused with it: *R. sumatranus* Miq. (Flora of Java 1: 515, as a variety of *R. rosaefolius)* which possesses the same habit, but is clearly different by the stem and stalks being densely capitate glandular long-hairy, the narrower leaflets (index ± 3), the elongate fruit, and the reflexed calyx beneath it.

PLATE 45

EXPLANATION OF PLATE 46

ROSACEAE (continued)

1. **Rubus calycinus** D. Don—Flowering, on the right above a fruit—Flora of Java 1:515—Mt. Jang.

A profusely branched, creeping and rooting plant producing runners, 1-2 m long. Leaves simple and dark green, glossy, cordate at the base, 2^-7 cm through, with short spines on petiole and leaf undersurface. Flowers large, solitary. The orange berries quite edible.

In Indonesia only on three mountains in East Java (Ardjuno, Kawi & Jang), in dense patches on the forest floor of both mixed and tjemara forest, locally gregarious, at 1950-2800 m. A rare plant. Furthermore in the Himalayas.

It belongs to the small northern hemisphere subgenus *Chamacbatus,* of which one other species occurs in Luzon.

RUBIACEAE (continued on Plates 47 and **48)**

2. Allaeophania rugosa (Bl.) Boerl.—Short-styled form, the intended long-styled part absent—Flora of Java 2: 344—Mt. Papandajan. 11661.

An erect, but flaccid profusely branched herb, sometimes woody at the base, up to 2 m high. Leaves 2-12 cm long, 2-4 cm wide. Flowers bisexual, but may appear to be functionally unisexual, as plants carry either long-styled (not drawn) or short-styled flowers and are compulsory cross-pollinated by bees and bumble-bees.

In West & Central Java, from Mt. Salak eastwards to Sumbing, rather common in forest, glades, thickets and elfin forest, at 1500-3050 m. SE. Asia, also in Sumatra.

3. **Neanotis hirsuta** (L. f.) Lewis—Flora of Java 2: 288 (as *Anotis hirsuta* 3: 655—Mt. Salak.

A weak, ascending, little branched herb with rooting stems up to 40 cm high. Leaves 1-4 cm long, \-*i* cm wide.

In Java from Mt. Karang to Mt. Tengger, in sunny to moderately shaded, moist places, in secondary growths, along forest trails, but also a common weed in cinchona, tea and coffee plantations, at (800-) 1000-2100 m. SE. Asia, also in Sumatra and New Guinea.

When bruised giving off a fetid smell but used for stomach ache and eaten as a vegetable like the equally fetid *Paederia* (46-9). See the note under no. 9.

4. Neanotis indica (DC.) Lewis—Flora of Java 2: 289 (as *Anotis leschenaultiana* 3:65 5—Mt. Papandajan.

Prostrate, ascending, rooting herb, often branched from the base, up to 40 cm long. Leaves £-3 J cm long, \-\\ cm wide.

On a few Priangan mountains in West Java (the most western being Mt. Patuha) and in East Java on Mt. Kawi, in sunny to moderately shaded, dry to rather swampy places, locally sometimes abundant, at 1600-2600 m. SE. Asia, also in N. Sumatra (Karo Plateau).

Smell and uses as of JV. *hirsuta* **(46-3).**

5. **Argostemma borragineum** DC.—Flora of Java 2: 294—Mt. Salak.

Erect, rather fleshy, often little branched herb, creeping and rooting at the base, up to 80 cm high. Leaves 4-16 cm long, 2-7 cm wide, those of each pair often markedly unequal. Buds nodding. Corolla greenish white. Fruits erect.

In Java only in the western half, in evermoist, shady localities in humus forest, at (4oo-)iooo-i5oo m, rather rare. Also in Sumatra, Malaya and Borneo.

6. **Argostemma montanum** DC.—Flora of Java 2: 293—Tjibodas(Mt.Gedé).

Ascending, often little branched, fleshy herb, rooting at the base, up to 50 cm. Leaves 2-8 cm long, 1-3 cm wide, pale beneath. Corolla very white. Buds erect.

Throughout Java, in humus, evermoist, shaded localities in damp forest, at (400-) 1000-2000 (-2400) m. Also in Sumatra.

West of Nirmala (west of Bogor) I have found specimens which I tentatively regard as hybrids with the preceding species (vanSteenis 12439).

7. **Argostemma uniflorum** DC.—Flora of Java 2: 293—Geger Bintang (Mt. Gedé).

Almost creeping, ascending, often little branched, delicate herb, up to 40 cm long. Flowers facing the earth. Corolla with a green centre and a golden yellow stigma protruding from the white anther-tube; filaments pale greenish. Pedicels in fruit enlarged, glassy, erect. Leaves distichous, alternatingly one of each pair very small, 2-5 cm long, 1-2 cm wide.

In Java only in the western part eastwards to the Priàngan Mts, in evermoist shaded, humus localities, at 900-2000 m, characteristic for elfin forest on ridges. Also in Sumatra.

8. Coprosma sundana Miq.—Lower part with male flowers, upper part with long-styled female flowers and berries—Flora of Java 2: 348—Mt. Ardjuno, saddle with Mt. Welirang. 11880.

A densely branched, straggling shrub, with long pendulous branches and numerous short branchlets, up to 3 m high. Leaves 1 £-5 cm long, J-i} cm wide. Dioecious; flowers of the male plants conspicuous by large anthers dangling out of the flowers on long filiform filaments, flowers of female plants with very long, papillose stigmas; clearly a wind-pollinated plant.

In Java only on Mts Ardjuno, Jang & Suket (W. Idjèn), in open, sunny, stony places, in I *'actinium* thickets, sometimes in the vicinity of craters, at 2800-3300 m.

East Java is one of the two most western stations of this large genus which is characteristic of the southern half of the Pacific Ocean.

9. **Paederia scandens** (Lour.) Merr.—Flora of Java 2: 347—Redjèngans on Mt. Idjèn.

Shrub, twining to the right, up to 4 m. Leaves 3-12 cm long, 2-7 cm wide. Inflorescence up to 30 cm long.

In Java throughout the island from sea-level to 1500 (-2100) m, in brushwood, hedges, forest borders and secondary growth. SE. Asia and almost throughout the Archipelago.

All parts giving a very fetid smell when crushed, alluded to in the Javanese names *datm kentut, kahitntan, kasèmbukan* and the Linnean name *Paederia foetida* to which species the Javanese plants were formerly classified.

The faecal smell of this and some other *Rubiaceae* (see under *hasianthus* and *Neanotis)* is, according to Dr. D.R. Koolhaas (1931) due to the presence of methylmercaptan. In spite of this the leaves are used as a vegetable and a medicine. Vorderman says that the latter use is superstitious (transmigration principle).

I'LATE 46

EXPLANATION OF PLATE 47

RUBIACEAE (continued)

1. **Galium cuspidulatum** Miq.—Flora of Java 2: 355—Mt. Slamat. 11626.

A flaccid, scrambling herb, £-1 m long. Adhering to fur or clothes by minute hooked bristles on ovary, fruit, and above along the margin of the leaves. Leaves 8-30 mm long, 3-12 mm wide, in whorls of 6(-7) with distinct lateral nerves, and with a 1-2 mm long point on the apex.

In Java on Mt. Papandajan (in West) and from Mt. Slamat eastwards to Mt. Suket (Idjèn), in forest borders, in rain-forest and tjemara forest, shrubberies, on ridges and along forest trails, locally sometimes gregarious, at 2000-3000 m. Also in Ceram, probably wider, and also in Asia.

When dried this species has the agreeable scent of drying hay in which are the grasses belonging to *Anthoxanthum, Hierocbloe,* etc.; the substance causing this, called cumarin, is not present in the living tissue.

2. Galium subtrifidum Bl. —Flora of Java 2: 356 (as *G. innocuum)*—Mt. Papandajan. 12260.

Annual, delicate, leaning herb, 20-60 cm long. Leaves in whorls of (4-)6(-7), 3-8 mm long, 1-2 mm wide, without bleak sharp point at apex. Flowers in triplets with 3 white rather *blunt* segments. Fruit of two globular halves, smooth.

In West Java on Mts Patuha & Papandajan, and from Mt. Diëng eastwards to Mt. Jang, in marshy places, along brooks and streamlets, at 1100-2500 m. Also in N. Sumatra, the Philippines, Buru, and New Guinea.

Unfortunately there has been a confusion of the names and hence the identity of the species. See also my paper on *Galium* (Si 936) and the remarks under figure 4 of this plate.

3. **Galium rotundifolium** L.—Flora of Java 2: 355—Mt. Papandajan.

Perennial, scrambling or leaning herb, J-i£ m long. Leaves broad-elliptic, hairy, in whorls of 4, each with 3 lengthwise nerves, 3-30 mm long, 2-15 mm wide.Fruit with hooked hairs or only slightly rugose.

In West Java on Mt. Papandajan, then from Mt. Diëng eastwards to Mt. Idjèn, in grassy plains, forest borders and tjemara forest, at 1200-3250 m. In the broad sense distributed from the Mediterranean through SE. Asia to all higher mountains of the entire Archipelago.

