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Article

A Preliminary Study of Forests in Sri Lanka[1)]

Wasantha ILLANGASINGHE[2)], Kazue FUJIWARA[2)], and Hitoshi SAITO[2)]

スリランカの森林の予報的研究[1)]

ワサンタ　イラガシンゲ[2)]・藤原　一繪[2)]・斉藤　　均[2)]

Synopsis

Sri Lanka is a small island with total land area of 65,525 km^2. About 36.5% of this land is covered by forest, including sparse forest. Even though it is a very small island, it has many forest types and great biological diversity, due to the relatively large variation of altitude from 0 to 2500 m, related parameters such as temperature, and also due to the monsoonal rainfall pattern. The mean annual rainfall is about 2000 mm and the mean annual temperature is 27℃. Climatically, Sri Lanka can be divided into four main regions: the dry zone, wet zone, intermediate zone and arid zone. About eight types of forest are recognized in these different climatic regions (Somasekaram, T. ed. 1982, Malcolm, F. B. ed. 1995, Gunathilaka I. A. U. N. and Gunathilaka C. V. S. 1991). Four of these eight forest types were surveyed in April 1998. The lowland rainforest in the wet zone, which covers the southwestern part of the island, has the most profuse plant cover. The lowest part of the wet zone is lowland rainforest. Three field relevés were made in this area (*Shorea megistophylla-Shorea stipularis* community, in Sinharaja). This forest type gradually changes to sub-montane forest at middle elevation to montane forest at higher elevation. Upper slopes and crests of the Knuckles Range have wet montane forests, whereas on the middle slopes, the forest type is sub-montane forest. A field relevé was made in the mid-slope area of the Knuckles Range (*Gonphia serrata-Palaquium heenmolpedda* community). The dry zone is the northern and northeastern part of the country. Large parts of the dry zone have tropical dry mixed evergreen forests and moist deciduous forests. A third field survey was carried out in the dry zone (*Pterospermum canescens-Eugenia bracteata* community). The extreme southeastern and northwestern parts of the country, which represent the arid zone, have very long dry periods. These areas are covered with tropical thorn forests. The transition between the dry zone and wet zone, which encounters seasonal dry periods, has semi-evergreen forests with their own characteristic species as well as some common to the adjacent zones. Two field relevés were made in this area (*Michelia champaca-Syzygium gardneri* and *Mangifera zeylanica* community, Gannoruwa). Riverine forests found along the rivers and mangrove forests in the coastal areas are two other types of forest, which cover smaller areas. There are a few smaller areas consisting of four main types of grassland: damana, villu, dry and wet pathana, and talawa.

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1) Contribution from the Department of Vegetation Science, Institute of Environmental Science and Technology, Yokohama National University, No.227

2) Department of Vegetation Science, Institute of Environmental Science and Technology, Yokohama National University, Hodogaya-ku, Tokiwadai 79-7, Yokohama, 240-8501 Japan
横浜国立大学 環境科学研究センター 植生学研究室

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Introduction

Topography

Sri Lanka is an island located in the Indian Ocean close to the south tip of India. The geographical coordinates are from 9° 50' to 5° 55' N latitude and 81° 53' to 79° 31' E longitude. The main island has a maximum length of 432 km in the north-south direction and 224 km in the east-west direction. The land area is 65,525 km^2; together with the internal waters the total area is 67,095 km^2 (Somasekaram, T. et al. ed. 1982) (Figure 1).

The topography of Sri Lanka consists of a highland massif, situated in the south center, which is surrounded by an intermediate zone of upland ridges and valleys at a lower elevation. The intermediate zone is in turn surrounded by an outer or lower zone of lowlands. A coastal fringe consisting of sandbar lagoons and islands skirts the main island. The mountainous area ranges from 500 m to 2500 m, with the highest peak of 2524 m at Pidurutalagala. The land in the mountainous area accounts for a little less than one-third of the country's total land area. The remaining over two-thirds in the northern and northeastern part is flat and undulating, with gentle slopes (Somasekaram, T. et al. ed. 1982) (Figure 2).

Land Use

About one-third of the land is put to agricultural use. Paddy rice is the dominant crop in terms of land use, but it is tea, grown under plantation agriculture, which earns the largest foreign exchange for the country. In the mid-nineteenth century under the British Colonial policies, tea was introduced to Sri Lanka as a plantation crop. Vast amounts of tropical montane forest were cleared for tea plantations. In the dry and intermediate zones of the country, shifting cultivation was employed, which involves clearing the forest for a season or two of use, abandonment to fallow (which allows the forest to regenerate), and subsequent repetition of the cultivation cycle.

Forest gardens are another dominant form of land use especially seen in the middle of the country. The forest gardens represent two or three-tiered structures consisting of shrubs in the understorey, medium-sized fruit trees in a mixed-level layer, and large fruit and timber producing trees in the canopy. Compared with typical agricultural fields, this increases the area for photosynthesis and thus production in vertical space. Structural characteristics of these gardens, including their high density and species diversity, are comparable to measures from natural forests in similar elevations and climates.

Forests and wildlife use another third of the country's lands, and the rest is used for transportation, human settlements and various other uses.

Geology

The land of Sri Lanka was never fully submerged by the sea. Hence only about 10% of the land area is covered by sedimentary rocks. Most of the country is underlain by crystalline rocks of Pre-Cambrian age. The rest is made up of Miocene limestone in the north and northwestern coastal regions and Quaternary deposits along the northwestern, southern and eastern coastal regions. Among the superficial deposits of recent origin in many parts of the country are alluvium on the river floodplains and loose unconsolidated sand in the coastal belt.

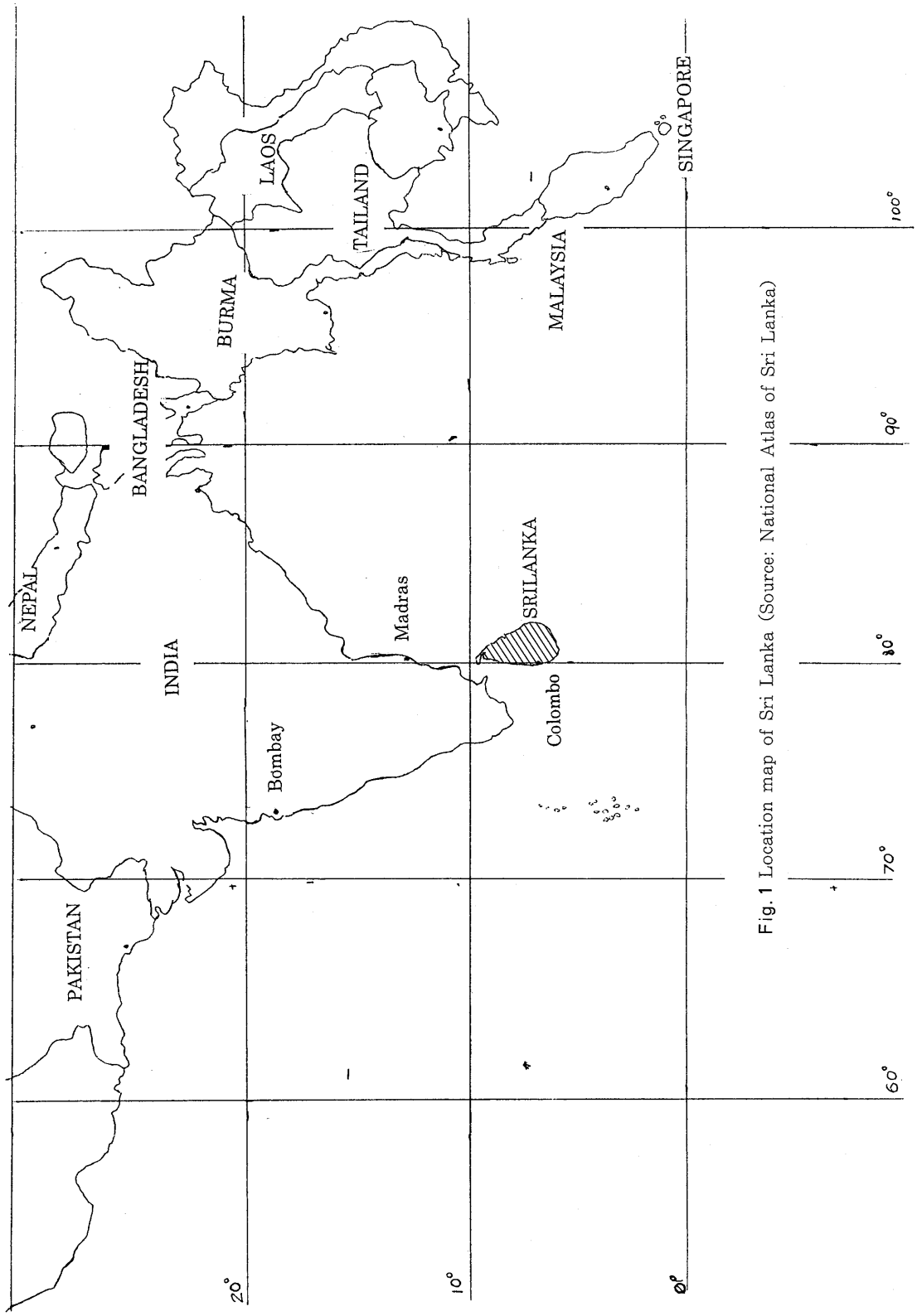

Fig. 1 Location map of Sri Lanka (Source: National Atlas of Sri Lanka)

