

THE AFTERMATH OF THE PLEISTOCENE IN THE UPPER NILGIRIS OF SOUTHERN INDIA¹

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There has been much debate as to why grassy landscapes have persisted in portions of the Nilgiris above 1,200 m. While there is no doubt that firing (especially by the tribal Todas) led to grassland formation and maintenance, we can now conclude with some confidence that climatic changes during the Pleistocene also contributed to the existence of grasslands over long periods. This is confirmed by the results of varied palynological studies (examination of pollen grains) by Blasco, Gupta, Menon, Thanikaimoni, and Vishnu-Mittre in marshy low-lying (= bog) areas within the Upland Nilgiri Island. The most likely, ideal grasslands for continued persistence, probably during the Pleistocene and for possibly millions of years earlier (now, only suggestive), are the high rainfall grasslands of the far western Nilgiris. The harsh climatic controls in these grasslands frequently created environmental conditions in which only grass and not tree species could dominate. The appendices to this paper are designed to help us obtain a greater understanding of the complexity of environmental, cultural, and especially vegetational factors that have endured in the Nilgiris since the Pleistocene ended.

Altogether, they also demonstrate the uniqueness of the Nilgiri Upland Island.

Key words: Upland Island, Pleistocene, Vegetation, Complexity, Grassland, High Rainfall Grassland

Nilgiri Environmental Factors

The region discussed is located where the Western and Eastern Ghats of India converge at their southern ends to form the Nilgiri massif. This mountainous block that is tilted toward the east, with several peaks rising above 2,400 m (8,000 ft), is clearly defined by its precipitous western slopes and the Moyar and Bhavani rivers which flow in fault strike valleys within the lower terrain to the north and south of the block. The Nilgiris form the largest charnockitic mass in southern India and, interestingly, due to the lighter composition of charnockite, are amazing in having far more ancient rock that has risen far above the younger rocks of the plains below. The main focus in this contribution is upon the grasslands which are, or were until contact times when the British first started to live in the upper and cooler climate, in that portion of the region here referred to as the Upland Island lying above 1,200 m. At the start, some consideration is given to different possible causes that may contribute to the presence of grasslands. According to Ranganathan (1938: 523) there is a "wilting effect due to plants exposed to the morning sun being unable to draw water from the frozen soil" as an explanation for why grasses grew together in such stark contrast to the nearby sholas (low canopy evergreen forests) of the upper Nilgiris. Ranganathan reasoned that micro-environments related to the trees within sholas remained above freezing point. Because more energy is radiated out at night on open grasslands, it is particularly at the

earth's surface that temperatures might drop below 0 °C. Plants needing to transpire more in response to rapidly increased heating by insolation after sunrise are unable to draw up sufficient moisture due to surface freezing, and thus they wilt. There can be no doubt that fires followed by grazing have also had an impact, as Bor (1938: 608) concluded: "I believe that the shola forest is the relic of an evergreen forest climax which has been pushed back to its last stronghold by fire and grazing. The grassland I consider to be a biotic climax rendered stable by fire and grazing and only one more proof of the stability of grassland under such condition." Among the complex influences upon vegetation which exist in the Nilgiri Upland Island, it seems reasonable to draw a parallel with the treeless balds of the Appalachians in the United States, as conceptualized by Billings and Mark (1957: 140): "The balds are then essentially forest margin or ecotone phenomena existing near the tolerance limits of the principal forest dominants." It is noteworthy that most upper Nilgiri plants are tropical and not temperate in nature, and so we must think of plants spreading upwards into stressful limits. Quite apart from the shock of widespread morning frost and the burning heat of fires, the tolerance limits of upper Nilgiri plant species are severely tried by strong, gusty wind, sometimes over 110 km per hour, heavy rain, drought sometimes prolonged for weeks, exposure to a bright tropical sun that can soon burn the human skin, and cooling from the enfolding, clinging damp mist (the

last two sometimes experienced within 30 minutes). Along with the spread of glaciers to lower elevations in the Himalaya during the later Pleistocene (De Terra and Paterson 1939), some evidence is now forthcoming for sufficient climatic change farther south to cause grasslands to form and persist.