4. Galium subtrifidum Bl. —Flora of Java 2: 356 (as *G. innocuum)*—Rawa Tjibitung (Pengalengan). 11644.

This is the same species as in figure 2 of this plate, but a slightly coarser plant. It had been my intention to depict another species which it resembles and with which it grows together on Mt. Papandajan, viz. *Galium asperifolium* Wall, (in the Flora of Java under the wrong name *G. subtrifidum* and the proper name with a question mark in the synonymy). This differs from *G. subtrifidum* by 4-merous flowers in more profuse inflorescences, corolla lobes acute, leaves with a bleak, sharp point at the top, and granular fruits. This occurs in SE. Asia and in Malesia only in Luzon and on Mts Papandajan (Java) & Kerintji (Sumatra), at 2000-2500 m. It is figured and described in my cited paper (Si936).

5. **Lasianthus capitatus** Bl.—Flora of Java 2: 337—Puntjak (Mt.Gedé). 11265.

An understorey treelet, 2^-3$ m high, hairy except the upper surface of the leaves. Leaves 9-17 cm long, 3-5 cm wide. Flowers with 6-7 segments, several together, sessile, on top of **an** axillary stalk, pale as is the drupe. Some flowers with long, others with short style.

Only in West Java, in dense primary forest, at 1500-1800 m. Also in Sumatra.

All species of the genus *Lasianthus* are distinctly 1-stemmed and are properly miniature trees. The patent branches are often only developed in one axil of the decussate leaves, **and that** alternatingly, so that they form together a spirally branched whole round the main stem.

6. **Lasianthus laevigatus** Bl.—Flora of Java 2: 337—G. Bèsèr, near Pat jèt (Mt. Gedé). 11782a.

A glabrous understorey treelet, up to 5 m high. Leaves 12-18 cm long, 3-5 cm wide.

Only in West Java, in the understorey of damp rain-forest, at 750-1700 m. Also in Borneo.

The leaves when bruised emit a fetid smell (see under 46-3 and 46-9), due to the presence of methylmercaptan (Koolhaas, **1931).**

7. **Lasianthus purpureus** Bl.—Flora of Java 2: 336—Tjibodas (Mt.Gedé). 11688.

A glabrous understorey treelet, 3-7 m high. Leaves 8-19 cm long, 2-44 cm wide, often long-acuminate.

In Java from Mt. Karang eastwards to Mt. Ungaran, especially common on Mts Salak, Gedé & the Priangan Mts; a common rain-forest understorey plant, also in elfin and mossy forest, at 900-1800 m, conspicuous by its contrasting vivid colours. Also in Sumatra (to 2400 m).

Like the preceding species emitting an offensive smell **when** bruised.

8. Lasianthus stercorarius Bl.—Flora of Java 2: 341—Puntjak Pass(Mt. Gedé). 11707.

An understorey treelet, up to 4 m high. Branchlets at least towards the apex with brown hairs. Leaves short-hairy, 5-17 cm long, 2-4 cm wide.

Throughout Java but especially common in the damp West-Javanese rain-forest, understorey plant, at 1000-2300 m. Also in Sumatra and Borneo.

When bruised the leaves emit an offensive smell, like the preceding species.

9. **Morinda sarmentosa** Bl.—The twig is drooping and is depicted upside down—Flora of Java 2: 350—Mt. Papandajan. **12243.**

A thin, woody liana, several metres long, with drooping branches. Leaves 7-10 cm long, 2-4 cm wide, with pit-domatia in nerve axils. Flowers with a delicious scent. Ovaries as usual in the genus connate in twos or threes, the fully ripe colour of the fruit not known to me.

Thusfar only found on Mts Burangrang, Papandajan & Tjeremai in West Java, in mountain forest, but very inconspicuous and possibly less rare than assumed. Also in Timor and ? New Guinea.

10. **Mycetia cauliflora** Reinw.—Flora of Java 2: 305—Tjibodas (Mt.Gedé). 11712.

A lowbranched shrub, 1-3 m high. Characteristic of the genus are the yellow flowers, white berries, and at a random place a sudden change of the green living bark of the twigs into straw-coloured or pale dead bark. Leaves 8-24 cm long, 3-8 cm wide, more or less heaped towards the branch ends. Flowers long-pedicelled.

Throughout Java, a constituent of the undergrowth of the rain-forest, on rather damp humus, at 600-2200 m. Widely distributed, from Sumatra and Malaya eastwards to the Philippines, Borneo and Flores.

11. **Spiradiclis caespitosa** Bl.—Flora of Java 2: **289**—Mègamendung (Mt. Gedé).

A delicate, ascending, annual herb, 8-50 cm high. Flowers in erect terminal spike-like inflorescences, placed one-sided on each axis, only one flower open at the same time. Capsule bottle-shaped, ribbed, 5-6 mm long, 2-valved, containing numerous minute seeds.

Only in West Java in moist shaded places, along ditches **and** streamlets, on wet walls and rocks, at (40-)2 5 0-1200 m. Also in Sumatra and Borneo.

PI.ATK 47

EXPLANATION OF PLATE 48

RUBIACEAE (continued)

1. Mussaenda frondosa L.—Flora of Java 2: 304—Tjibodas (Mt. Gedé).

A small tree, sometimes scrambling up to 5 m high. In flower immediately recognized by a few whitish or yellow decoy leaves in the corymb of flowers; these are no true leaves but are a specialized lobe of the calyx, the other four lobes being inconspicuous, triangular and shaped like bracts. Leaves very variable in shape and size, 5-17 cm long, 2-7 cm wide, decoy leaves 4-9 cm long. Male and female flowers on the same plant. Fruit an ellipsoid berry, covered by sparse lenticels, iJ-2 cm long, finally black.

Throughout Java, along forest edges, in clearings, thickets, secondary growth, from the lowland up to c. 1700 m. In the wide sense this species occurs throughout the Archipelago.

It is usually suggested that decoy leaves provide a "show apparatus" to increase or stimulate attraction to flower-visiting insects, but a word of warning is in place to discourage uncritical acceptance of a superficial "explanation" of the ecological (flower biological) usefulness of any structure, especially as not all species of the genus possess decoy leaves. The suggestion is not supported by any experiments. Mr. Caspers and I tried to make some in Holland with *Viburnum opulus,* but such experiments in the field proved by no means easy to devise.

2. **Nertera granadense** (L. f.) Druce—Flora of Java 2: 348—Tjibeureum (Mt. Gedé).

A sometimes mat-forming, rooting, delicate herb creeping on the soil or base of tree trunks, to 60 cm long. Leaves 2-17 mm long, i±-2 mm wide. Flowers in Java unisexual, very insignificant, hidden between the two upper leaves of short lateral branches.

In Java from Mt. Halimun near Nirmala eastwards to Mt. Idjèn, in wet shady localities, often on stones and rocks, decayed tree trunks, in mossy forest and in elfin scrub on ridges, near waterfalls in the open, at 1500-3000 m. In SE. Asia and from Sumatra and Malaya eastwards through the Archipelago (1000-3300 m), also in Madagascar, Australia, the Pacific and the Americas.

In autumn sold as a cushion plant covered with berries in pots in florist shops in Europe.

3. **Ophiorrhiza longiflora** Bl.—a. In flower, b. bunch of fruit—Flora of Java 2: 290—Geger Bintang (Mt. Gedé).

An erect herb, ij m high. Leaves 8-13 cm long, 3-44 cm wide. Capsules erect, fleshy, opening with an apical slit.

In Java common in the western half, in damp primary forest, stream bottoms, trail sides, at (1000-) 1700-2400 m. Also in Sumatra.

4. **Psychotria montana** Bl.—Flowering branch and an infructescence—Flora of Java 2: 332—Puntjak (Mt. Gedé). 11703.

An erect shrub, &-2£ m high. Leaves 10-25 cm l°ng> 3~10 cm wide. Drupes 8-13 mm diameter, containing two pyrenes, like in coffee, which are lengthwise ribbed.

Throughout Java, in forests and thickets, village groves, at 800-2000 m. SE. Asia, also in Malaya, Sumatra, Borneo, the Philippines and Bali, probably wider.

5. **Rubia cordifolia** L.—Flora of Java 2: 356—Tjibodas (Mt. Gedé).

A climbing plant, up to 6 m long. The acutely 4-angled brittle stem and leaf margin with bristles, adhering to clothes, rough to the touch. Leaves 4-10 cm long, 1-5 cm wide, beneath with prickly nerves. Berry 2-lobed with 2 seeds, or by abortion 1-lobed and with 1 seed as is usually the case.

Throughout Java along forest edges and trails, in thickets, locally often abundant, at 500-2000 m. Africa through SE. & E. Asia (where a red-berried variety) to Japan, in the Archipelago also in Sumatra, Borneo and the Philippines, curiously absent from the area east of the Wallace Line, but not found in Bali.

6. **Wendlandia** densiflora. (Bl.) DC—Flora of Java 2: 295—Mt. Guntur. L. van der Pijl.