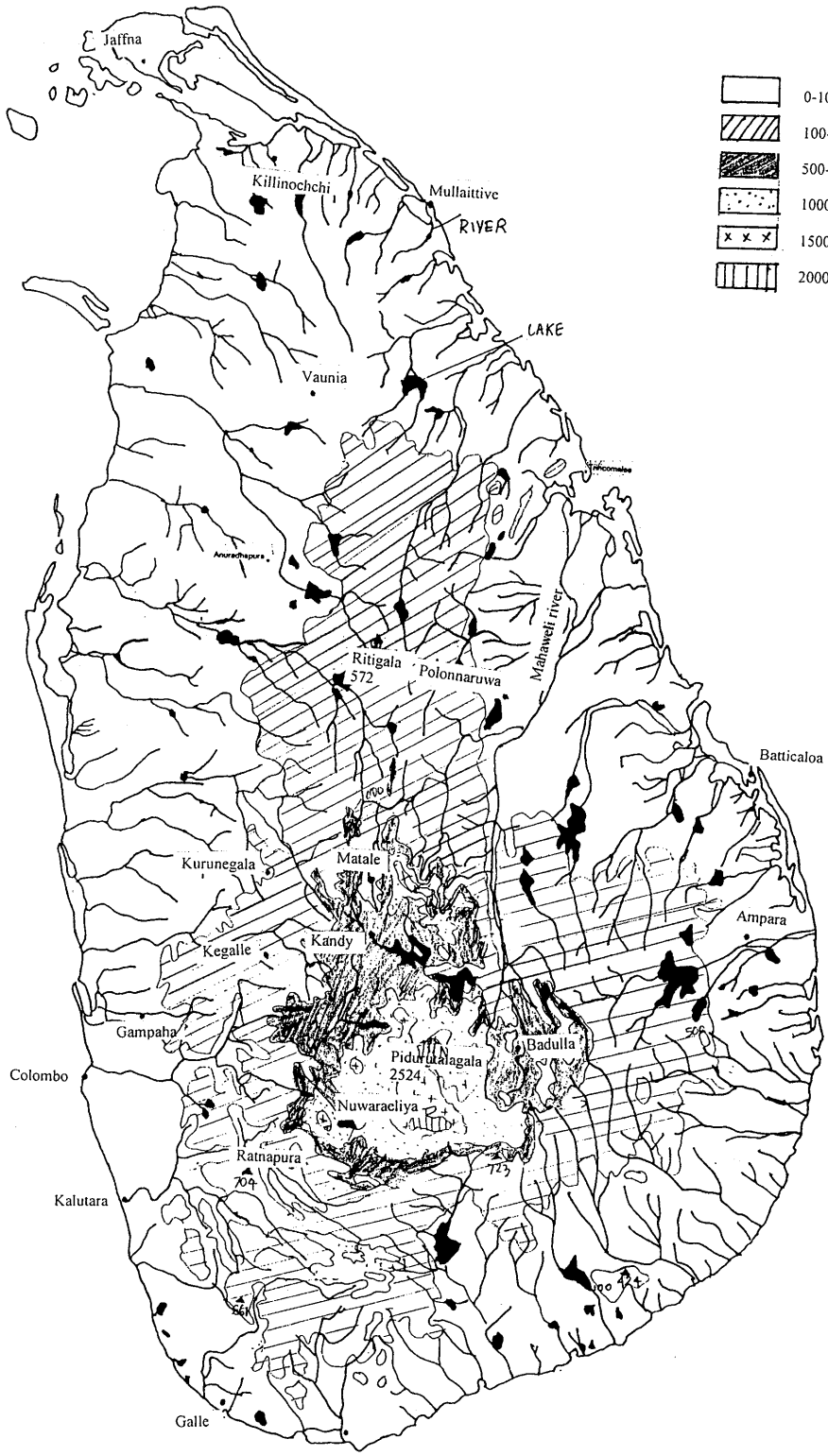

Fig. 2 Topography of Sri Lanka (Source: National Atlas of Sri Lanka)

Because of Sri Lanka's alternate seasonal exposure to heavy sunlight and high rainfall, rocks weather rapidly. The major factor influencing the soil formation in the country is the climate, followed by parent material and topography. Fourteen great soil groups have been recognized in Sri Lanka. Mainly these could be subdivided into two categories. Reddish brown earth and low humic gley soils are encountered in the dry zone and semi-dry intermediate zone, which has an undulating terrain. In the wet zone and semi-wet intermediate zone with mountainous or hilly and rolling terrain, the prominent soil type is red-yellow podzolic soil.

Climate and Rainfall

Due to her location north of the equator, the climate of Sri Lanka is tropical monsoonal with a marked seasonal rhythm of rainfall. Two seasonal wind regimes determined by seasonal pressure and wind systems give rainfall and temperature variations. The annual rainfall comes in four distinguishable periods. The first, inter-monsoon period is experienced in March to April, which has constant daily weather with bright clear mornings and induced rain clouds followed by thunderstorms in the late afternoons. May to September is the southwest monsoon period, which brings the largest amount of rainfall to the southwestern lowlands.

October to November is the second inter-monsoon period. Sometimes cyclones and occasional heavy rainfall, which produces floods or landslides, occurs in this period. The northeast monsoon period, which brings rain to the northern and eastern parts of the country, is experienced from December to February. Average annual rainfall is about 2000 mm (varying from year to year), but the distribution is not uniform over time or geographical space. The country could be divided into two major zones according to climatic parameters. These are the wet zone 2500-5000 mm in the southwestern area and the dry zone in the northern part. The transition between these two zones is identified as the intermediate zone. The dry zone of the country has an annual mean rainfall of about 1250 mm (Somasekaram, T. et al. ed. 1982) (Figure 3).

Sri Lanka's tropical location ensures uniformly high temperatures throughout the year, but the influence of the sea makes the island free from temperature extremes. Mean annual temperature in the lowland is around 27℃, with a mean daily range of about 6℃. Ground frosts can sometimes appear in Nuwara Eliya in the central highlands, where the mean annual temperature is 15℃ (Somasekaram, T. et al. ed. 1982) (Figure 4). Relative humidity varies from 70% during the day to 90% at night.

Hydrology

Sri Lanka's only source of fresh water is rainfall. According to rainfall data, the country is richly endowed with high mean annual rainfall. It has 103 river basins, which cover 59,217 km^2. The largest river basin is Mahaweli river basin. It has a length of 335 km and an area of 10,448 km^2, which is one-sixth of the country's land area. In addition to the perennial river system, Sri Lanka has a well-established irrigation system built by the ancient rulers in the ancient capital in the dry zone. Large tanks were built to capture the monsoonal rains and utilize them in cultivation. The history of these goes back to 309 BC. The total number of such tanks in the country is about 18,000.

The groundwater distribution is related to the geological formations and rainfall intensity. About 7% to 30% of rainfall goes to recharging the groundwater table in the dry zone. Groundwater is used as a water source mostly in the dry zone.

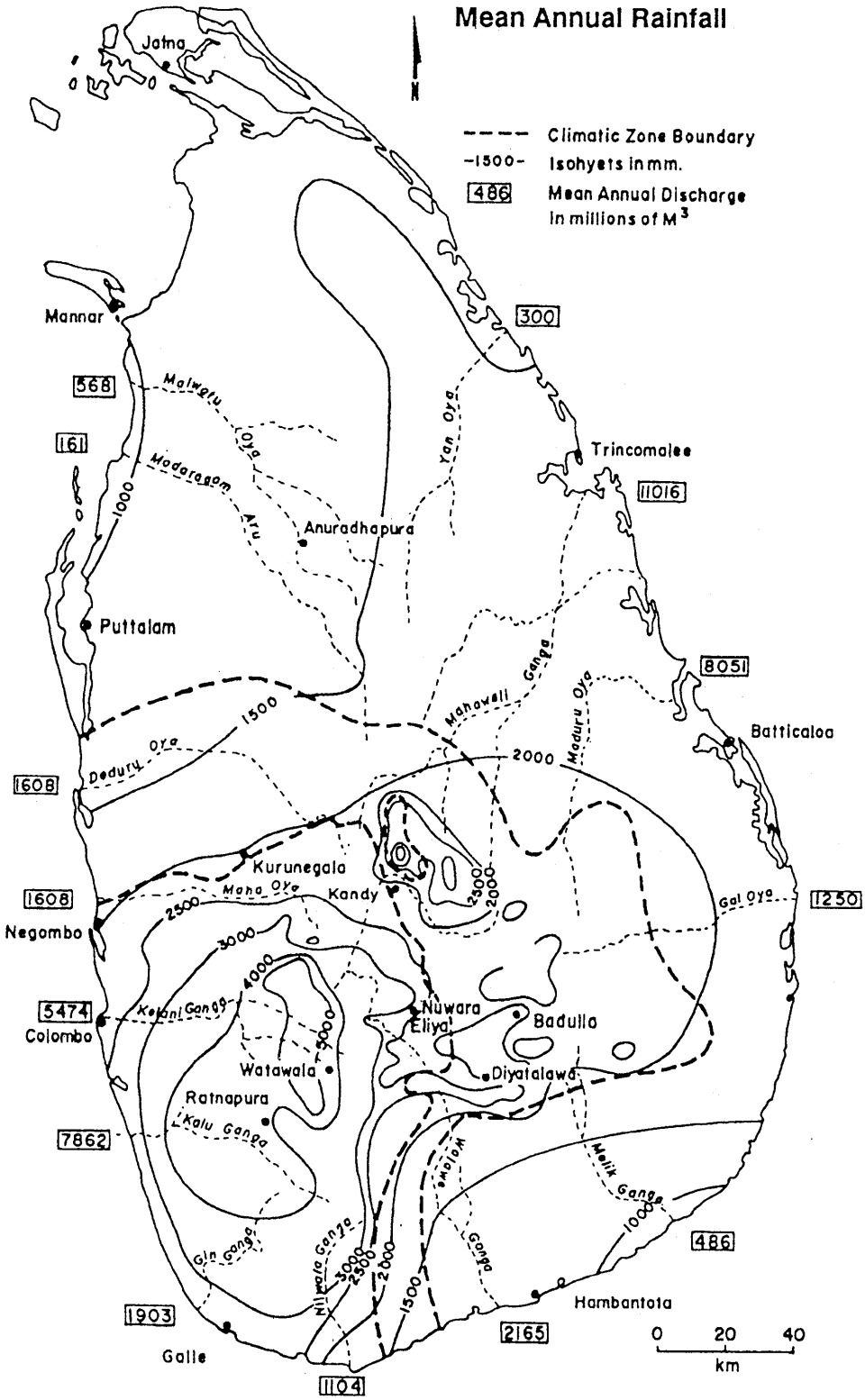

Fig. 3 Rainfall pattern of Sri Lanka (Source: National Atlas of Sri Lanka)