Before continuing with vegetative changes during and after the Pleistocene, a comment regarding the writer's use of the term grassland is in order. Blasco and Lengerke (1989: 59-61) use "common savanna" and "high rainfall savanna" instead of grassland, and quite correctly so in terms of their view that grasses on the Nilgiri Upland Island are typically accompanied by a host of herbs and shrubs. While recognizing this fact, the writer prefers to use grassland because, historically, the British colonials did. They also conceptualized grassland by using the term downs, the Nilgiri downs reminding them of open grassy tracts in their homeland. Secondly, considering the original tropical *sabana* of Cuba, from which the word savanna is derived, the more specific use of savanna for a landscape with grasses and scattered trees seems appropriate. While rhododendron and other tree species scattered on Nilgiri grassland form limited savanna areas in that sense, it is the overwhelming presence of low-lying grasses over larger tracts (sometimes over 90% of the terrain) that visually gains the upper hand. Grasses have for long formed a significant part of the vegetation in the Nilgiri Upland Island lying above 1200 m, and that over 10% of the grasses are endemic is suggestive of evolutionary processes that have gone on for millions of years (Appendix 1).

Possible Changes over 40,000 Years

The palynological evidence provided by Vishnu-Mittre and Gupta (1972) and Gupta (1971, 1989), involving bogs and study of pollen grains from soil profiles in a bog at Kakathope on the upper Nilgiris, tentatively suggests the past presence of grasslands — in the above-mentioned sense — over a long period. However, the evidence is tempered by later samplings that indicate a lack of tree pollen accumulation, or even the absence of tree pollen, in sites 1-4 km from the sholas which were investigated. Bera and Gupta (1992: 243) cite i. insect pollination and ii. outer fringe plants preventing the escape of pollen grains as the main factors preventing greater spread of tree pollen. In contrast to a past consensus that grasslands resulted from firing by humans, we can now subscribe to the idea that grasslands have existed far longer, but should be cautioned in our thinking by the realization that sholas have, in all likelihood, simultaneously existed to a greater degree than the pollen record might reveal. A cooler

and drier climatic regime probably existed from about 40 to 35,000 years Before the Present (BP), and the evidence indicates that there was widespread grassland on the upper Nilgiris. Along with dominant grass and sedge pollen grains, there was evidence for a variety of herbs and shrubs. It was impossible to identify actual species from the pollen grains gathered from different depths in soil profiles, but plant genera could be identified. Herbs of the genera *Campanula*, *Chenopodium*, *Geranium*, *Justicia* and *Lilium*, shrubs of the genus *Berberis*, and a few sporadic trees of the genera *Ilex* and *Rhododendron* appear to have spread in from the north (Appendix 2). What is even more significant are species that did not move down into the Peninsula from the north. Thus, the oaks (*Quercus*) and pines (*Pinus*) of Meghalaya never managed to spread southward.

Latitudinal variation and insufficient change in climate as a result of glaciation appear to have jointly operated to prevent the spread of other temperate plant species from the north. The species of genera *Berberis*, *Ilex*, and *Rhododendron* that did come are currently hardy, quite capable of surviving as lone sentinels on grassland. Significantly, pollen grains prove that *Strobilanthes* shrubs were also present.

Pollen grains from between 35,000 and 15,000 BP indicate an increase of shrubs and the spread of thickets over grassland. Cool and dry climatic conditions probably persisted, with a shift toward greater aridity. The summer westerly monsoon may have greatly weakened (or not have existed?), and did the easterly monsoon become stronger (Sukumar *et al.* 1993: 704-705)? There was a decline in the pollen grains of grasses and sedges, while those of the Compositae, Dipsacaceae, Leguminosae, Malvaceae, and Rosaceae families, and the genus *Jasminum* (or *Ligustrum* instead?) notably increased. *Strobilanthes* also appears as a dominant group. Pollen grains identified with the genus *Portulaca* were present, but no related species survives today. While pollen grains of the genera *Campanula*, *Geranium*, and *Justicia* declined, those of *Chenopodium* and *Lilium* continued to be present in about the same quantity. The pollen grains of *Berberis*, *Ilex*, and *Rhododendron* are also present, with the last declining as time went by. Among shrubs, there is some evidence of the genus *Sarcococca*, and a better representation of *Lonicera*. Sporadic pollen grains of the genera *Artemisia* and *Impatiens* were also present. Ultimately, there were indications of widespread heaths with some scattered trees. The presence of *Impatiens* pollen grains suggests plant ancestry going back to Madagascar (Appendix 2). There seems some potential of there being grassland over millions of years, as the Indian Peninsula Shield drifted northwards within the Cretaceous to Tertiary periods (between 85 and 30

million years ago), and eventually smashed into the northern continental mass of Laurasia. Along with the high degree of endemism among Nilgiri grasses, a high degree of plant endemism has occurred among the genera *Impatiens* and *Strobilanthes* (Appendix 3). In all of India, it is in the Nilgiris that the greatest evolutionary diversity and multiplicity of species has occurred in these two genera.