A shrub, treelet or tree, up to 17 m tall. Leaves up to 18 cm long and 13 cm wide, decrescent in size below the inflorescence. Stipules either acute and triangular or with an apical appendage. Flowers subsessile. Calyx, pedicels and floral bracts densely short-hairy. Fruit (not drawn) a small 2-celled and 2-valved capsule containing many reticulate-veined minute seeds.

In Java common in the eastern half, in West only, it seems, on Mt. Tjeremai, G. Parang and Mt. Guntur, in primary and secondary forest, but mainly in thickets, and as a pioneer on lavastreams, on screes of volcanic ash, a common pioneer in grassland and in light tjemara forest, at 600-2100 m. Also in Borneo (?), Celebes, and the Lesser Sunda Is.

A second species of similar ecology and habit is IF. *glabrata* which differs in more graceful panicles, glabrous calyx, pedicels and bracts, and short-pedicelled flowers.

SANTALACEAE

7. **Dendromyza reinwardtiana** (Korth.) Danser—Flora of Java 2: 77—Tjianten (SW. of Bogor). 11762.

A shrub, intertwining amongst itself, up to several metres long, parasitizing on tree branches (like mistletoe), but also on its own branchlets by suckers (haustoria). Leaves thickish, 2-10 cm long, 1J-8 cm wide. Flowers male or female on different plants, inconspicuous, solitary and sessile. Drupes with one pyrene (S 1933, as *Henslowia reinwardtiana).*

In Java in the everwet western half, a parasite in the forest on several kinds of trees, in Central Java in Nusa Kambangan I., from sea-level up to 1600 m (in New Guinea even to 2500 m). Widely distributed in all islands of Malesia and the Solomons, but absent from regions subject to a dry monsoon, viz. the eastern half of Java and the Lesser Sunda Is.

PLATE 48

EXPLANATION OF PLATE 49

RUTACEAE (see also Plate 53-1/2)

1. **Acronychia pedunculata** (L.) Miq.—Flora of Java 2: 101 (as *A. laiirifolia* Bl.)—Tjibodas (Mt. Gedé).

Shrub or tree, up to 20 m high, trunk to 35 cm diameter, the bark with a fresh aromatic scent. Leaves 6-21 cm long, 3^-7 cm wide, with transparent pellucid dots. Flower with an orange disk. Fruit a green, globose drupe, 5-8 mm diameter.

All over Java, in rain-forest and secondary forest, in the mountains often in elfin wood on ridges and then more stunted, a common tree from sea-level up to 2000 m. SE. & E. Asia, throughout the Archipelago, but not in the Moluccas and New Guinea.

2. **Boenninghausenia albiflora** (Hook.) Meissn.—In flower and fruit—Flora of Java 2: 99—Mt. Papandajan.

An erect graceful herb, much branched, J-i J m high, with a blue-green tinge, strongly aromatic with a lemon-like smell (as that of *Rutd)* when crushed. Leaves up to 4 times pinnate, the lower ones 8-12 cm long, higher ones gradually smaller and less compound; leaflets 3-15 mm long, 2-10 mm wide. Flowers 4-merous with calyx and corolla; stamens 8. Fruit elevated on a thin gynophore, consisting of 4 separate carpels dehiscing on one side and containing 4-6 dark seeds 1-1J mm long.

In Java in West on Mt. Papandajan, then from Mt. Sumbing eastwards to Mt. Lamongan, in grassland and forest edges, also in elfin forest on ridges and mossy forest, at 1500-3000 m.

Superficially reminding in habit of *Thalictrum* (43-6), which, however, differs completely in floral details and is not aromatic.

3. **Acronychia trifoliata** Zoll.—Flora of Java 2: 101— Redjèngans near Sempol (Mt. Idjèn). 12004.

A tree up to 26 m tall, trunk to 30 cm diameter. Leaves consisting of 3 leaflets, each 7-15 cm long, 4-8 cm wide. Flowers pure white. Drupes pale.

Throughout Java, in mixed rain-forest, monsoon forest and tjemara forest, mostly at 600-1800 m, but in Kangean at sea-level and in Bawean at 250 m. Also in Bali, Celebes, Morotai and New Guinea.

4. Toddalia asiatica (L.) Lamk—a. Twig end with male flowers, to which is added a fruit bunch from another plant which should not have been attached, b. part of the stem—Flora of Java 2: 101—Tjibodas (Mt. Gedé).

A strongly branched, spiny liana, up to 30 m long, often smaller. Old main stems with large corky warts having a spine on top. Leaves consisting of 3 leaflets, each 3-10 cm long, 1-3 cm wide. Plant dioecious, either male or female. Fruit a hard drupe, finally orange, with 3-7 seeds, the kernel shallowly 5-angled, but in living state the drupe globular and rugose with small warts.

All over Java, in forest edges, along glades, and in ridge scrub, also in secondary forest and in tjemara forest, at 1000-2600 m. From E. Africa through SE. Asia to the Malesian islands, but not yet found in the Moluccas and New Guinea.

A similarly spiny, but *erect* shrub with 3-foliolate leaves is *Zantboxylum ovalifolium* this has smooth dehiscent capsules and larger leaves.

Spines of the type figured on the stem are also found e.g. in ***Zanthoxylum* (53-1), *Elaeagnus* (14-19), *Caesalpinia*, and *Me%p-neurum.***

SAPINDACEAE

5. Dodonaea viscosa Jacq.—Twig in fruit, left below a bunch of female flowers, on the right male flowers—Flora of Java 2: 141—Mt. Idjèn.

An erect shrub or small tree, up to 15 m tall, trunk to 25 cm diameter, mostly smaller. Young leaves lacquered and viscid by resin exuded by small glands. Leaves 5-14 cm long, 1-4 cm wide. Male and female flowers on different trees. The conspicuously winged capsule dehiscent, the seeds globose and black.

The present hairy form only on the mountains in the climatically seasonal part of Java, from Mts Sindoro, Sumbing & Merbabu eastwards, a pioneer in grassland and bare places (ash slopes, lavastreams), invading tjemara forest as a first step towards leafy forest, not seldom gregarious, at 1200-3000 m.

A fast growing tree, already flowering and fruiting at young age, often used for reafforestation in the mountains and also for fire-wood, e.g. on Mt. Diëng.

On the beach and behind the coast a glabrous form of the same species occurs, but this is also found in West Java.

As a whole the species is an ubiquist in all the tropics and subtropics. In the Archipelago it occurs in a very casual, scattered way.

The hairy mountain form of East Java occurs further only in Bali and Lombok. A glabrous mountain form is found in Timor, Celebes, the Philippines, the Moluccas and New Guinea. The lowland beach form is found scattered also in West Malesia.


4a
4b
5
1
2
3

EXPLANATION OF PLATE 50

SAURURACEAE

1. **Houttuynia cordata** Thunb.—Flora of Java i: 175—Cultivated at Tjibodas (Mt. Gedé).

Perennial herb, the subterranean thin rootstock to 70 cm long and strongly branched, the stems erect or ascending and jointed, 20-90 cm high. Inflorescence a spike of very small flowers, unassuming, at the base subtended by 4 white bracts.

In Java only known from the tea estate Ardjuna in Priangan, division Karang-Tumaritis, in light shade in the fringe of bamboo groves bordering the estate, at about 1250 m. Widely distributed in SE. & E. Asia to Formosa and Japan.

Only once found, by Mr. Kluit, then employee, in 1936 (S 1937, 1937). Efforts to find out whether this plant was at some time in the past imported for cultivation or sent out by the Botanic Gardens at Tjibodas had no result and consequently I have hesitantly accepted this plant as native. There are Asiatic species which are undoubtedly native in the Priangan Mts but restricted to a single spot or very limited area and plant-geographically its indigenous nature in Java is not impossible.

When crushed the plant spreads a somewhat sickly smell of blood, hence the Sundanese name *djitkut bandjir*, locally given to it. The local belief was that the plant arose from the flesh and blood of a man who was killed by a tiger on the same spot.

Once established it is very tenacious and not easy to weed out by its very large root system.

SAXIFRAGACEAE

2. **Astilbe rivularis** D.Don—Small part of a leaf, on it part of inflorescence, right upper corner part of it in fruit—Flora of Java 1: 203 (as *A., indicd)*—Mt. Jang. 11965.

Robust, perennial herb, i-2£ m high, brown-hairy, with hollow stem. Basal leaves large and compound, twice pinnate, the leaflets 4-16 cm long, 2-8 cm wide, upper leaves less compound and smaller. Flowers in very large cream-coloured panicles £-i| m long; there is no corolla, stamens (5-)8-io.

All over Java, from Mt. Salak eastwards, in forest fringes and near ravines, at 1200-3300 m. SE. Asia, also in Central W. Sumatra, Mt. Kinabalu in Sabah, the Philippines, Celebes, Bali, Ceram, and New Guinea.

Leaves of seedlings are simple.

Dr. Hoogland, who revised the genus in 1958, accepts only one species in the Archipelago, corroborating my former assumption.

3. **Dichroa febrifuga** Lour.—An inflorescence, no full-grown leaves, down to the left a bunch of sky-blue fruits—Flora of Java 1:509 (as *D. sylvaticd)*—Tjibodas (Mt. Gedé).