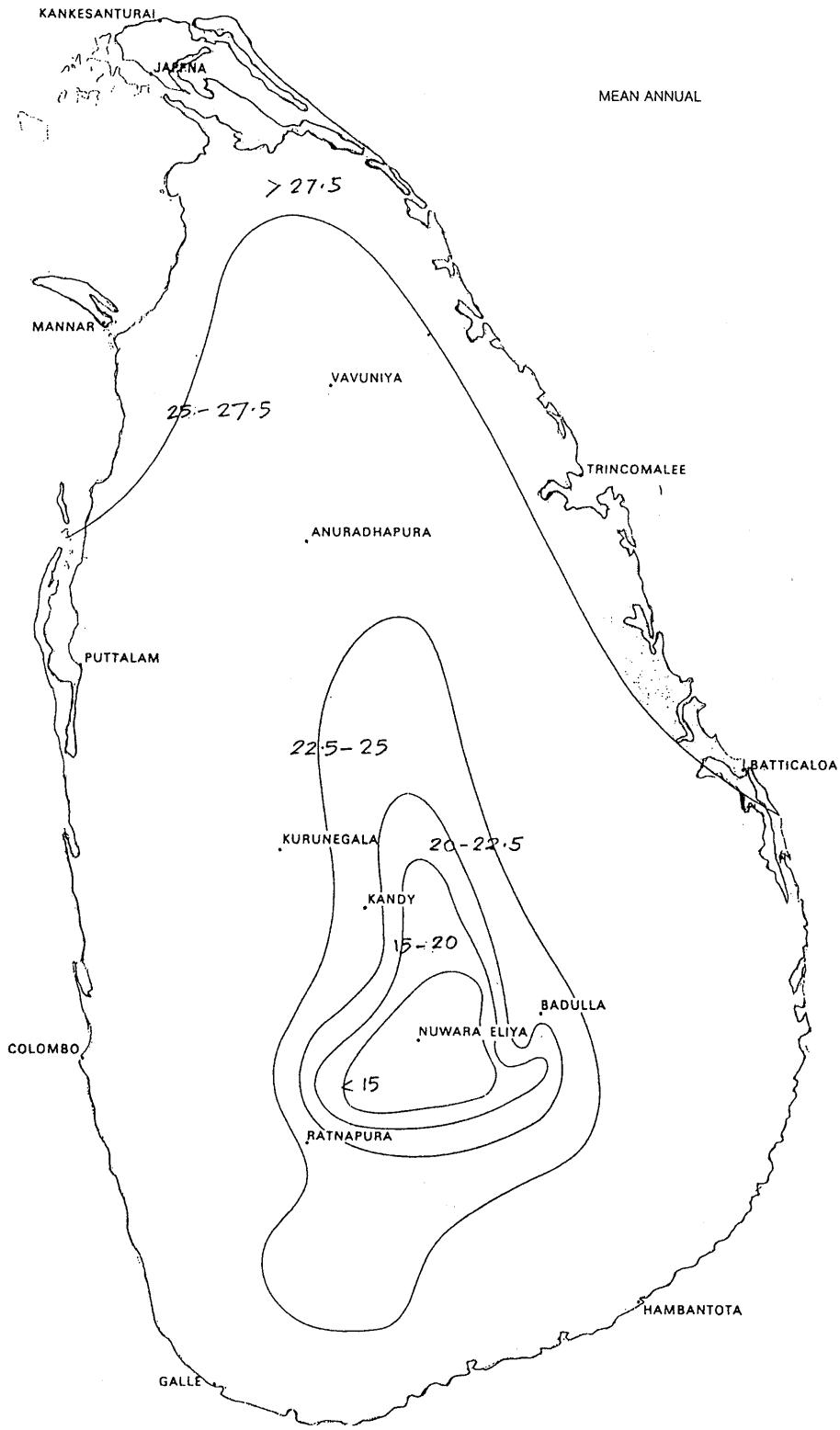

Fig. 4 Temperature pattern of Sri Lanka (Source: National Atlas of Sri Lanka)

Forests of Sri Lanka

Until the 19th century Sri Lanka was almost entirely covered by natural forest. This situation changed drastically when the plantation crops were introduced and the land use patterns were changed, due to increase in population. In the 1880s more than 80% of Sri Lanka's land was covered by natural forests. This was reduced to 44% by 1956, after the plantation crops were introduced at the beginning of 19th century. At present the total area of forest in the country, including sparse forest, remains at 2.375 million hectare (36.5% of total land area). The forest department is the main authority to handle forest reserves (Somasekaram, T. et al. ed. 1982) (Figure 5).

The Department of Wild Life Conservation and the Government Agents are the other authorities responsible for the forest in the country, according to the respective classifications. Forest reserves come under the jurisdiction of the Forest Department. National reserves and Sanctuaries, which include Strict Natural Reserves, National Parks, Nature Reserves, Jungle Corridors and Intermediate Zones, come under the jurisdiction of the Department of Wild Life Conservation. Village forests and other crown forests come under the jurisdiction of the Government Agents.

Despite the population pressure on natural forests, Sri Lanka has greater biodiversity per unit area than the other Asian countries. Currently about 50% of the country's natural forest (15% of the total land area) has been identified and is managed as protected areas.

Forest Classification

The forest in Sri Lanka has been classified by different researchers in different ways. A brief summary of prominent forest classifications is given below.

The southwestern region and the central highland in the wet zone of the country have the most luxuriant plant cover. The rainfall is from 2500 mm to 5000 mm with no moisture deficit period. The forest, which covers low land up to an elevation of about 900 m, is identified as tropical wet evergreen forest (Somasekaram, T. et al. ed. 1982), tropical wet lowland evergreen forest or lowland rain forest, (Gunathilaka, I.A.U.N. and Gunathilaka, C.V.S. 1991), or tropical rain forest (Malcolm, F.B. et al. ed. 1991). The trees represent about 100-140 species, 60-90 genera and 30-40 families. Dominant species are Dipterocarpaceae, Clusiaceae, Sapotaceae, Bombacaceae and Myrtaceae. The crown of the dominant trees forms a closed canopy from 25 m to 30 m above the ground, with emergents rising to about 45 m. These forests have a relatively sparse undergrowth but are rich in epiphytes and lianas.

The forest gradually gives way upward to sub-montane evergreen forests (Somasekaram, T. et al. ed. 1982), tropical wet sub-montane evergreen forests or sub-montane rain forests (Gunathilaka, I.A.U.N. and Gunathilaka, C.V.S. 1991), or sub-montane forests (Malcolm, F.B. et al. ed. 1991). These occur in the hills between 900 m and 1350 m. Sub-montane rain forests are dominated by the families Dipterocarpaceae, Clusiaceae and Myrtaceae. The proportion of endemic species in these forests is above 50%.

The sub-montane forests then extend to montane temperate forests (Somasekaram, T. et al. Ed. 1982), tropical wet montane evergreen forest or montane rain forest (Gunathilaka, I.A.U.N. and Gunathilaka, C.V.S. 1991), or wet evergreen montane forests (Malcolm, F.B. et al. ed. 1991) at elevations above 1500 m. These have a lower canopy of about 13 m and denser undergrowth. Their stems are often covered with lichens, bryophytes and other epiphytic plants. They have

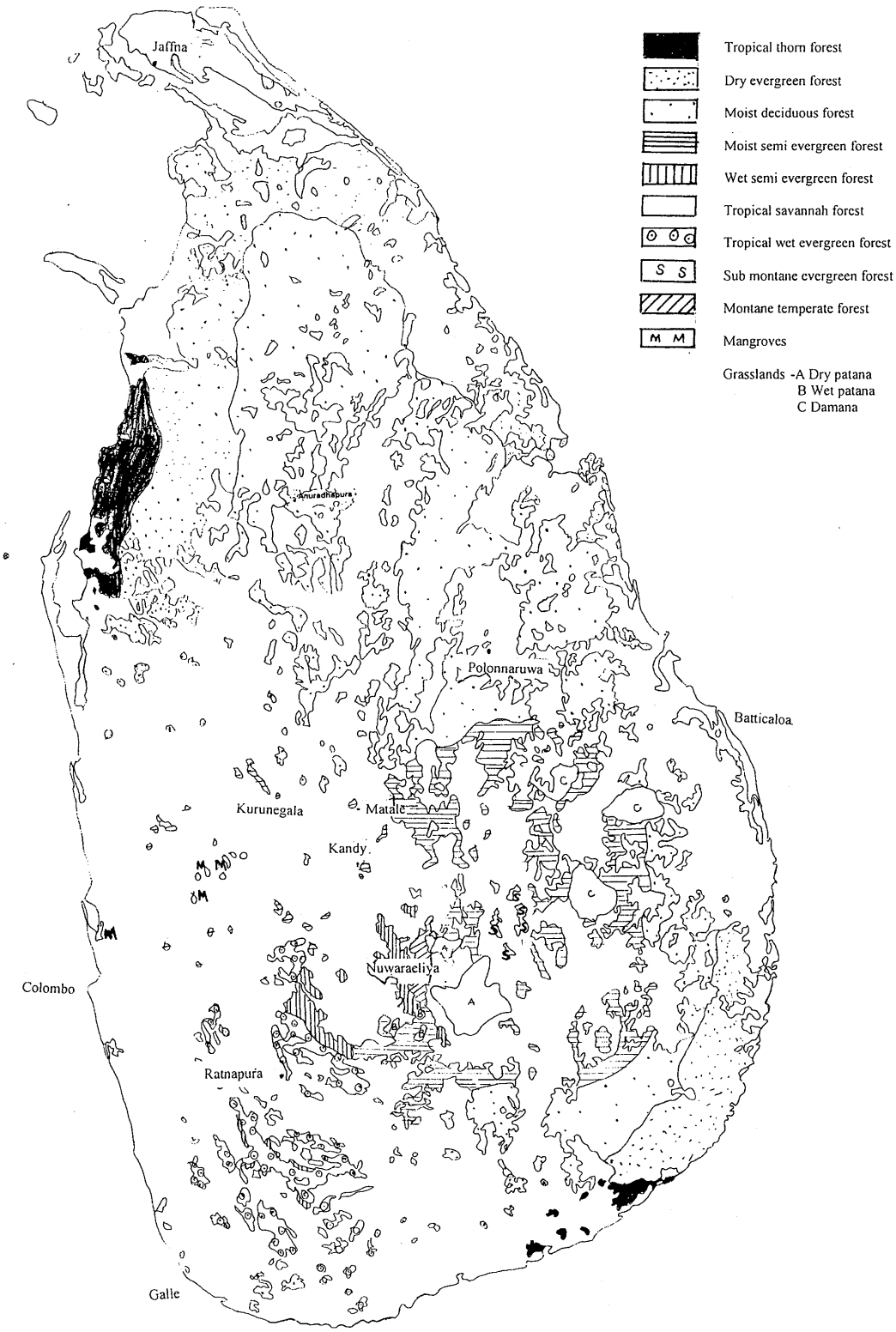

Fig. 5 Forest resources of Sri Lanka (Source: National Atlas of Sri Lanka)

about 90 species, 60 genera and 40 families. The dominant families in them are Myrtaceae, Lauraceae, Rubiaceae, Symplocaceae and Sapindaceae. About 40% of the tree species in these forests are endemic to Sri Lanka.