The climate probably became warmer and more humid between 15,000 and 7,000 BP. Was there a strengthening of a summer westerly monsoon, eventually somewhat akin to that which now occurs, in this period? There is some evidence for the summer monsoon reaching a peak at about 11,000 BP, and for a progressively drier period to 6,000 BP (Sukumar *et al.* 1993: 705). The greater presence of tree pollen grains in related soil horizons indicates the spread of shola with evergreen tree genera *Elaeocarpus*, *Euonymus*, and *Gordonia*. The spread of sholas also tends to be supported by the marked increase of pollen grains of the genus *Peperomia*, now a common epiphyte in the sholas. It seems unlikely, however, because of a strong continued presence of grass and sedge pollen grains, that the Nilgiri Upland Island was ever covered entirely by sholas.

From about 7,000 BP and continuing into the Post-Contact Era, starting in the early 1820s when the British came, a decline in the pollen grains of shola species indicates a reduction in the areal extent of sholas and an increase in grasslands. There are intervals with a marked decline of *Peperomia* pollen grains, which contrast with a marked increase of *Impatiens* pollen grains. While pollen grains of the genus *Jasminum* (or *Ligustrum*?), so abundant in the earlier heaths, are conspicuously absent, those of the families Compositae, Dipsacaceae, Malvaceae, and the genus *Geranium* are present. In contrast to the earlier heaths, too, there is a lack of *Berberis*, *Ilex*, and *Rhododendron* pollen grains. Might this be due to fires on open grasslands increasingly destroying these genera? Climatic change may, in part at least, be responsible for the increasing shift from sholas to grasslands. A stage to at least 6000 BP, and probably beyond, may be due to increased drying. A weakened westerly monsoon may have again been established by 6000 BP. About 600 BP, and approximately between 1200 and 1400 AD, there appears to have been a warmer and moister period than that which exists at present (Sukumar *et al.* 1993: 705). It is thus, perhaps, no coincidence that there is an abundance of archaeological evidence (partially seen by the author during 1994 field work in the area) for more people living in the Mysore Ditch, just to the north of the Nilgiris, in that period. The possible role of lightning

strikes or spontaneous combustion during dry seasons in starting fires and thereby increasing the areal extent of grasslands, leading to an increase of grass pollen grains in Nilgiri waterlogged soils, have not been investigated. Human hunter-gatherers setting fires for millennia might have contributed to shola destruction, *but there is still no archaeological proof of this.*

The Past 3,000 Years

A more conservative time span of 3,000 years provides us with a still more revealing and possibly more accurate glimpse of the past. The pioneering effort of Vimala Menon (1966-1967) is most useful because of its zone-by-zone analysis of a soil profile in a bog at Pykara, west of Ootacamund in the Nilgiris. The profile extends to a depth of 1.7 m and is divided into 15 zones. From zone 1 at the bottom to zone 15 at the top, the percentages of grass pollen grains are: 83, 61, 54, 53, 60, 49 (the lowest), 55, 53, 59, 78, 83, 79, 85 (the highest), 80, and 71. The evidence (count of 2,368 pollen grains) thus indicates a dominance by grasses through most of the period. The spores of ferns are the next largest group (spore count of 340). Although many ferns prefer shadowy, cool and moist environments, suggesting shola, some thrive in shade provided by the rocks and plants of open grassland. We must remember, too, that ferns give off many spores, which can profoundly affect the rate of their accumulation in a soil profile. Sedges (Cyperaceae, pollen count of 159) come next. The following families (with pollen counts) are represented: Liliaceae (123), Compositae (100), Balsaminaceae (96), Scrophulariaceae (63), Xyridaceae (62), Chenopodiaceae (21), Gentianaceae (15), Umbelliferae (12), Cruciferae (12), and Caprifoliaceae (11). These generally indicate the presence of grassland with herbs and shrubs, while pollen grains from trees are conspicuously lacking. The occasional pollen grains of these families probably represent species living in sholas: Araceae, Ericaceae, Euphorbiaceae, Meliaceae, Orchidaceae, Thymeleaceae, and Urticaceae.