An erect shrub, 1^-3 m high, branched, the foliage rather dark, with flowers in terminal panicles. Leaves 8-30 cm long, 3-12 cm wide, very herbaceous. Flowers sky-blue, variable in intensity in different individuals and places, and with age, and also in size (petals 5-10 mm long). Fruit a berry.

All over Java, especially common in the western part in the depth of the forest undergrowth and in forest edges, at 700-2000 m. SE. Asia, also in almost all islands of the Archipelago, scarce in the Lesser Sunda Is. (Flores), in Borneo also at 450 m.

A rather variable plant described under various names, but Dr. Hoogland corroborated the initial opinion of Dr. Backer.

It is used against fever, hence the specific *epithet febrifuga* given to it by the old priest and botanist Loureiro, who wrote an early Flora of Cochinchina, published in 1790.

4. **Hydrangea aspera** D. Don—Inflorescence with some upper leaves—Flora of Java 1: 508 (as *H. oblongifolid)*—Mt. Papandajan. 11673.

A shrub, 2-5 m high, sometimes rather slack. Leaves 12-36 cm long, 3-14 cm wide. Flowers in terminal panicles, a number of marginal flowers sterile or male and with much enlarged, pale calyx lobes.

In Java from Mt. Salak eastwards to Mt. Jang, in forest edges, along glades, in elfin and mossy forest, rare, and always only one or a few specimens, at 1200-2800 m. From the East Himalayas to eastern China and Formosa, also in Sumatra.

A beautiful plant; the biological importance of the sterile flowers forming the "show apparatus", which is by no means common to all species of the genus, is unclear (see discussion under 48-1).

5. **Polyosma ilicifolia** Bl.—The bend at the base of the inflorescence is not natural—Flora of Java 1: 507—Tjibodas (Mt. Gedé).

A gnarly shrub or tree, 3-17 m tall, the trunk 5-30 cm diameter. Leaves 5-15 cm long, 1J-6 cm wide. Flowers on pedicels 1-4 mm long, in shades of purple, with laxly hairy or glabrous filaments which at flowering time are 2-3 times as long as the anthers; fragrant. Fruit a drupe with one seed.

All over Java, as far east as Mt. Jang, in the eastern part becoming decidedly rarer, in forest, especially common on slopes and ridges in elfin and mossy forest, glades and forest edges, also in open tjemara forest, at 1400-2800 m. Also in Sumatra (up to 3200 m), in N. Borneo on Mt. Kinabalu, and in Bali and Lombok.

The flowers are sometimes transformed into galls. Their colour is various, in shades towards creamy, but not white.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SCROPHULARIACEAE

1. **Lindernia ruelloides** (Colsm.) Pennell—Flora of Java 2: 512—Tjibodas (Mt. Gedé).

Stem creeping and rooting, at each node giving off an erect flowering shoot, 8-12 cm high, with but a few pairs of leaves; these 2-4 cm long, 1 £-2 cm wide, acute, serrate. Fruit a linear pod 2-2 £ cm long.

In West & Central Java (Banjumas), in forest and other shady places, along trails, in village groves, under trees in parks, from the lowland up to 1700 m. SE. Asia and all through Malesia.

2. **Sopubia trifida** D.Don—Flora of Java 2: 514—Mt. Idjèn. **12064.**

A stiffly erect annual herb, 30-90 cm high, mostly branched, living as a hemiparasite (see sub 29-1) on grass roots. Lower leaves usually consisting of 3 linear segments, upper ones entire, up to 4 cm long; developed axillary shoots often present.

In East Java (Idjèn Plateau), in grassy places and light tjemara forest, at 950-1800 m. From tropical Africa to Asia and Australia, also known from Bali, Sumba, Timor, SW. Celebes (Mt. Bonthain), the Philippines, and New Guinea.

The flowers wilt very soon after picking, and probably last but one day on the plant; these flowers were drawn on the lid of the boot of a car. During drying the plant becomes blackish, like this is the case with related genera of hemiparasitic herbs.

3. **Torenia asiatica** L.—Flora of Java 2:508—Mt. Salak.

An erect or ascending herb, 40-75 cm long, glabrous or short-hairy. Leaves 3-10 cm long, ii-2j cm wide. Calyx 5-winged. Flowers large and dark purple-blue, no more than a few on each stem.

In West Java, mostly in moist, shaded places, along streams and ditches, more rarely in elfin forest, at 800-1800 m. SE. Asia, also in Sumatra and Central Celebes.

4. **Veronica** javanica Bl.—Flora of Java 2: 512—Tjibodas (Mt. Gedé).

An unassuming, erect, annual herb, 5-30 cm high, older plants sometimes partly prostrate. Stem long-hairy. Leaves I-3 cm long, *i-ii* cm wide. Flowers pale purple or whitish, in axillary racemes, often not or scarcely opening, the corolla shorter than the calyx.

All over Java, in sunny or moderately shaded places, on roadsides, in tjemara forest, and on open mountain, tops, but also a weed in gardens and fields, at 1100-3200 m. Tropical Africa and Asia, also in Sumatra and the Philippines.

The only *Veronica* species of Java, probably native.

5. **Wightia borneensis** Hook. f. ssp. **ottolanderi** (Koord.) Steen.—Right a leafy twig with opened pods, left a piece of a branch with an inflorescence and just developing leaves of the flush—Flora of Java 2: 503—Mt. Idjèn. 11972.

A leaf-shedding tree to 12 m tall (in forest sometimes to 30 m tall and 30 cm diameter, see below) and with a trunk to 35 cm diameter, low-branched and with rough corky bark. Pods 24-5 cm long, opening with 2 coriaceous valves, exposing very many thin, winged seeds, 1-1J cm long, which are easily spread by wind.

Only in East Java on Mts Lawu, Wilis, Meru Betiri, Penanggungan & Idjèn, often the sole tree in sparse stands on redjèngans (old lavastreams), by ravines, iq remains of primary forest, and on grassy slopes, at 300-15.00 m. Also known from Sumbawa (Bima) and Flores (Endeh).

In the primary forest the plant starts as a sturdy epiphytic shrub, sending down a root (or roots) along the' stem of the supporting tree and clasping its stem with lateral roots. At that stage the plant looks like a liana. As soon as the main root(s) strike the soil, under favourable conditions of growth, the hemi-epiphyte has become a terrestrial plant and its growth is speeded up, the main root becoming thick as that of a slender tree while the crown is expanding like that of a true tree. When the supporting tree dies *Wightia* may remain standing as a high, slender tree in its own right and one cannot distinguish any more that part of its stem which originated from a root and the part which is the true stem. This peculiar mode of growth is also found in figs (32-1) and *Fagraea* (28-7).

It will take quite some time before the root reaches the soil and sometimes it does not and in that case the plant remains an epiphyte. Collectors have gathered it at various stages and labels consequently record its habit at variance as a liana, an epiphyte, and a slender tree, contradictions which find their solution thus explained, first by Koorders, more explicitly by myself (S 1949).

The fine, winged seed obviously germinates only in light.

This subspecies of *Wightia* is restricted to regions subject to a dry season, during which period the tree is completely bare, bearing only the dehisced pods. In August-September with rains coming on the gorgeous flowers are produced together with the pretty flush. One of the finest trees I know, allied to *Paulownia,* deserving to be planted along mountain roadsides in East Java; a slow grower with hard wood and thus technically also suiting this purpose. Its thick corky bark makes it insensitive to grass fires.

The other subspecies of *Wightia borneensis* is only found as a rare hemi-epiphyte in West Java (Bantam to Priangan), Sumatra, Malaya, and Borneo; this has distinctly larger flowers, about twice the si2e of those of the subspecies *ottolanderi,* but is otherwise similar.

SOLANACEAE

6. **Lycianthes** lysimachioides (Wall.) Bitt.—Flora of Java 2 : 476—Mt. Suket (on the W. rim of Idjèn caldera). 1215 6.

A long-creeping, hairy herb, rooting at the nodes, to 1 m long. Leaves 2-7 cm long, 1-4 cm wide.

In West Java near Tjidadap (S. of Sukabumi) and in East Java on Mt. Idjèn, on the forest bottom, at 1100-2000 m. Local and rare, but easily escaping attention. SE. Asia, also in Bali, northern Sumatra (Gajo Lands & Mt. Malintang), and in N. Celebes.

Lycianthes is a segregate of the huge genus *Solarium,* characterized by a cup-shaped calyx with either an entire margin or with subulate teeth.

7. **Lycianthes biflora** (Lour.) Bitt.—Flora of Java 2: 476—Mt. Idjèn. 12094.

Herb, £-1 m high. Stem sparsely to densely hairy. Leaves often unequal, 4-20 cm long, 2}-7 cm wide, upper surface sparsely, undersurface densely hairy, rarely shallowly lobed. Calyx including its teeth densely hairy. Berry red.

A variable species, throughout Java, in shaded places, in high forest, also in elfin wood and in light tjemara forest, from the lowland up to 2400 m. SE. & E. Asia, and throughout Malesia.