The transition zone between the wet zone and the dry zone has moist semi-evergreen forests and wet semi-evergreen forests (Somasekaram, T. et al. ed. 1982), tropical moist semi-evergreen forests or intermediate forests (Gunathilaka, I.A.U.N.and Gunathilaka, C.V.S. 1991), or tropical semi-evergreen forests (Malcolm, F.B. et al. ed. 1991). Elevation is below 1000 m and the rainfall varies between 1900 mm and 2500 mm, with a rainfall peak from October to January followed by a pronounced dry period of about three months. They have their own characteristic species as well as some species common to the adjacent zones. There are about 40-60 species, 40-50 genera, and 20-30 families. The dominant families in these forests are Anacardiaceae, Sapindaceae, Euphorbiaceae and Moraceae. The proportion of tree species endemic to Sri Lanka is only 17%.

In the dry zone the mean annual rainfall is from 1250 to 1900 mm, with a rainfall peak between October and January and a pronounced dry period of 3 to 6 months. The forests in this area are identified as dry evergreen forests in some parts and moist deciduous forest in the majority of the area (Somasekaram, T. et al. ed. 1982), tropical dry mixed evergreen or moist deciduous forest (Gunathilaka, I.A.U.N. and Gunathilaka, C.V.S. 1991). or tropical dry mixed evergreen forests (Malcolm, F.B. et al. ed. 1991). In these the dominant species now present often do not form a closed canopy and seldom exceed 20 m in height. The trees represent 50-60 species, 40-50 genera and 20-25 families. The dominant families are Euphorbiaceae, Sapindaceae, Ebenaceae, Sapotaceae and Rutaceae. In these forests only about 13% of the tree species are endemic to Sri Lanka.

The extreme southeastern and northwestern regions of the island, which have very long dry periods, are covered with tropical thorn forests (Somasekaram, T. et al. ed. 1982 Gunathilaka, I.A.U.N. and Gunathilaka, C.V.S. 1991, Malcolm, F.B. et al. ed. 1991) or thorn scrubs (Gunathilaka, I.A.U.N. and Gunathilaka, C.V.S. 1991) with low trees and an undergrowth of thorny shrubs. The rainfall in these areas is less than 1250 mm. Dominant families here are Salvadoraceae, Leguminosae, Euphorbiaceae and Rhamnaceae. Very often endemic species are absent in these forests.

In the dry zone intensive felling and a form of shifting cultivation has badly degraded the forests. During fallow periods, secondary successions lead to the development of scrub or low jungle. Where succession is prevented by frequent clearing or burning, however, tropical savannah forest (Somasekaram, T. *et al.* ed. 1982), or Savannah forest (Gunathilaka, I.A.U.N. Gunathilaka, C.V.S. 1991) has formed, with fire-resistant trees. The dominant families in these forests are Combretaceae, Leguminosae and Euphorbiaceae. The grasses *Imperata cylindrica, Cymbopogon nardus* and *Panicum maximum* dominate the ground layer of the forest.

Sheltered inter-tidal coastlines in association with lagoons and mouths of rivers harbour mangrove forests (Somasekaram, T. et al. ed. 1982, Gunathilaka, I.A.U.N. and Gunathilaka, C.V.S. 1991). These forests are different from all the rest in that they are dominated by salt-resistant species. The dominant families are the Rhizophoraceae, Acanthaceae and Avicenniaceae. There are no tree species endemic to Sri Lanka in these forests.

Four main types of grassland are also identified: damana, villu, dry and wet patanas and talawa. All these are considered to be of secondary origin, and climax vegetation is represented by closed forest types peculiar to each climatic region.

Flora

Sri Lanka has a greater biodiversity per unit area than any other country in Asia (Figure 6). The present flora of Sri Lanka is represented by six floristic elements: Sri Lankan, Indo-Sri Lankan, Himalayan, Malayan, African, and pantropic and cosmopolitan (Abeywicrama B. A. 1955). Although the predominant named forms of Sri Lankan plants are present in peninsular India, evidence is found of high concentration of diversity and endemicity.

The indigenous flora of Sri Lanka consists of about 7206 species. In the 15th century the Europeans introduced many new plants to the country. Table 4 shows the composition of the indigenous flora of Sri Lanka. About 230 endemic flowering plants are considered as 'endangered species'.

Due to overexploitation, most of the species are facing a danger of disappearance. The Sri Lankan flora demands special attention because of its high degree of biodiversity, endemism, and its vulnerability to habitat destruction.

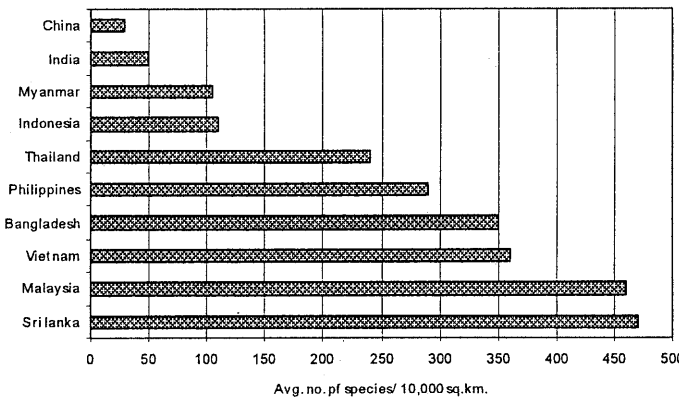

Fig. 6 Flowering plants of Asian countries (Malcom, F. B. *et al.* ed. 1991).

Table 1 Composition of indigenous flowers in Sri Lanka (Malcom, F. B *et al.* ed. 1991)

Group	Number of species
Algae	896
Fungi	1920
Lichens (Thelotremataceae)	110
Mosses	575
Liverworts	190
Ferns & Fern Allies	314
Gymnosperms	1
Angiosperms	3100
Total	7206

Field Surveys at Selected Locations

Field surveys were carried out to get a clear idea of forest types of Sri Lanka, their vegetation patterns and other characteristics. After studying the existing literature about forest and vegetation patterns, six locations were selected to carry out field surveys. These six locations were selected to cover the four most prominent forest types available in the country. Seven field relevés

were made in these forests. The field data are summarized in Table 2 below. The locations are shown in Figure 7. Nomenclature in the relevés follows various references and involved the help of local experts.

Table 2 Details of fieldwork

Name of Site	Location	Altitudem	Number of relevés	Forest Type
Udawatta Kale	Central	500	0	Semi-evergreen forest
Horton Plains	Central	2600	0	Wet nontane evergreen
Nakals-Kosgaswala	In the borde rof North	1570	1	Wet-nontane ever-green to sub montane
Sinharaja	Southwest	525-530	3	Lowland rain forest
Gannoruwa	Central	550-580	2	Semi-evergreen forest
Sigiriya	North Central	170	1	Dry Mixed evergreen

The field relevés made in each forest are given in Annex 1-7, along with photographs of each location. The relevés include all the species in the sampling areas, the occurrence and importance of each species, estimated by means of a 'total estimate' (combining abundance and cover degree), and a 'sociability' factor, which shows the horizontal aggregation pattern of the species.

Necessary basic environmental data are also recorded, such as altitude, location, sampling date and year, slope and aspect, general topography, water depth (if standing water is present), soil condition, geological condition and the personnel involved in the field work. The methodology is as explained in Fujiwara, K (1987).

Udawatta Kale

This forest, which is located in the heart of the second largest city, Kandy, is the only man-made urban forest in the country. In 1938 the forest department, having obtained authority over the forest, carried out successive planting. Elevation is about 500 m. The area is in the intermediate zone. The trees present were very tall, and climbers could be seen in almost all the trees. The root systems were about 1-2 meters deep.

The dominant canopy has tree species *Aleurites moluccana, Democarpus longana, Ficus fergusonii, Gmelina arborea, Madhuca longifolia, Mangifera zeylanica, Pometia exima, Swietenia macrophylla, Michelia champaca, Filicium decipiens, Artocarpus nobilis* and *Careya arborea* (Greller, A.M. et al. 1980). Predominant canopy consists of *Carallia brachiata, Careya arborea, Sticulia balanghas, Vitex altissima, Mesua ferrea, Aleurites moluccana, Adenanthera pavonnia, Syzygium gardineri* and *Myristica dactyloides*. Photo 1 shows the forest area.

Horton Plains

Horton Plains is situated in the central hill country. It is the highest plateau in Sri Lanka. Its elevation ranges between 1800 m and 2300 m and encompasses 3162 hectares. It has rolling hills covered with either forest or grassland. The forests could be seen on the hilltops or upper slopes, whereas grassland covers the valleys and lower slopes. The grassland appears to be evenly