Blasco and Thanikaimoni (1974) studied pollen grains from profiles in sediments down to 3.8 m at Pykara and down to 2.1 m at Parson's Valley, south of Pykara. They divided the pollen grains examined into four separate ecological groups: i. herbaceous (grass mainly, but other herbs as well), ii. forest border (forest-grassland ecotone), iii. tree/shrub savanna (trees/shrubs growing on the grassland), and iv. forest (shola). With one exception (decrease of herbaceous pollen grains and increase of forest border pollen grains from the 1.3 to 1.9 m depth at Pykara, into the wetter period c. 600 BP), the graph profiles of herbaceous pollen grains consistently ranged far higher than the graph profiles

for the three other groups. Next came the forest border group, then the tree/shrub group, and, lastly, the forest group (Appendix 2). The pollen grains of shola species in the families Celastraceae, Lauraceae, and Myrtaceae were relatively rare, and those of Araliaceae, Elaeocarpaceae, Sapotaceae, Symplocaceae, and the genus *Ilex* were also recorded. While the pollen grains from both places in general ranged from 65 to 80 percent for plants of the open grassland, the pollen grains of forest species were at a low of about 5 percent. Thus, the overall findings parallel those of Menon (1966-67).

Unfortunately, Menon (1966-67) and Blasco and Thanikaimoni (1974) have no radiocarbon dates for any parts of their profiles. However, Blasco and Thanikaimoni (1974) used comparable evidence from the Palnis to devise a dating system. Interpolating with a 1770 AD date for a sample at about 30 cm below the surface and a 1050 BP date for a sample at about 130 cm below the surface in the same locality, they postulate a going back to some 3,000 to 4,000 BP, for layers 3 to 4 m below the surface in the Nilgiris and Palnis. Considering the evidence covered, we are confronted with the possibility of there being extensive natural grasslands on the Nilgiri Upland Island for thousands of years, and more likely for at least the past 3000 years. So strong is the cumulative evidence that we no longer need to primarily use the annual burning of grasslands to explain their presence. There is no denying, however, that the annual burning of grasslands contributed to their spread. While we have no archaeological proof for the burning of grasslands over thousands of years, their seeming presence for so long now raises the possibility of there being humans on the upper Nilgiris far longer than was hitherto proven.

While a characteristic polished Neolithic pointed butt stone implement found in the Mysore Ditch just north of the Nilgiri massif may indicate the presence of humans there by 1000 BC, there is no such indication for the Nilgiri Upland Island. From the evidence yielded thus far from prehistoric sites, among which are the walled stone circles on the tops of peaks, we have no proof of the presence of humans prior to 1 AD (Noble 1989: 127-130). The most logical choice of a people who could have been around for long are the Todas, who are a main element making the Nilgiri Upland Island distinctive. After watching a Toda gather the roots of so-called Toda potatoes (*Ceropegia pusilla* Wt.), eating some of them myself in 1994, and realizing the variety of other foodstuffs which can be gathered, one concludes that Toda ancestors could have been gatherers on the Nilgiri Upland Island and outer slopes. However, ever since 1603, when the priest Yacome Finicio wrote his account of a visit to the Nilgiris, we know that the