8. Solatium nigrum L.—Berries unripe—Flora of Java 2: 471—Tjibodas.

An erect herb, up to 1J m high. Leaves 3-16 cm long, 2-12 cm wide. Flowers and berries nodding. Flowers white or violet. Ripe berries purple or blackish purple, 8-10 mm diameter.

A common weed throughout Java and Indonesia in waste places, fields, fallow land, thickets, estates, forest borders, along trails, from sea-level to 3100 m.

I do not regard this as indigenous, but as introduced long ago; it was already known to Rumphius, but this does not exclude a post-Columbian introduction from tropical America. It is a form or race of an extremely variable cosmopolitan species; sometimes it is regarded as a distinct species *S. nodiflorum* **Jacq.**

The plant is a common wild vegetable (lalab), called *leuntja* in Sundanese and *ranti in* Javanese.

The proper *S. nigrum,* with the large black berries and the large white flowers, from Europe, which is by some regarded as a poisonous plant, is rather recently also introduced in Java, but still very scarce.

PLATE 51

STAPHYLEACEAE

1. **Turpinia montana** (Bl.) Kurz—Node with i panicle of flowers and i leaf—Flora of Java z: 146.

A shrub or slender treelet, up to 15 m tall. Leaves opposite, with 3-7 leaflets, the latter 3-10 cm long, ij-j cm wide. Panicles graceful, glabrous, the flowers unassuming. Fruit globular, thin-walled, 3-celled but not dehiscent, J-i cm diameter.

In West and more rare in Central Java, in forests on slopes, particularly in elfin wood on ridges, at 750-2300 m. SE. Asia, also in Sumatra.

STYRACACEAE

2. **Bruinsmia styracoides** Boerl. & Koord.—Flora of Java 2: **204.**

Tree, 15-37 m tall, the trunk 1 /3-1 £ m diameter. Leaves 7I-19 cm long, 3-10 cm wide. Fruits pear-shaped, indehiscent, 5-celled, with many small prismatic seeds.

In West Java only in Bantam west of Bogor, in rain-forest, at 700-1600 m, fairly rare. Also in Sumatra, Borneo, Celebes, Mindanao and New Guinea.

SYMPLOCACEAE

3. **Symplocos henschelii** (Mor.) Clarke—a. Flowering twig with 1 leaf, b. fruit, the fruit-wall partly removed—Flora of Java 2: 204—Tjibodas. 11490. Tjisarua. 12217.

Tree, often rather low-branching, 12-30 m tall, the trunk to £ m diameter. Leaves 9-16 cm long, 4-7 cm wide. The silver-hairy flowers are deliriously fragrant. Fruit an ellipsoid drupe with a thick, fleshy fruit-wall surrounding a 4-seeded stone, 3-5 cm long, 2-4 cm wide; stone j-i £ cm diameter.

In West Java largely from Mt. Gedé to the Priangan Mts, always solitary or in a few specimens, rare, a lower-storey tree of primary rain-forest, at 1200-1800 m. SE. Asia, also in Malaya, Sumatra, Borneo and Luzon.

This species differs distinctly from the next one by the long corolla tube, not a common flower type in most *Symplocos* species. It differs also from the next and other species in that the flush is not bluish or violet and the fruit not of those colours. Also the leaves do not turn yellowish or pale green in drying as most *Symplocos* species do because of alum accumulation in the tissues, discussed under *Helicia* (42-5). The two species here depicted belong to two different subgenera of the genus ***Symplocos.***

4. Symplocos cochinchinensis (Lour.) S. Moore ssp. sessi**folia** (Bl.) Noot.—Flora of Java 2: 205 (as *S. sessilifolia* (Bl.) Giirke)—Mt. Pangrango.

Stiff shrub, often gnarly, or small tree 1-8 m tall. Flush blue-violet. Leaves mostly conferted, hard and leathery, 4-11 cm long, 2-4 cm wide. Flowers in plenty at a time, fragrant. Fruit a drupe, first green, later dark violet.

In Java on Mts Salak, Gedé-Pangrango, Patuha, Papandajan, Diëng & Sumbing, often dominant in elfin wood on ridges and summits, exposed sterile places, in stony places near craters, **together with *\'actinium* (17-8), *Rhododendron* (16-6), *Myrsine*** (32-9), *Photinia* (44-5), *Eurya*(52-6), and *Myrica* (32-5), at 2000-**3100 m.**

A characteristic local high-mountain race of a very widely distributed, very variable species, *S. cochinchinensis* which ranges from Japan to the Himalayas and through Malesia to Queensland.

THEACEAE (see also Plate 53-3/4)

5. **Adinandra javanica** Choisy—The fruit should not have been attached to the flowering twig—Flora of Java 1: 322.

Low to medium-sized tree, 8-30 m tall, sometimes a low-branching treelet in more open places, yielding a red sap when cut. Leaves alternate in 2 rows (in one plane) on the twig, 6-14 cm long, 2-6 cm wide. Corolla initially light lilac with white margin, filaments white, anthers orange, style green, but all presently turning purplish brown (like, unfortunately, the ones drawn here, which were too old). The flower is fragrant, and falls off as a whole with the stamens; the style remains on the fruit, a pretty large, ellipsoid, soft brown appressed-hairy berry with very many small seeds.

Only in East Java, on Mts Tengger, Jang, Raung & Idjèn, in rain-forest, elfin wood and on forest edges, at 1700-2200 m. Also in Bali, Lombok (Mt. Rindjani) and Sumbawa.

6. **Eurya acuminata** DC.—Flora of Java 1:323.

Shrub or tree to 15 m tall, often profusely branched; young twigs mostly hairy. Leaves in two rows, rather firm, 5-10 cm long, 1 £-3 cm wide, the veins forming a prominent meshwork below, the upper surface sometimes slightly bullate. Male and female flowers on different trees.

In Java in rain-forests, in thickets, common in elfin and mossy forest on ridges and summits and quite near to solfatara, sometimes locally co-dominant, frequently associated with the species mentioned under no 4. *Symplocos*, mostly above 700 m up to 3000 m. Also in SE. Asia, Sumatra, Celebes, and the Philippines.

This is also an alum-accumulating plant: see its coloured flush and the sky-blue fruit 1

7. Schima wallichii (DC.) Korth. ssp. **noronhae** (Bl.) Bloemb.—Flora of Java 1: 321—Mt. Salak.

Shrub or tree to over 40 m tall and 1 **i** m diameter, at times conspicuous by its reddish flush and on the ground by the great masses of fallen flowers strongly resembling those of tea; the outer petal is half-globose, smaller than the others and clasps them in bud. Leaves 7-24 cm long, 11-7 cm wide. Fruit a hard capsule getting slits at the top where the fine winged seed is spread by wind and heavy rains.

In West Java as far as the Priangan Mts common in rain-forest, in Bantam and the Djampangs at both low and montane altitudes, in the Priangan Mts mostly above 700 m, often a major constituent of the forest, eagerly regenerating in depleted forest, abandoned humas and ladangs, and there gaining dominance. *Puspa* (Sundanese) or *seru* (Malay) already produces flowers and fruit at a very early age.

In Central and East Java it is used successfully for reafforestation ; its timber is not very valuable but it is good for restoring forest conditions.

Originally *puspa* was named scientifically *Schima noronhae,* after Fernando de Noroña, one of the first botanists who got a glance of tropical interior mountain vegetation, and several other species were later described from other places, Banka, Borneo, and in Asia. Closer examination showed, however, that these populations are only feebly distinct mutually, by insignificant characters; for example most Sumatran specimens differ from the Javanese only in having crenate leaves, those in Java being entire. It appeared further that these slight distinctions are "geographical", which means that in one place or area one finds only one facies or type. The "geographical structure of the species" is hence not unlike that of man: it is a biological entity split into geographical races, which exclude or replace one another. Just as in man, who is biologically manifestly one species, border areas have transitional specimens and the structure of the races is a whole capable of fertile interbreeding. Thus it is that, after a thorough study, Bloembergen concluded to merely one widespread species, distributed through SE. & E. Asia to the Ryu Kyu and Bonin Is. and Formosa to Malaya and the Great Sunda Is. Sumatra, Borneo (incl. Palawan) and West Java, of which he distinguished 9 subspecies.

THYMELAEACEAE

8. Daphne composita(L. f.) Gilg—Flora of Java 1: 269.

A lax, graceful shrub or small tree toiom tall, the trunk 16 cm diameter, the bark tough from silky fibers. Leaves 7-14 cm long, 2-5 cm wide. In bud the head of flowers is enveloped in two red-tinged involucral bracts, and may at first sight be taken for a fruit. In fact, the fruit is an ovoid drupe. The silver-white flowers are fragrant as usual in this genus.

Only in West Java, often on slopes and ridges both in elfin and rain-forest, an inconspicuous plant, at 1200-2000 m. SE. Asia, also in Sumatra, Malaya, and Borneo.

PLATE 52

RUTACEAE (see also Plate 49-1/4)

1. **Zanthoxylum scandens** Bl.—Poise inverted—Flora of Java 2: 96(as *Fagara scandens),* 3: 653—Mt. Jang. 11951. Mt. Papandajan. 12261.