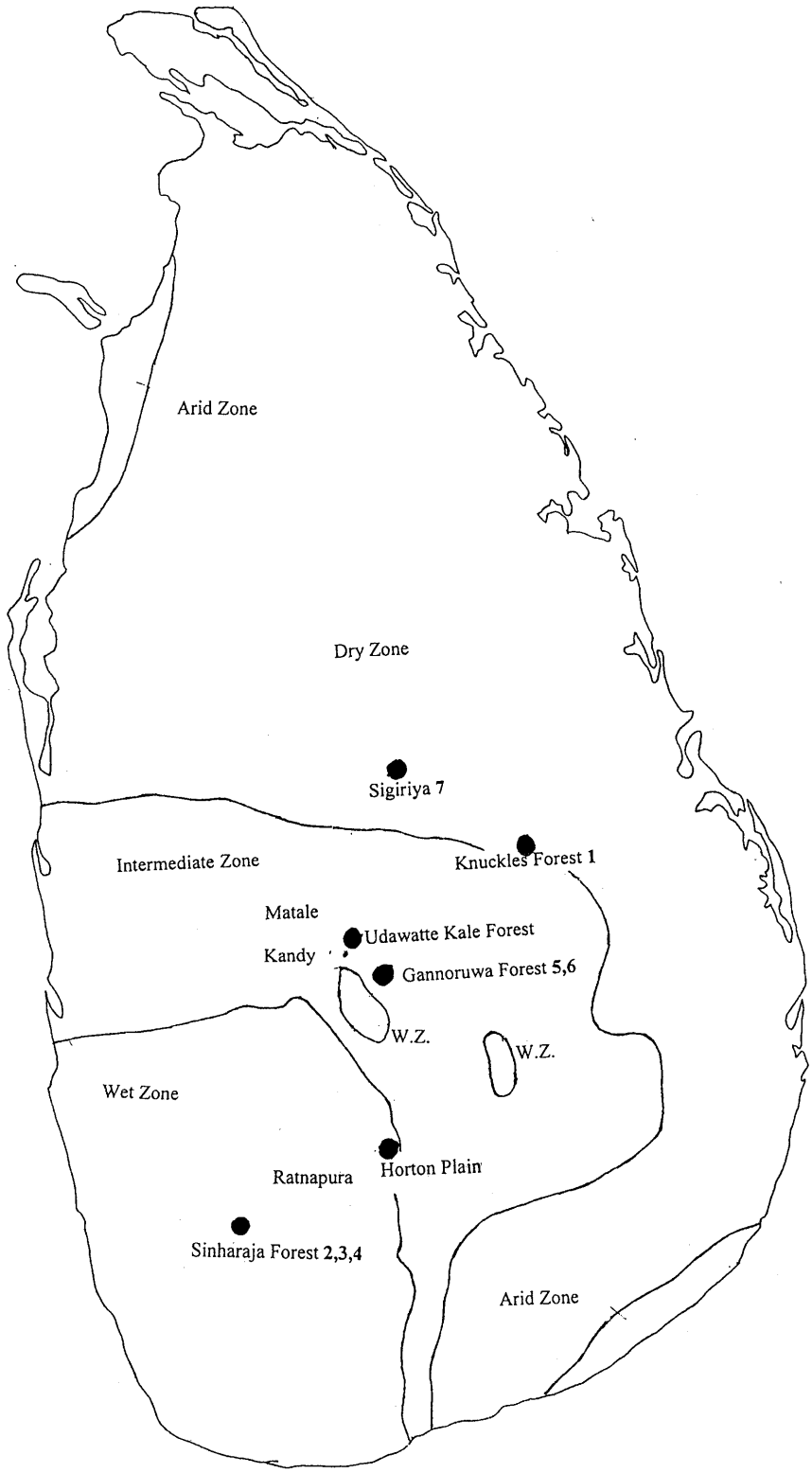

Fig. 7 Location of field surveys

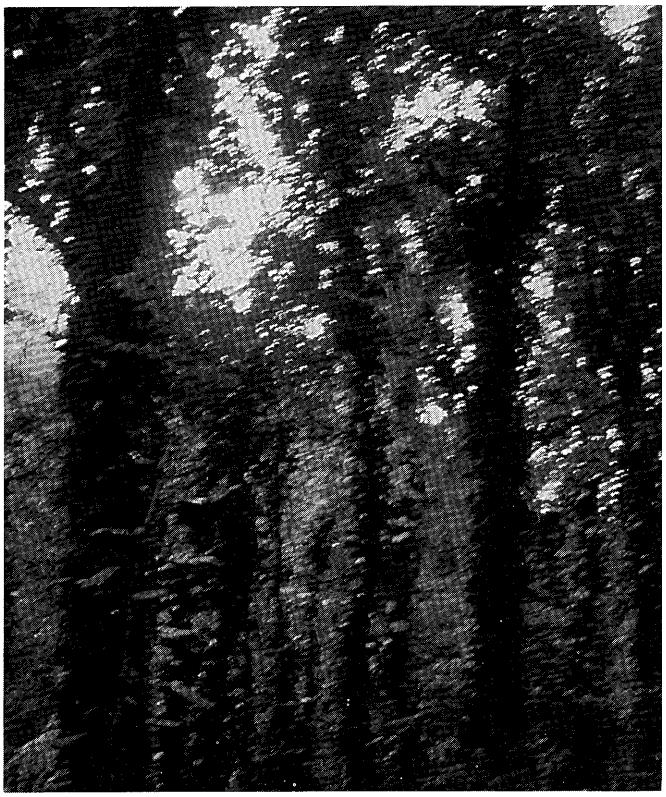

Photo 1 Udawatta Kale forest reserve

Photo 2 Horton Plains

spread like a carpet. The literature says that earlier (1950s) the grassland present was dominated by a single bushy grass species. The land was utilized for potato seed farming carried out in the

late 1950s and abandoned thereafter. The species that are available now are the species introduced by the manure and vehicular traffic from potato farming (Gunathilaka, C.V.S. 1996). Horton Plains is the watershed for several tributaries that feed the major rivers of Sri Lanka. In 1969 the entire area was declared a nature reserve.

The herb species that could be seen are *Chrysopogon zeylanicus, Garnotia tectorum* and other unidentified herb species. Several tree species could be seen in the grassland. *Rhododendron arboreum* is the most beautiful and eye-catching tree that could be seen because of its bright crimson flowers. *Ulex europeus, Rubus leucocarpus, Rubus ellipticus, Aristea ecklonii* and *Erigeron karvinskianus* are a few of the other plants in the grassland.

Species like *Indocalamus debilis, Arundinaria densifolia, Aponogeton jacobsenii,* and *Isolepis fluitans* could be seen on the banks of the streams.

Some of the tree species, which could be seen in the natural forest are *Calophyllum walkeri, Actinodaphne speciosa, Syzygium rotundifolium, Litsea* sp., *Vaccinium simplocifolium, Symplocos bractealis, Cinnamomum ovalifolium* and *Elaeocarpus obovatus*. Photo 2 shows the forest area and grassland.

Knuckles-Kosgaswela

Kosgawela forest is located on the northern side of the central hills. The Knuckles is a forest range dominated by wet montane forests in the upper slopes and crests to semi-evergreen forests in the northern region. Kosgaswela forest shows intermediate characteristics between submontane and semi-evergreen forests. The field relevé was made in a 30x50 m^2 plot. Ten species in the T1 layer, 9 species in the T2 layer, 27 species in the shrub layer of 5 m height, and 7 species in the 0.5 m-high herb layer were identified. Figure 8 gives the vegetation profile of the forest. According to the relevé, the community could be identified as a *Litsea-Palaquium heenmolpedda* community. Photo 3 shows the forest area.

Sinharaja

Sinharaja Man and Biosphere Reserve is a lowland rain forest located in the southern part of Sri Lanka. It is the sole lowland rain forest in the country which could be considered relatively undisturbed rain forest (Ashton, P.M.S. 1997, Gunathilaka, S. Gunathilaka, N. 1996). It is recognized as a world heritage site. It covers an area of about 47,370 ha including the forest reserves surrounding it. Based on physiognomic, ecological and floristic criteria, the forest is divided into four categories: Lowland tropical wet evergreen forests with *Mesua-Doona (Shorea)* formation, submontane tropical wet evergreen forests with *Calophyllum-Cullenia* formation, submontane patana grasslands dominated by *Chrysopogon zeylanicus,* and secondary forests.

Field relevés were made at three locations. The first relevé was in a plot of 20x40 m^2, and the other two relevés were in a mantle community along a path. The plot areas of the latter two are 1.5x4 and 1.5x3 m^2 respectively. In the first relevé, three tree species were identified in the super tree layer, which is 43 m high. Seven species in the T1 layer, 8 species in the T2 layer, 18 species in the shrub layer of 4 m height, and 18 species in the 0.5 m-high herb layer were identified. This community could be identified as a *Shorea megistophylla-Shorea stipularis* community. Figure 9 gives the vegetation profile of the forest.

The mantle communities of the second and third relevés were selected to get an idea about the herb layer. The average height of the herb layer of the second relevé was 1.2 m. Twelve species

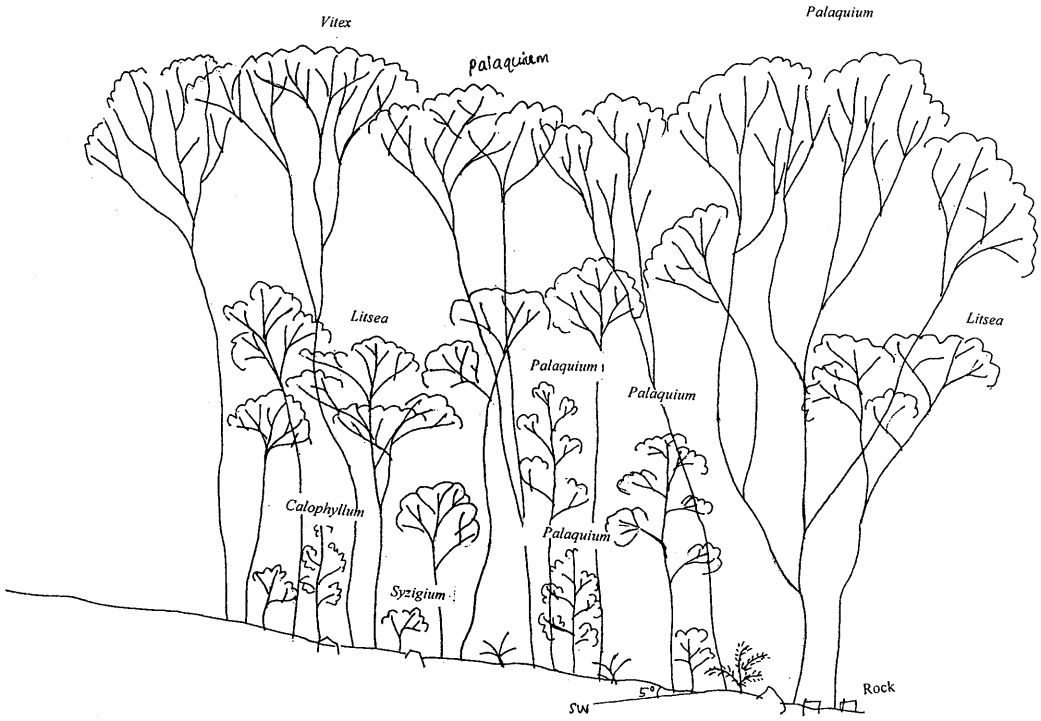

Fig. 8 Vegetation profile of Knuckles Kosgaswela forest relevé area.