Todas were buffalo herders from then and into post-contact times (Rivers 1906: 721-730). The historic record shows that they burned the grasslands each year (Appendix 4). Fires set for even 300 years must have contributed to the spread of grasslands, to the detriment of the sholas. We have no idea as to when the distinctive Kota farmers settled on the upper Nilgiris. They are artisans who can still make knives and pots, and there is some potential for their ancestors being the makers of the effigy pots and knives buried at the centre of the stone circles. Ancestors of Badaga farmers, a third distinctive group on the upper Nilgiris and now far outnumbering the other two, probably lived on the upper Nilgiris for centuries before the fall of the Vijayanagar Empire in 1565 AD. Badagas continue a strong tradition of being ruled from Ummatur in Mysore (later absorbed by Karnataka). After the ruler there was overcome by Krishnadevaraya around 1510-1512, a Vijayanagar representative called Wodeyaraya who lived at Konakorai on the upper Nilgiris married the Lingayat Muddu Gowri. At nearby Nedugula, there is still an ancestral temple dedicated to Muddu Gowri (Francis 1908: 333-334, Mulley 1997: 5). While the Badagas used to annually migrate to *hundis* (seasonal livestock stations) in the western Nilgiris, and typically fired nearby grasslands prior to moving back eastward before the onset of westerly monsoon rains, the Kotas to a lesser degree also seasonally occupied grasslands and fired them (Noble 1977). The Forest Department eventually prohibited the annual firing and migration into the grasslands, and these activities for the most part came to an end in the 1960s. The Department also engaged in the planting of trees, and by now black wattle (*Acacia mearnsii* Willd.), blue gum (*Eucalyptus globulus* Labill.) trees, indigenous to Australia, and Mexican pine (*Pinus patula* L.) grow over thousands of hectares once dominated by grasses. By 1987, eucalyptus alone covered about 12,000 ha (Meher-Homji 1987-1988: 159). Mexican pines have typically been planted in frost pockets where the other two species failed.

High Rainfall Sholas and Grasslands

Because the high rainfall sholas and grasslands of the far western Nilgiris are the most ideal candidates for natural grassland occurrence going far back into the Pleistocene, they now receive brief coverage. These little known but ecologically distinctive sholas and grasslands are, for the most part, located in a zone running from a northerly to southerly direction, following the western escarpment, and then, for a shorter distance, the southerly escarpment. Included are the Pandiar cliffs, all the area surrounding Nilgiri Peak, the Mukerti Peak area, the three Western Catchments, Bangitapal Rest

House and adjacent area, areas next to the cliffs in the Nadgani and Sispara areas, and then an area running alongside steep southerly slopes to and somewhat eastward from the Bison Swamp area. These areas have received the highest rainfall in the Indian Peninsula during the westerly monsoon. If we consider the 10,867 mm (424", or 35.3ft) of rain which fell in Western Catchment Three during 1961, the heaviest rainfall of 713 mm (28") ever recorded in a 24 hour period at Western Catchment Three, on July 7, 1958, and the heaviest rainfall of 1,283 mm (50") ever recorded in a 48-hour period at Mukerti Ridge Top, on July 12 and 13, 1943 (Lengerke 1977: 174, 188; Blasco and Lengerke 1989: 39), we can grasp how unusual these high rainfall areas are.

So harsh is the environment to humans that Toda and Badaga pastoralists made it a regular practice to migrate eastwards, away from the high rainfall and adjacent areas before the westerly monsoon set in. In contrast to the high rainfall and great frequency of clouds, mainly in the period of the westerly monsoon and during the easterly monsoon as well, there are also periods of drought and intense insolation during the year.

In response to the variable and frequently harsh climatic conditions, and associated soils leached by high rainfall, grassland typically dominates. While there are sholas in protected valleys and depressions, high rainfall grasslands sometimes dominate up to both banks of streams and over low-lying terrain. Interestingly, a description by Rao (1974: 214) reveals how some Nilgiri landscapes compare with those in the very high rainfall Cherrapunji area of northeastern India: "...the situation at Cherrapunji, until recently famed as the wettest place on earth, needs special notice. The area looks disappointingly bleak and bare of wooded vegetation, due to the poor soil cover; all the soil being leached out by the heavy rains, leaving behind smooth, bare rocks. For vast distances all around, only dwarf grass growth is visible. It is only in the comparatively sheltered depressions, as at Mamloo and Moswmai, where there is a deposit of soil and humus, that there are small islands of wooded vegetation, in an otherwise vast sea of grassland."

High Rainfall Sholas: According to Blasco and Lengerke (1989: 54-61), high rainfall sholas are composed of a dense growth of trees, often dwarfed, forming a shorter canopy up to c.10 m from the ground.

The dominant tree species is often a black plum *Syzygium calophyllifolium* Walp. [trop.]. Other trees, all tropical species, are cinnamon (*Cinnamomum macrocarpum* Hook. and *C. perrottetii* Meissn.), another black plum (*Syzygium densiflorum* Wall. ex.