Very spiny liana 2-10 m long. Leaves compound; leaflets 10-21, 3-8 cm long, i-2£ cm wide. Flush dirty purple. Fruit consisting of 4-5 red carpels each of which dehisces with 2 valves and contains 1-2 hard, black seeds.

In Java eastwards to Mt. Diëng, in mixed forests, forest edges and old secondary forest, at 1000-2100 m. SE. to E. Asia, also in Sumatra and Borneo (Mt. Kinabalu).

The Sundanese name *kupu heulang,* or eagle's claw, alludes to the striking resemblance with the spines on the older stems.

2. **Lavanga sarmentosa** (Bl.) Kurz—Flora of Java 2: 105—Tjibodas. 11492.

Coarse liana, 5-25 m long; seedlings often erect, little-branched, 1-2 m tall. Main shoots armed with straight spines and bearing unifoliolate, linear-lanceolate leaves; climbing twigs with hooked spines and leaves consisting of 3 leaflets; flowering twigs often unarmed. Leaflets 7-20 cm long, 2-8 cm wide, entire. Flowers pale green, fragrant, (3-)4-5-merous. Berry resembling a *Citrus* (djeruk), globose, 14-3 cm diameter, aromatic.

All over Java, especially in West Java, in primary and secondary forests, forest edges and river banks, from the lowland up to 1700 m. SE. Asia, also in West Malesia.

THEACEAE (see also Plate 52-5/7)

3. **Pyrenaria serrata** Bl.—a. Flowering twig, b. flush, c. fruit with partly removed pericarp to expose seed—Flora of Java 1: 321—Tjibodas (Mt. Gedé). 12336.

Shrub or tree, up to 15 m tall, sometimes already fertile when 2 m high. Leaves 7-20 cm long, 3-7 cm wide, serrate or crenate. Sepals very unequal in size, the outer ones obtuse. Petals fleshy. Style one, the top with 5 stigmatic branches. Fruit fleshy, globose, not dehiscent, 3-5-celled, with 2 black seeds per cell.

In West and Central Java as far east as Mt. Merapi, in rain-forest, at 200-2200 m, mostly above 1000 m. Also known from Sumatra, Malaya, and Borneo.

4. **Camellia lanceolata** (Bl.) Seem.—Only in fruit—Flora of Java 1: 319—Mégamendung (above Bogor). 12214.

Unassuming, erect, branched shrub 2-5 m high. Twigs with patent-hairy tops. Leaves 6-13 cm long, 2J-5 cm wide, serrate-dentate, eventually glabrous. Flowering is sparse and inconspicuous. Flowers white (like those of tea), i£-2 cm diameter, the sepals very unequal. Outer stamens connate to a fleshy tube which bears the anthers mainly at the rim inside; the inner stamens small, free. Style at the top with 3 stigmas stuck together. Fruits hard with 1-3 cells, dehiscing with rather woody valves, detaching from a persistent central column (the columella) at the apex of which the seeds are attached. Seeds 2-3 in each cell, angular, brown to dull black.

In West Java in primary rain-forests, especially in elfin wood on ridges, at 900-1600 m. SE. Asia, also in Sumatra, Borneo, the Philippines, and Celebes.

This is the one wild species of tea in Malesia; there is presumably a second undescribed one in Sumatra and N. Borneo.

VITACEAE

5. **Tetrastigma papillosum** (Bl.) Planch.—Tendril and fruit not drawn—Flora of Java 2: 88—Rarahan near Tjibodas (Mt. **Gedé). 12281.**

High-climbing liana to 40 m and possibly longer; young stems round on section, often very densely set with corky warts resembling spines but not prickly, sending down many slender aerial roots. Leaves mostly with 3 leaflets, rarely pedate and with 4-5 leaflets. Tendrils opposite the leaves, bifid. Flowers small, unisexual, 4-merous. Female flowers with a 4-lobed stigma.

All over Java, in forests, forest edges, and secondary forest, at 500-1500 m. SE. Asia and West Malesia.

This is one of the host species of the parasitic *Rafflesia* and ***Rbi^anthes.***

PLATE 53

EXPLANATION OF PLATE 54

UMBELLIFERAE

1. **Hydrocotyle javanica** Thunb.—In flower and fruit—Flora of Java 2: 173.

Annual herb, aromatic, creeping with ascending flowering branches, the young stems sometimes erect, 10-50 cm long. Leaves 3-10 cm across.

All over Java, in moist shaded places, in forests and coffee plantations, on ravine slopes and talus, from the lowlands up to 2400 m. All over the Old World and rather common throughout the Archipelago but obviously absent in the Lesser Sunda Is.

2. **Oenanthe javanica** DC.—In flower and young fruit—Flora of Java 2:177—Mt. Tengger. 11924.

Perennial herb, stem with round, hollow nodes, erect or ascending, 10-100 cm long. Leaves variable in shape and size; umbels on 1-20 cm long stalks, initially terminal, later taking a position opposite a leaf.

All over Java, in marshy places, near lakes, from the lowlands, mainly above 600 m, up to 2200 m altitude. SE. to E. Asia, throughout Malesia, to Queensland in Australia.

The plant serves the Sundanese as a vegetable *(lalab)* with the rice.

3. **Pimpinella javana** DC.—a. Leaf, b. inflorescence, flowers only—Flora of Java 2: 177—Mt. Ardjuno.

A lush perennial herb, erect or ascending, 40-200 cm long, with a sturdy taproot or rhizome and hairy stem. Lower leaves nearly in a rosette, decrescent in size upwards, the blade up to 12 cm long and 10 cm wide; petiole with a large sheathing base.

In Java from Mt. Sindoro eastwards in dry, sunny or slightly shady places, along paths and in grassfields, often in light tjemara forest, at 1700-3125 m, not rarely gregarious. Also in Bali.

Close relatives of this beautiful species occur in SE. Asia.

4. **Pimpinella pruatjan** Molkenb.—In flower only—Flora of Java 2:176—Mt. Papandajan.

A very aromatic perennial herb with a thick tuberous root or rhizome. Leaves mostly in rosettes, with 1-11, usually 5-7 pairs of leaflets. Leaflets 1-2$ cm long. Plant green or in various shades of red. Many ascending flowering stems with sparsely developed leaves.

In Java from Mt. Pangrango eastwards to Mt. Jang, in meadows, by streamlets and ditches, but also on dry sunny plains and in tjemara forests, at 1800-3300 m.

On Mt. Pangrango the specimens in the rivulet draining the summit aloon have rooting inflorescences.

The roots of *antenan gunung* (Sundanese) are used medicinally as a diuretic. In East Java *purwa tjeng* (Javanese) is supposed to be an aphrodisiacum.

5. **Sanicula europaea L.** ssp. **elata** (D.Don) Hultén—Flora of Java 2: 173 (as *S. elata* D. Don, Prod. Fl. Nepal. 183.1825)—Kandangbadak(Mt. Gedé).

An erect, aromatic herb, 30-80 cm high, with creeping rootstock. Stem furrowed. Leaves glabrous, mostly consisting of 3 free leaflets. Central flower(s) in each head bisexual, outer 1-8 (mostly 3) male. Fruit densely set with hook-like bristles.

All over Java from Mt. Salak eastwards, in shaded places, in rain-forest, particularly in elfin and mossy forest, and in tjemara forest, at (600-800-) 1000-3000 m. From the Himalayas to S. China, Japan and Formosa, in all Malesian islands except New Guinea, and in the Lesser Sunda Is. only in Bali; the genuine species from S. Africa and Madagascar to Europe, Asia Minor, Siberia and N. China.

Shan & Constance have argued that our plant is a species distinct from the African-European one, which has 10-25 male flowers per head and the leaf-segments connate at base. The latter character breaks down in certain Himalayan specimens, in certain specimens from Sumatra (Gajo Lands, Brastagi, Mts Sibajak, Singalang, Merapi & Dempo); furthermore in Java where all specimens on Mt. Gedé *above* 2500 m possess this character (as the present figure shows) and those of Ceram in the Moluccas. The Pacific-Asiatic population is clearly a replacing race, hence should merit not more than subspecific status.

Sterile specimens are easily distinguished from sterile *Ranunculus* by lack of hairs.

6. **Torilis japonica** (Houtt.) DC—In flower and fruit—Flora of Java 2: 174—Mt. Tengger. 11931.

An erect herb, i-ij m high. Leaves hairy. The bracts subtending the umbel 2-7 in number, simple. Fruit densely set with hooked bristles.

In Java only on Mt. Tengger, in grassland and along roadsides, at 1700-2500 m, possibly not indigenous. Europe, N. Africa, Asia, also in the Toba Lands in N. Sumatra, at 1200-1400 m.

PLATE 54

EXPLANATION OF PLATE 55

URTICACEAE (continued on Plate 56)

1. **Cypholophus lutescens** (Bl.) Wedd.—Flora of Java 2: 48—Mt. Jang. 11953.