Photo 3 Knukles-Kosgaswela relevé area

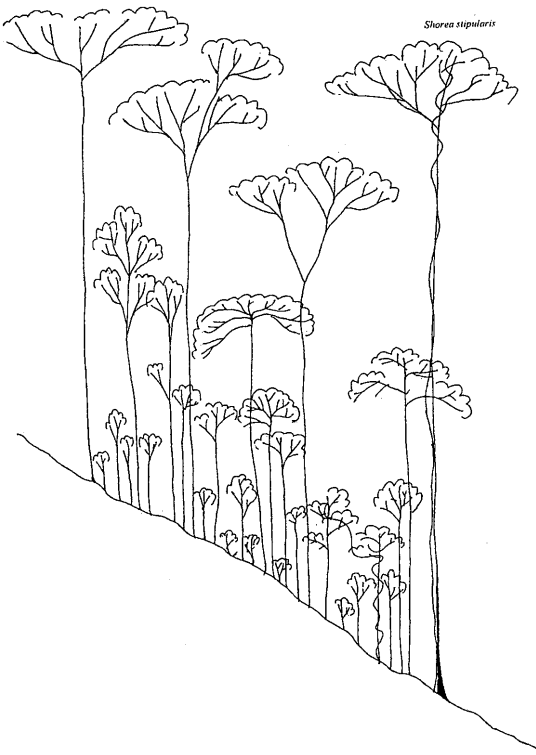

Fig. 9 Vegetation profile of Sinharaja forest relevé area.

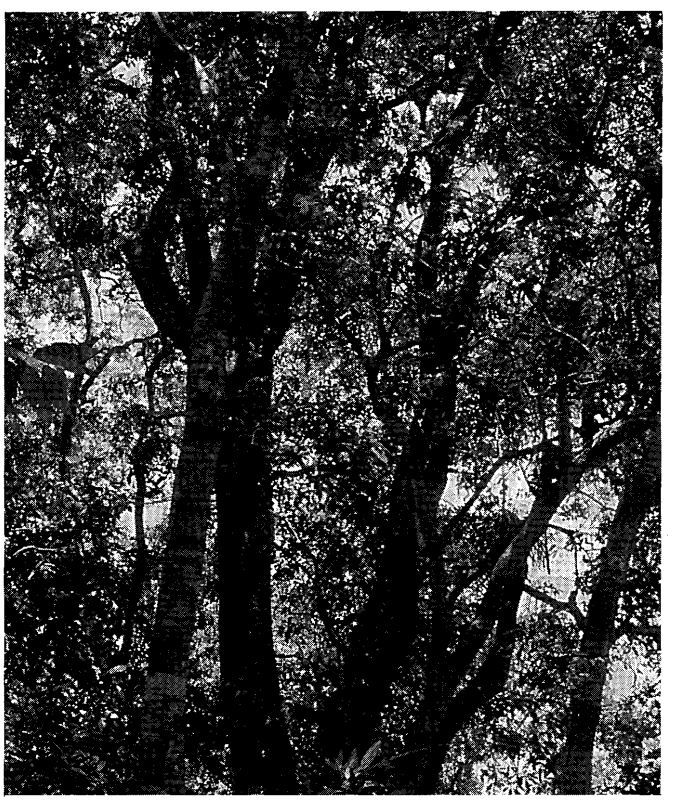

Photo 4 Sinharaja forest relevé area

could be identified, and the community could be identified as *Ichaemum-Cleidemia hirta* community. Photo 4 shows the forest area.

The average height of the herb layer of the third relevé was about 2 m. Seven species could be identified, and the community could be identified as *Arundinela-Blechnum* community. Photo 4 shows the forest area.

Gannoruwa

Gannoruwa is situated in the intermediate zone. The forest is disturbed for fuel gathering. *Michelia champaca* and *Syzygium gardneri* were identified as the dominant species in the forest at lower elevations. The summit area of Gannoruwa Mountain has taller and more massive trees and appeared to be less disturbed. The dominants in this area are *Artocarpus nobilis, Mangifera zeylanica, Neolitsea cassia, Pometia tomentosa* and *Terminalia bellirica* (Greller, A.M. et al. 1980). Relevées were made at two locations. The first relevé was in a 20x50 m^2 plot. Six species in the T1 layer, 10 species in the T2 layer, 32 species in the shrub layer of 5 m height, and 15 species in the 1.2 m-high herb layer were identified. The community could be identified as a *Michelia champaca-Mangifera zeylanica* community. Figures 10 and 11 give the vegetation profile of the forest. In the releve number two, which was in a plot of 30x30 m^2, there were 9 species in the T1 layer, 9 species in the T2 layer, 28 species in the shrub layer of 6m height, and 9 species in the 0.5 m-high herb layer. This community also could be identified as *Michelia champaka-Mangifera zeylanica* community. Figure 12 gives the vegetation profile of the forest. Photo 5 shows the forest area.

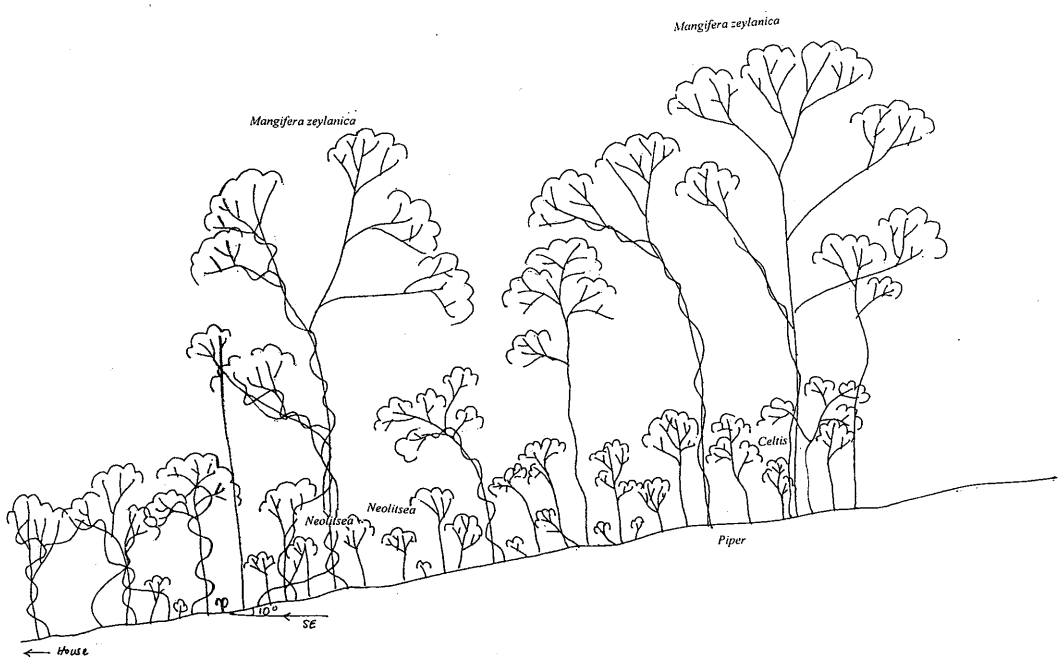

Fig. 10 Vegetation profile of Southeast elevation, Gannoruwa forest relevé area 1.

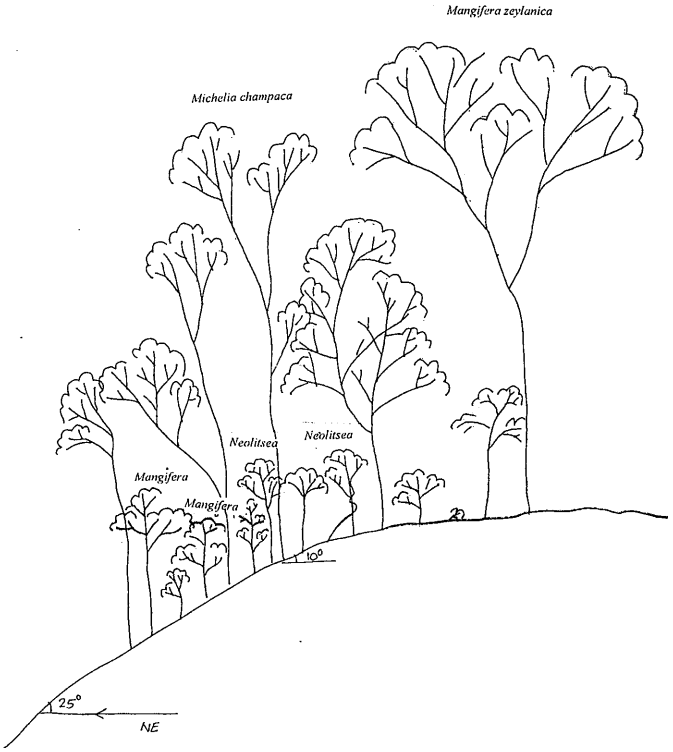

Fig. 11 Vegetation profile of northeast elevation, Gannoruwa forest relevé area 1.

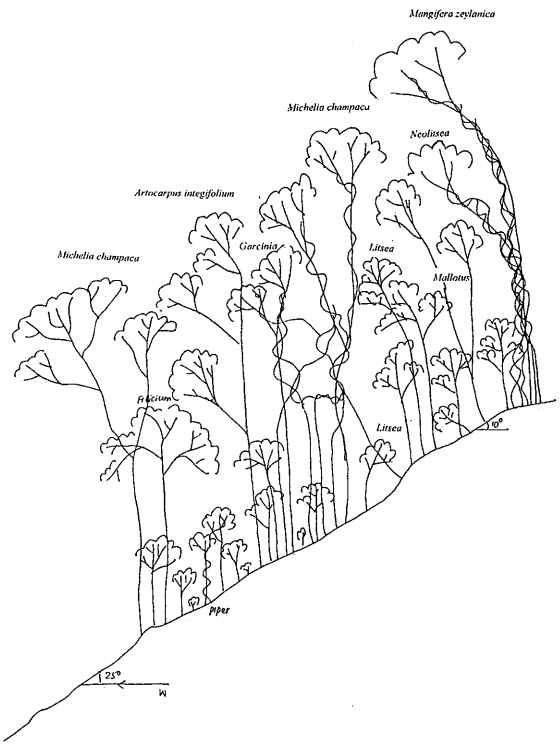

Fig. 12 Vegetation profile of Gannoruwa forest relevé area 2.