Erect, rather stiff shrub, up to 3$ m high. Leaves decussate, characteristically bullate (inflated) between the veins, 5-18 cm long, 2-4 cm wide. Flowers minute, in unassuming, hard, sessile, axillary globular clusters.

In Java from Nirmala eastwards to Mt. Tengger, in open forest and sometimes common in thickets on ridges, at 1000-2400 m, often in serai growths on ridges. Also on Mt. Kinabalu (N. Borneo), Bali, Celebes, and Ceram.

2. **Lecanthus peduncularis** (Royle) Wedd.—Flora of Java 2: 41—Klètak Pass (Mt. Tengger). 11908.

Herb up to 50 cm long, with a prostrate rooting stem on the nodes of which erect leafy stems and solitary inflorescences emerge. Stems and peduncles juicy. Leaves 2-8 cm long, 1-6 cm wide. Flowers minute, in dense heads, sometimes the male and female mixed in one head, if in separate heads then the male heads smaller.

In Java very rare, only known from Mt. Diëng (Junghuhn) and Mt. Tengger, in groups in shaded, damp places as well as exposed seepage spots or wells (pantjurans), at 2000-2500 m. From Abyssinia through SE. Asia and S. China, in Malesia besides in Sumatra, Celebes, the Philippines and common in New Guinea (where ascending to 3 500 m).

3. **Elatostema lancifolium** Wedd.—Flora of Java 2: 44—Klètak Pass (Mt. Tengger). 11915. Mt. Jang. 11958.

A decumbent, fleshy, almost glabrous, sparingly branched herb up to 1 m high, several together emerging from a massive roundish tuberous rhizome. Leaves 2-3 £ cm long, £-1 cm wide. Nerves almost obsolete. Flower heads small, axillary, solitary, almost sessile.

In Java only found on Mts Tengger, Wilis & Jang, in open places on most soils, near seepage places, at 1600-2100 m. Also on G. Bantulanteh in Sumbawa, at 600 m.

4. **Girardinia palmata** Gaud.—a. Leaf, b. flowering stem top—Flora of Java 2: 39—Mt. Idjèn.

A dioecious plant, coarse in all its parts, the stem woody at the base, up to 3 m high, with long, very stinging hairs all over. Leaves alternate and more dissected, in contrast with *Urtica* (see no. 6) which has them opposite. Besides the stinging hairs patent long grey hairs on stem and petioles. Leaves deeply 5-9-fid, 11-21 cm long, 14-21 cm wide.

In Java only known from Mts Tengger, Jang & Idjèn, in grassy thickets and in tjemara forest, at 2000-2400 m. Also known from SE. Asia, in Indonesia further in N. Sumatra (Kabandjahé) and Mt. Tambora in Sumbawa. It can best be collected wearing gloves, as no. 6.

5. **Parietaria debilis** Forst. f.—Flora of Java 2: 51—Above Lalidjiwo, on trail to Mt. Bakal (Mt. Ardjuno).

An erect, delicate herb, up to 50 cm high, with a glassy stem. Leaves 1-3 cm long, 1-2 cm wide. Flowers very inconspicuous, bisexual, axillary.

In Java once found by me on Mt. Ardjuno in a shallow abris sous roche on bare soil together with *Pilea peploides* (56-3) at c. 2700 m, in tjemara forest. Almost ubiquist, in Abyssinia, the Americas, Hawaii, New Zealand, Australia, Malesia to SE., E. and NE. Asia, in Malesia also on Mt. Rindjani in Lombok (1900-2600 m) and in W. New Guinea (up to 3850 m).

6. Urtica **bullata** Bl.—Stem top with two small leaves—Flora of Java 2: 38—Mt. Idjèn.

A very coarse plant, up to 4 m high. Stem to 4 cm diameter, usually with many very stinging hairs. Leaves soft-hairy but also with stinging hairs, 4-18 cm long, 3-14 cm wide.

In Java from Mt. Diëng eastwards to Mt. Idjèn, in thickets, forest edges, and tjemara forest, at 1250-2600 m. Also on Mt. Kerintji in Central Sumatra, Mt. Rindjani in Lombok, and in the Philippines (Luzon and Mindanao).

The dry period, mostly July to August, when the East Javanese plateaus are cold and dry and the grasslands are covered with hoar-frost in the early morning, is the mating season of deer; they eat from both *Girardinia* (no. 4 above) and *Urtica* by which the sting of these plants raises their heat and fighting capacity; their antlers get sometimes entangled, death following; all according to information by the late Mr. Ledeboer of **Mt. Jang.**


4a
4b
1 ←
2
6
3
5

EXPLANATION OF PLATE 56

URTICACEAE (continued)

i. **Debregeasia longifolia** (Burm. f.) Wedd.—Flora of Java 2:49—Mt. Papandajan. 11672.

A shrub, 3-5 m high. Leaves rough above, grey-tomentose beneath, 6-25 cm long, 2-8 cm wide. The small, globular heads of flowers are in the fruiting stage bright red by the fleshy persistent tepals concealing the small pale green nutlets.

Throughout Java in thickets, open and secondary forest, forest edges, river banks, trails and talus in tea estates, not rarely pioneering in volcanic ash slopes (Mt. Lamongan), a serai species characteristic of secondary growth, forest borders, at 500-2600 m. SE. Asia, also in Malaya, Sumatra, Borneo, the Philippines and the Lesser Sunda Is., more rare in East Malesia.

Known as *totongan* in Sundanese, *mendjugan, urang-urang* and *tongo* in Javanese language. The mature fruit heads (pseudocarps) are eaten as a flavouring. The stems and fibrous bark are very tough, a not uncommon feature in the family of Urticaceae.

1. **Elatostema strigosum** (Bl.) Hassk.—Flora of Java 2: 44—Puntjak Pass (Mt. Gedé). 11501.

A rather coarse, ascending herb, up to 1 m high. The leaves are oblique, 3-11 cm long, with scattered hairs above, the nerves underneath as well as the young stems and the petioles with dense short grey hairs. Flower heads densely white hairy, solitary, axillary and sessile.

In Java common in the western half on Mts Salak & Gedé, in the east on Mt. Dorowati, in humid places, in rain-forest undergrowth, along damp stream sides or ditches and near waterfalls in the open, but preferring half shade, often gregarious and carpeting the forest floor, at 13 00-1700 m. Also in Sumatra.

3. **Pilea peploides** (Gaud.) Hook. & Arn.—Flora of Java 2: 40—Mt. Ardjuno. 11830.

A decumbent or ascending, very delicate annual herb, up to 20 cm long. Stem transparent. Leaves 3-20 mm each way; petiole 1-10 mm.

Throughout Java, along ditches, on bare moist soil and mud, above Lalidjiwo (Mt. Ardjuno) at the highest locality between moss on rocks in tjemara forest together with *Parietaria* (5 5-5); on Mts Diëng, Sumbing, Ardjuno & Jang, at 1800-2700 m, in West Java also as a tiny weed in villages along slokans and near homesteads at 250-900 m (S 1941: 154). Widely distributed, from India to Manchuria, Japan, Formosa, and the Pacific islands, also in N. Sumatra, Luzon and SW. Celebes (Mt. Bonthain).

4. **Pilea melastomoides** (Poir.) Bl.—Flora of Java 2: 40—Tjibodas (Mt. Gedé).

A lush, erect herb, 1-2 m high. Leaves curvinerved, 6-20 cm long, 3-10 cm wide. Stalk of inflorescence exceeding the petiole.

Throughout Java, in damp or marshy forest, stream bottoms, mossy forest, in shady places except near waterfalls, often locally gregarious in carpets, at 600-2700 m. SE. Asia, widely distributed in the Archipelago.

The watery, blunt-quadrangular internodes frequently show in the middle a gall-like conspicuous swelling, which is caused by an interesting parasitic alga, *Phytophysa treubii*, described and depicted by Mrs. Weber-van Bosse (1890).

5. **Gonostegia hirta** (Bl.) Miq.—Flora of Java 2: 48—Mt. Papandajan.

An erect or scrambling herb, 40-75 cm high. Stem, petioles and larger nerves often pale red-tinged. Leaves 2-10 cm long, 1-4 cm wide.

Throughout Java, common in grasslands, thickets, on talus and along forest edges, tjemara forest, in dry or preferably in rather damp places, at 1000-2500 m. From Malaya through the Archipelago to Australia and the Solomons.

VALERIANACEAE

6. **Valeriana hardwickii** Wall.—Flora of Java 2: 361—Tjibodas (Mt. Gedé).

A perennial herb up to 2 m high. Stem fistular, emerging from a short rhizome. Fruit small, c. z\ mm long, crowned by the finely divided calyx which is thrice as long and which serves as a feathery parachute for wind dispersal.

In Java from Mt. Gedé eastwards to Mt. Idjèn, in thickets, grassland, along forest edges and in light forest, often in damp places, also in tjemara forest, at 1700-3200 m. SE. Asia, also on Mt. Kerintji in Central Sumatra.

Flowers remain open for 3 days, but insect visitors are few and self-pollination will be the rule.

VIOLACEAE

7. **Viola arcuata** Bl.—Flora of Java 1: 195—Mt. Papandajan.

A perennial herb with a rootstock and slender, procumbent to erect stems to 80 cm long. Leaves £-4 cm long and wide, usually more reniform and more shallowly crenate than in the drawing.

In Java from Mt. Patuha eastwards to Mt. Jang, in wet meadows, marshes, stream and lake margins, ditches and grassy clearings, at 1000-3000 m. SE. Asia, also Sumatra, Luzon, Buru and New Guinea.

8. Viola betonicifolia J.Sm.—Flora of Java 1: 196, in note—Mt. Idjèn. 12055.

A perennial, stemless herb, from a short vertical rhizome bearing a rosette of leaves. Leaves i£-7£ cm long, £-3 cm wide, rather variable in shape, often much longer than wide (to linear-lanceolate), usually triangular(-hastate), with the leaf blade usually long-decurrent on the petiole which seems winged (the leaf shape in my drawing not typical).

In Java only in the east on Mts Tengger & Idjèn in grassland and light tjemara forest, at 1100-1800 m. SE. & E. Asia (to Japan) through Malesia to Australia, also in Sumatra, the Lesser Sunda Is. (Bali, Alor; Timor, to 2700 m), Celebes, the Philippines and New Guinea (up to 3 300 **m).**

9. **Viola pilosa** BL—Flora of Java 1: 195 (as *V. serpens* Wall.), 3: 644—Tjibeureum (Mt. Gedé).

Perennial, from the rhizome leaves and stems up to 1 m long, rooting and with flowers at some nodes. Leaves 1-10 cm long, 1-7 cm wide, usually hairy, the petiole 1-16 cm long.

In Java the commonest species, from Mt. Salak eastwards to Mt. Idjèn along forest trails, in grasslands, and elfin and mossy forest, at 1100-3100 m- SE. Asia, also on Mt. Kerintji in Central Sumatra, in Bali and Timor, on Mt. Bonthain in SW. Celebes, and in Buru and Ceram in the Moluccas. See the following drawing.

10. **Viola pilosa** Bl.—See above—Specimen from Mt. Idjèn. **12087.**

This robust form, formerly regarded as a species distinct from *V. pilosa*, is according to Dr. Moore merely a form from a particularly sheltered place accounting for its large size.

PLATE 56

EXPLANATION OF PLATE 57

XYRIDACEAE

1. Xyris capensis Thunb. var. **schoenoides** (Mart.) Nilss.—Upper part of a culm—Flora of Java 3: 25—Rawa Gajongong near Tjibeureum(Mt. Ged£). 12330.

A tussock-forming, erect, sedge-like plant. The leafless wiry culms are 30-90 cm long and several arise from a tuft of leaves which are 10-50 cm long and 2-4 mm wide. Flowers apically in a head of dark-brown to almost black bracts and by their yellow colour well contrasting; on one head mostly only one flower open at a time, lasting only one day.

In Java from Mt. Gedé eastwards as far as Mt. Diëng, in particular characteristic for swinging bogs of peat moss on lake shores, often co-dominant with *Eriocaulon* (19-1), *Rhynchospora* (14-15) and *Carex* species, at 1500-2700 m. This variety in SE. Asia, also in Malaya, Sumatra, Celebes, Buru and New Guinea, the species as a whole distributed from Central Africa to Australia.

On Mt. Diëng culms serve to make wajang figures for offerings at the ancient Hindu temples.

ZINGIBERACEAE

2. Amomum coccineum (Bl.) K.Sch.—One inflorescence as emerging from the forest soil—Flora of Java 3: 5 7—Tjibodas.

A very robust, juicy, erect herb with an aromatic smell of ginger, consisting of a sturdy horizontal rootstock, branching through runners, on the nodes of which either leafy "stems" or inflorescences emerge at intervals. The "stems" are extraordinary because they consist of the sheaths of leaves, each clasping the following, and each provided with a green blade. As the total "stem" (really "pseudo-stem") is 24-7 m tall, the sheaths of the inner (highest) leaves measure that length as their insertion is found at the tuberous base. It is a similar structure as is found in bananas. The leaf-blades are £-1 m long and 10-20 cm wide and placed distichous (in 2 rows forming a plane). The peduncle of the inflorescence is surrounded with long-persistent scales, 10-20 cm long, but remains underground, only the inflorescence emerging from the dark-brown, humus forest soil as a circular bunch of scarlet flowers with a yellow streak on the labellum, aptly called "earth flame". The fruits are sessile fleshy capsules opening with 3 valves exposing the seeds which are covered by an acid, edible seed-coat (aril).

All over Java, mainly in the western part, a constituent of the rain-forest undergrowth, almost always gregarious, in deep damp soils, river bottoms, and slopes, at 800-1650 m. Also in Sumatra.

There is no relation between the number of pseudo-stems and flower-heads, the first being generally more numerous. As is the case under bananas and bamboos the soil under these gingers is mostly barren of herbs and this can hardly be ascribed to the shade of the leafy stems, but is possibly due to substances emitted by the plant prohibiting germination of other plants. As the rootstocks persist underground, these gingers are sometimes found in young clearings and estates. In thickets following deforestation they may become dominant. In Sundanese these large gingers are called *hondjè*.

3. **Globba marantina** L.—Upper part of flowering stem in bud—Flora of Java 3: 73—Mt. Panderman (above Pudjon).

A perennial herb from a short rootstock, 25-70 cm high; roots fleshy, spindle-shaped thickened. Stems often 3-5 together, green or tinged with red. Leaves c. 4-9 on a stem, 5-17 cm long, 2 J-6 cm wide. Peduncle of the inflorescence short. Under the flowers large bracts, the lower ones with an elongate pale yellow bulbil (in the figure 3 are visible), the upper ones supporting a short lateral axis with 3 flowers (which may be also replaced by a bulbil).

In Central and East Java, in the area which is subject to a dry season with a preference for heavy marls and calcareous soil, very rare in West Java (e.g. Radjamandala, W. of Bandung), in secondary and teak forest, along roadsides, from sea-level up to 1250 m. SE. Asia, also rare in Malaya in the isthmus and Penang, absent from the everwet Sunda shelf area, but reappearing again in the Lesser Sunda Is., Celebes, the Philippines, Moluccas, New Guinea, and the Solomons.

The bulbils are solid bodies from which a new plant may arise, a form of vegetative reproduction not uncommon in this genus.

4. **Hedychium roxburghii** Bl.—a. An inflorescence on an obliquely inserted epiphytic stem, b. in fruit—Flora of Java 3: 66—Tjibodas (Mt. Gedé).

An aromatic, perennial herb, I-I£ m long, on rocks sometimes terrestrial, but mostly epiphytic on the base of tree trunks under such an angle that the distichous leaves attain an almost horizontal poise, the mostly hairy inflorescence an erect one. Leaves c. 6 on a stem, 25-40 cm long, 5-11 cm wide. Flowers very fragrant, the corolla first creamy-white, the next day yellowish pale brown. Capsule orange, dehiscing with 3 valves, the seeds with a scarlet fleshy outer coat (aril).

All over Java, in the depth of the forest, but also terrestrial in shady moist places on rocky stream sides, at 1000-2250 m. Also in Sumatra.

5. Nicolaia Solaris (Bl.) Horan.—Inflorescence only— Flora of Java 3: 63—Tjibodas (Mt. Gedé).

Tall, erect herb, up to 5 m, in structure matching that of *Amomum {no.* 2, see above). Leaves 60-80 cm long, 10-20 cm wide. Flowers in a globular head mostly emerging above the soil, the scarlet yellow-margined flowers contrasting with the dark-brown bracts; outer flowers opening first, subsequently proceeding to the inner ones; aptly called "earth sun" after the first stage when the outer ones radiate as the rays of a sun. Capsule juicy, dark pink; seed-coat acid, edible.

In Java almost confined to West Java, in Central Java only on Mt. Merapi, in rain-forest, mostly in groups, at 850-1700 m. Also in Sumatra.

6. **Zingiber inflexum** Bl.—Inflorescence only—Flora of Java 3:47—G. Bèsèr, near Tjipanas (Mt. Gedé). 11769.

An erect, juicy, aromatic herb, toiim tall. Structure as in *Amomum* (see no. 2, above). Leaves on the pseudo-stem 10-20 cm long, 3-6 cm wide. Inflorescence from a thickened rootstock near the base of the leafy shoots, the peduncles only with sheathing bracts. Roots tuberiferous. Bracts in fruit often turning red. Flowers transparent, lasting one day, then marcescent (shrinking slimy) as in most members of this family. Seeds edible.

All over Java, in moist primary and secondary forest, once in teak forest, mostly at 800-1600 m, but rarely also at 600 m and in Nusa Kambangan even at 50 m. Also in Sumatra.

A rather variable plant as to size and shape of the spikes and the size of the bracts.

PLATE 57

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Vernacular and scientific names, concepts, key words, etc. which are *occasionally* mentioned in the explanations to the colour plates are referred to in the same way, but **not** in bold type.

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Newly proposed epithets of scientific names are in **bold type,** synonyms in *italics.*