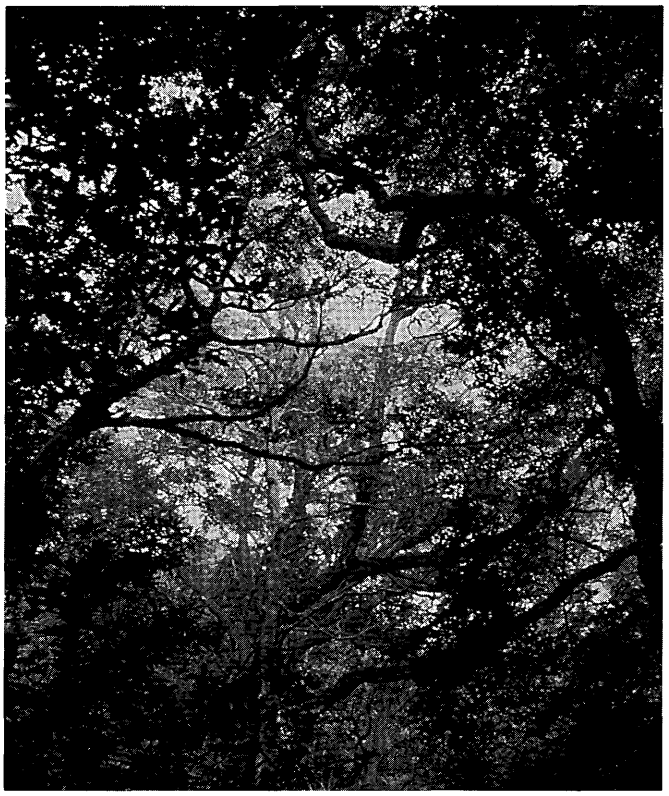

Photo 5 Gannoruwa relevé area 1

Sigiriya

Sigiriya is located in the northern part of the island. The civilization of the island was started in the northern part. Therefore all the forests in this area were cleared for cultivation and human settlement. The forest could be categorized as dry mixed evergreen secondary forest (Cramer L.H. 1993). A relevé was made in a plot of 15x20 m^2. Three species were identified in the T1 layer, 8 species in the T2 layer, 25 species in the shrub layer of 2.5 m height, and 15 species in the 0.2 m-high herb layer. The community could be identified as a *Pterospermum canescens-Eugenia bracteata* community. Figure 13 gives the vegetation profile of the forest. Photo 6 shows the forest area.

Conclusion

The study tour to learn vegetation types and characteristics of Sri Lanka was planned to get the maximum knowledge possible during the short duration of the visit. The itinerary allowed the group to get a comprehensive knowledge of vegetation patterns, their sustenance and also degradation in various types of forests and other areas throughout the country.

The vegetation in Sri Lanka has unique characteristics among South Asian countries. It has a greater diversity for the size of the country than any other country. The main reason for this is the huge difference in altitude, related climatic conditions and rainfall patterns in the island. The amount of natural forest in the country is deteriorating rapidly.

Photo 6 Gannoruwa releve area 2

The forest garden concept used by the majority of Sri Lanka's households contributes much to the abundance of vegetation in the country. The forest garden, which is unique to Sri Lanka, is located immediately around the owner's house. Throughout the year it provides a wide variety of food, fuel, fodder, wood, medicinal and cash crops including coffee, bananas, as well as a cool and pleasant living environment. Structural characteristics of the forest garden, including its high density and species diversity, are comparable to measures from natural forests in similar elevations and climates.

In some parts of the island, especially in hilly areas of the central region where tea plantations were established and in the dry zone where shifting cultivation and paddy cultivation were carried out, fallow areas or abandoned areas could be seen. Some parts were exposed to firing caused by natural causes or human activities. Creating buffer zones between the areas where human activities are carried out and the forest will be a practical solution to prevent the fires.

Further studies should be made about the vegetation pattern of the country to learn about successful vegetation patterns as well as forest degradation and methods of improving and preventing the degradation.

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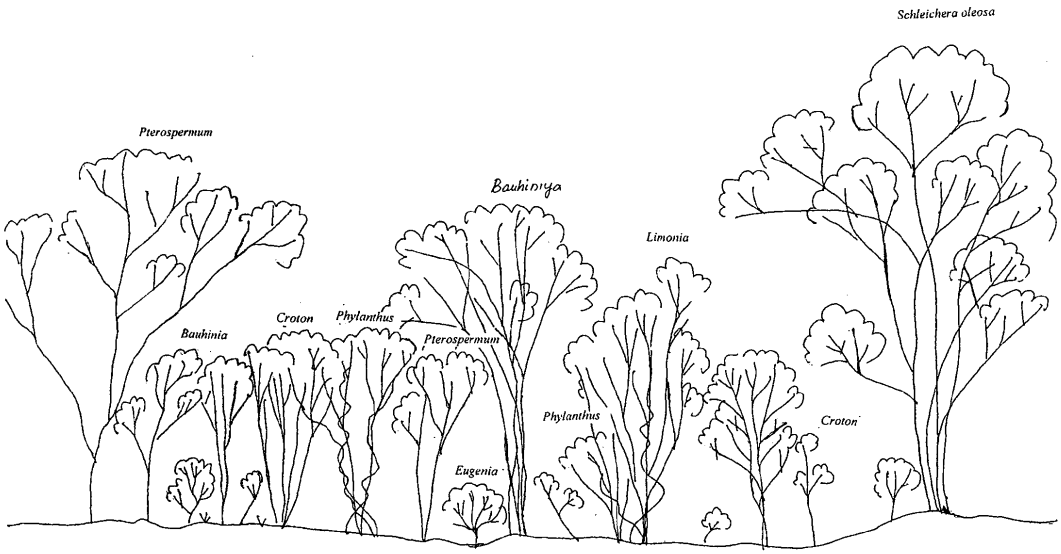

Fig. 13 Vegetation profile of Sigiriya forest relevé area.

Photo 7 Sigiriya releve area

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Appendix 1
Relevé Number: SL-1 Vegetation type: sub-montane evergreen forest Date: 01.04.98
Location: Nakals - Kosgaswela
City/Town : Rattota Elevation : 1570 m Country : Sri Lanka

	Height	Cover		
T_1	26 m	80%	Slope:	5
T_1	16 m	45%	Aspect:	SW
S	5 m	45%	Relevé size:	30 x 50 m^2
H	0.5m	3%		

No. of spp.: 36 spp.

T_1		S		H	
2.2					
2.2	*Palaquium heenmolpedda*	2.2	*Palaquium heenmolpedda*	1.2	*Calamus zelanicus*
2.2	*Vitex altissima*	2.2	*Miliusa indica*	+	*Palaquium heenmolpedda*
1.2	*Dimocarpus longan*	2.2	*Calamus zelanicus*	+	*Litsea* sp.1
1.1	*Litsea gardneri*	2.2	*Gonphia serrata*	+	*Drypetes* sp.
+	*Filicium decipiens*	+	*Psychotria* sp.	+	*Diospyros* sp.
1.1	*Altobotris serenicus*	1.2	*Jasminum angustifolium*	+	*Ardisia* sp.
2.2	*Terminalia bellirica*	1.2	*Dirmocarpus longan*	1.2	*Litsea gardneri*
1.1	*Syzygium cumini*	1.2	*Litsea gardneri*		
1.1	*Pterocarpus marsupium*	+	*Piper ceylanica*		
	Semecarpus gardneri	+	*Hiptage bengalensis*		
		+	*Myristica dactyloides*		
		+	*Syzygium gardneri*		
		+	*Semecarpus nigro-viridis*		
T_2		+	*Garcinia morella*		
1.2		2.2	*Litsea* sp.		
1.2		+	*Pterocarpus marsupium*		
2.2	*Filicium decipiens*	+	*Pterospermum canescens*		
+	*Gonphia serrata*	+	*Nothopegia beddomei*		
2.2	*Dimocarpus longan*	+	*Mangifera zeylanica*		
2.2	*Piper ceylanica*	+	*Carissa spinarum*		
+	*Litsea gardneri*	+	*Syzygium aqueum*		
+	*Syzygium cumini*	+	Unknown 1 (Sapotaceae*?)*		
+	*Benkara* sp.	+	Unknown 2(Annonaceae?)		
	Nothopegia beddomei	+	*Calophyllum tomentosa*		
	Mangifera zeylanica	+	*Syzygium cumini*		
		+	*Aglaia roxbergiana*		
		+	*Notopoditis poetidia*		

Appendix 2
Relevé Number: SL-2 Vegetation type: Lowland rain forest Date: 03.04.98
Location: Sinharaja
City/Town : Ratnapura Elevation : 530 m Country : Sri Lanka

	Height	Cover
ST	43 m	30%
T_1	24 m	45%
T_1	16 m	60%
S	4 m	30%
H	0.5m	10%

Slope: 20
Aspect: NW
Relevé size: 20 x 40 m^2

No. of spp.: 40 spp.

Emergent		S		H	
2.2	*Shorea megistophylla*	2.2	*Memecylon varians*	1.2	*Rumora* sp.
2.1	*Shorea stipularis*	3.2	*Shorea megistophylla*	1.1	*Calamus* sp.
1.1	*Dalbergia pseudosico*	1.2	*Palaquium* sp.	+.2	*Adiandtum* sp.
		2.2	*Camnosperma zeylanica*	+	*Dalbergia pseudosico*
T_1		2.3	*Syzygium makul*	1.1	*Pandanus* sp.
		+	*Psychotria* sp.	+	*Artobotrys seranica*
2.2	*Shorea megistophylla*	+	*Bhesa ceylanica*	1.1	*Psychotria* sp.
+	*Syzygium makul*	2.2	*Callophyllum bracteatum*	1.1	*Syzygium makul*
1.2	*Cullenia ceylanica*	1.2	*Humboldtia laurifolia*	+	*Filicium decipiens*
1.2	*Cullenia rosayroana*	1.2	*Memecylon porceren*	+	*Lasianthus* sp.
1.1	*Shorea disticha*	+	*Anisophyllea cinnaomomoides*	+	Zingiberaceae sp.
2.2	*Shorea trapezifolia*	+	*Lepisanthes* sp.	+	*Cullenia ceylanica*
2.2	*Mesua ferrea*	+	*Shorea stipularis*	+	*Chaetocarpus chestinofilia*
		+	*Palaquium petiolare*		
		+	*Dalbergia pseudosico*	+	*Memecylon* sp.
T_2			(climber)	+	*Ptilopteris maximowiczii*
		+.2	*Ficus* sp. (climber)	+	*Mesua ferrea*
1.2	*Shorea megistophylla*	+	*Vitex altissima*	+	*Cleinia roseiana*
1.2	*Shorea disticha*	1.2	*Mesua ferrea*	1.1	*Agrostistachys* sp.
1.1	*Shorea trapezifolia*	+	*Agrotistachys hookeri*		
1.1	*Semecarpus nigro-viridis*	+	*Schumacheria castaneifolia*		
2.3	*Mesua ferrea*				
2.2	*Humboldtia laurifolia*				
+	*Syzygium makul*				
+	*Cullenia rosayroana*				

Appendix 3
Relevé Number: SL-3 Vegetation type: Lowland rain forest Date: 03.04.98
Location: Mantle community along a path, Sinharaja
City/Town : Ratnapura Elevation : 530 m Country : Sri Lanka

	Height	Cover
T_1	-	-
T_1	-	-
S	-	-
H	1.2m	90%

Slope: 5
Aspect: NE
Relevé size: 1.5 x 4 m^2

No. of spp.: 12 spp.

H	
5.5	*Palaquium grande*
3.4	*Cleidemia hirta*
+	*Shorea stipularis*
+	*Nepenthus distifolia*
+	*Schumacheria castaneifolia*
+	*Humboldtia laurifolia*
+	*Mesua pulchella*
+	*Hydnocarpus octandra*
+	*Ichaemum* sp.
+	*Osbeckia octandra*
+	*Melastoma malabathricum*
+	*Hedyotis* sp.

Appendix 4
Relevé Number: SL-4 Vegetation type: Lowland rain forest Date: 03.04.98
Location: Mantle community along a path, Sinharaja
City/Town : Ratnapura Elevation : 530 m Country : Sri Lanka

	Height	Cover		
T_1	-	-	Slope:	5
T_1	-	-	Aspect:	NE
S	-	-	Relevé size:	3 x 5 m^2
H	2m	100%		

No. of spp.: 7 spp.

H	
2.2	*Arundinela* sp.
+	*Hedyotis fruticosa*
3.4	*Dichanopteris* sp.
3.3	*Blechnum orientale*
2.2	Malabaceae sp.
1.2	*Nepenthus distrifolia*
1.2	Apocynaceae sp.
	Rocky

Appendix 5
Relevé Number: SL-5 Vegetation type: Semi-evergreen forest Date: 04.04.98
Location: Gannoruwa
City/Town : Kandy Elevation : 550 m Country : Sri Lanka

	Height	Cover
T_1	28 m	50%
T_1	14 m	50%
S	5 m	60%
H	1.2m	90%

Slope: 15 ~ 10°
Aspect: SW 15° ~ SE 10°
Relevé size: 20 x 50 m^2

No. of spp.: 55 spp.

T_1		S		H	
2.2	*Mangifera zeylanica*	1.2	*Nothopegia beddomei*	1.1	*Piper sylvesta*
3.3	*Michelia champaca*	+	*Elaeocarpus* sp.	2.2	*Pterospermum canescens*
1.1	*Schefflera stellata*	+	*Nothopidiatis potida*	+.2	*Micromelum minutum*
	(climber)	1.1	*Litsea glutinosa*	+	*Pavetta indica*
+	*Zizyphus oenoplia*	2.2	Rubiaceae sp.	+	*Coffea arabica*
+.2	*Dalbergia pseudosico*	+	*Swietenia macrophylla*	1.1	*Neolitsea* sp.
2.1	*Swietenia macrophylla*	1.1	*Ardisia paniculata*	+	*Diospyros* sp.
		1.2	*Dimocarpus longan*	+	*Aporusa lanceolata*
		1.1	*Atalantia ceylanica*	1.1	*Neolitsea cassia*
T_2		1.1	*Morea paniculata*	1.1	Sapindaceae sp.
		1.1	*Neolitsea cassia*	+.2	Cyperaceae sp.
1.1	*Nothopegia beddomei*	+	*Cacao* sp.	+	*Pteris semipinnata*
2.2	*Dimocarpus longan*	1.1	*Piper sylvesta*	+	*Oplismenus* sp.
1.1	*Swietenia mahogani*	1.1	*Lepisanthes erecta*	+.2	Gramineae sp.
1.2	*Artocarpus integurifolia*	+	*Aglaia elaeagnoidea*	+.2	*Adiantum* sp.
+	*Alstonia macrophylla*	2.2	*Cinnamomum* sp.		
2.2	*Pometia pinnata*	1.2	*Bhesa ceylanica*		
1.1	*Meliosma simplicifolia*	1.2	*Pavetta indica*		
1.1	*Terpinia maraberica*	+	*Glochidion gardneri*		
1.2	*Artocarpus nobilis*	+	*Celtis wightii*		
1.1	*Mallotus philippensis*	+	*Alstonia scholaris*		
		+	*Filicium decipiens*		
		+	*Hydrocarpus venenata*		
		+	*Artobotrys cerenica*		
		+	*Syzygium operculatum*		
		+	*Mallotus philippensis*		
		1.1	*Turpinia malabarica.*		
		2.2	*Pterospermum canescens*		
		+.2	*Diospyros walkeri*		
		+	*Phyllanthus indicus*		
		+	*Micromelum minutum*		
		+	*Gonphia serrata*		

Appendix 6
Relevé Number: SL-6 Vegetation type: Semi evergreen forest Date: 04.04.98
Location: Gannoruwa
City/Town : Kandy Elevation : 530 m Country : Sri Lanka

	Height	Cover
T_1	28 m	75%
T_1	18 m	40%
S	6 m	65%
H	0.5m	8 %

Slope: 30°
Aspect: NW
Relevé size: 30 x 30 m^2

No. of spp.: 53 spp.

T_1		S		H	
3.3	*Michelia champaca*	1.2	*Pavetta indica*	1.1	*Micromelum* sp.
2.2	*Mangifera zeylanica*	+	*Swietenia macrophylla*	2.2	*Neolitsea* sp.
1.2	*Filicium decipiens*	+	*Hydnocarpus venenata*	+.2	*Adiantum* sp.
1.1	*Terminalia bellirica*	+	*Syzygium operculatum*	1.2	*Parica* sp.
+.2	*Enteda* sp.	+.2	*Aglaia elaeagnoidea*	+	*Pteris semipinnata*
1.1	*Artocarpus integifolium*	+.2	Menispermaceae sp.	+	*Pepper* sp.
2.2	*Artobotrys serenica*	3.3	*Neolitsea cassia*	+	*Lepisanthes erecta*
+.2	Rubiaceae sp. (climber)	1.1	*Ardisia paniculata*	+.2	Cyperaceae sp.
1.1	*Vitex altissima*	+	*Diospyros walkeri*	+	*Anometra* sp.
		+	*Lepisanthes erecta*		
		2.2	*Micromelum minutum*		
T_2		+	*Litsea glutinosa*		
		+	*Filicium* sp.		
1.1	*Garcinia morella*	1.2	*Bhesa ceylanica*		
2.3	*Dimocarpus longan*	2.2	*Nothopegia beddomei*		
2.2	*Zizyphus oenoplia*	1.1	*Coffea arabica*		
+	*Neolitsea cassia*	1.2	*Aporusa lanceolata*		
+	*Pometia pinnata*	1.2	*Gonphia serrata*		
+	*Meliosma simplicifolia*	+	*Cinnamomum* sp.		
1.1.	*Atlantia ceylanica*	1.2	*Atlantia ceylanica*		
1.2	*Mallotus philippensis*	+	*Alstonia macrophylla*		
2.2	*Filicium* sp.	+.2	*Pterospermum canescens*		
		+	*Celtis wightii*		
		+.2	*Pepper* sp.		
		+	*Artobotrys serenica*		
		+.2	*Ziziphus oenoplia*		
		+	*Litsea glutinosa*		
		+	*Morea paniculata*		

Appendix 7
Relevé Number: SL-7 Vegetation type: Dry mixed evergreen forest Date: 05.04.98
Location: Sigiriya
City/Town : Dambulla Elevation : 170 m Country : Sri Lanka

	Height	Cover
T_1	12 m	10%
T_1	7 m	75%
S	2.5m	50%
H	0.2m	35%

Slope: 0
Aspect:
Relevé size: 15 x 20 m^2

No. of spp.: 45 spp.

T_1		S		H	
2.1	*Schleichera oleosa*	3.3	*Eugenia bracteata*	3.4	*Paspalum* sp.
2.1	*Pterospermum canescens*	1.2	*Toddalia asiatica*	2.3	Cyperaceae sp.
1.2	*Bauhinia racemosa*	2.2	*Croton laccifer*	+	*Flacourtia* sp.
		2.2	*Phyllanthus polyphyllus*	+.2	*Carissa spinarum*
		1.1	Compositae sp. (climber)	1.2	*Croton laccifer*
T_2		1.2	*Limonia feronia*	1.1	*Phyllanthus polyphyllus*
		+	*Lantana camara*	+.2	*Menispermum* sp.
1.2	*Helicteres isora*	+	*Lepisanthes tetraphylla*	2.2	*Flueggea leucopyrus*
1.2	Compositae sp. (climber)	+	*Eupatorium odoratum*	+	*Cassia fistula*
2.2	*Bauhinia racemosa*	+	*Menispermum*	+	*Asparagus racemosus*
+	*Cassia fistula*	1.2	*Bauhinia racemosa*	+	*Vitex altissima*
2.2	*Syzygium cumini*	+	*Zizyphus rhamnacia*	+	*Chloroxylon swietenia*
1.2	*Bridelia retusa*	+	*Zizyphus oenoplia*	+	*Streblus asper*
+	*Allophylus cobbe*	+.2	*Flacourtia indica*	+	Sapotaceae sp.
2.2	*Pterospermum canescens*	1.1	Apocynaceae sp. (climber)	+	*Fluggea* sp.
		+	Unknown 1		
		1.2	*Clausena indica*		
		+	Unknown 2		
		+	Unknown 3(climber)		
		2.2	*Aglaia elaeagonidea*		
		1.2	*Flueggea leucopyrus*		
		+	*Dalbergia pseudosis*		
		3.3	*Pterospermum canescens*		
		+	*Flueggea leucopyrus*		
		+	*Jasminum* sp.		