Wt. & Arn.), apple bladder-nut (*Turpinia cochinchinensis* Merr.), white milk tree (*Isonandra perrottetiana* DC.), and mock-olive (*Elaeocarpus recurvatus* Corner). The less frequent Nilgiri magnolia (*Michelia nilagirica* Zenk. [trop.]), spindle (*Euonymus crenulatus* Wall. [temp.]), and cryptocarya (*Cryptocarya lawsoni* Gamb.[trop.]) trees also grow in these sholas. Epiphytes are more common. In addition to a variety of orchids, pepper-elder (*Peperomia reflexa* A. Dietr.) is a very common epiphyte.

As an evolutionary adaptation to the rigorous climatic conditions, two balsams are often epiphytic (*Impatiens orchioides* Bedd. & *laticornis* Fischer) on boulders and trees, whereas one (*neo-barnesii* Fischer) has become a full-fledged epiphyte on trees. It typically grows on branches with moss and pepper-elder, on trees sometimes located above 2400 m and close to or down the western escarpment.

High Rainfall Grasslands: The high rainfall grasslands have *Isachne kunthiana* Miq. and *Themeda triandra* Forsk. grasses. *Arundinella purpurea* Hockst. is the commonest grass in some areas. Among the plants most frequently growing in these grasslands are common anemone (*Anemone rivularis* Ham.), balsams (*Impatiens* spp.), creat (*Andrographis lawsoni* Gamb.), everlasting (*Anaphalis* spp.), kurunji (*Strobilanthes* spp.), Nilgiri privet (*Ligustrum perrottetii* DC), teasel (*Dipsacus leschenaultii* Coult.), wood germander (*Teucrium wightii* Hook.), stunted black plum (*Syzygium* spp.) and rhododendron (basically the *Rhododendron arboreum* Sm. of the Himalaya, now considered subsp. *nilagiricum* (Zenk.) Tagg by Matthew). The high rainfall grasslands offer the ideal habitat for Nilgiri Tahr (*Hemitragus hylocrius* Blyth), animals that prefer living on and close to cliffs. The grasslands are sometimes still burned over in the dry season, despite regulations to the contrary, and it is noteworthy that tahrs relish young grasses that sprout after firing. Thus, they often tend to congregate in such areas. Attempts by the Forest Department to plant trees in high rainfall grasslands have typically ended in failure. Row upon row of dead young plants now stand out on them.

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Appendix 1: A Representative List of Nilgiri Grasses above 1,200 m

Based upon listings in Bor (1960), Sharma *et al.* (1977) (only the Gramineae section), with additional assistance from the Gramineae section in the three Floras: FYSON 1931: 650-681; GAMBLE 1967: vol 3, 1171-1290 [this section done entirely by C.E.C. Fischer] and MATTHEW 1999: Pt 3:1442-1604, along with notes made by H.S. Suresh, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India.

*Endemic; # Most probably introduced

GRAMINEAE (SMALLER GRASSES)

Agrostis peninsularis Hook., 1,800-2,100 m, Kodanad, Nanjanad, Sispara; insufficiently collected and possibly rare, according to Bor.

Agrostis pilosula Trin. var. *filifolia* Bor, 1,800-2,300 m, little known.

Agrostis pilosula Trin. var. *pilosula*, 2,000-2,500 m, Doddabetta, Mudimund, Ootacamund, and Sispara.

**Agrostis schmidii* (Hook f.) Bor, 2,400 m, Ootacamund (no specimen in MH).

#*Agrostis stolonifera* L., 2,400 m, Ootacamund; widespread in Europe, Asia, N. America, introduced to the Nilgiris; common, an important fodder grass.

Andropogon lividus Thw., 2,200-2,400 m, purple grass, Kollimund, Mudimund, Ootacamund, Sispara; often in burnt areas, valuable fodder grass.

**Andropogon longipes* Hack., 2,400 m, Ootacamund; hardly known.

**Andropogon polytychus* Steud. var. *deccanensis* Bor, 2,300 m; common perennial around Bison Swamp, in upper Nilgiri marshes, on moister slopes near them; mainly in the far west, the dominating grass in some areas.

#*Anthoxanthum borii* Jain & Pal, 2,000-2,400 m, common, widespread in low-lying ground, especially meadows.

Andropogon odoratum L., 2,400-2,575 m, sweet vernal grass, Doddabetta and Ootacamund; widespread from Europe to temperate Asia, introduced to Nilgiris, sometimes cultivated; has a fragrant odour, can be used as hay, but is not very acceptable to livestock

Apluda mutica L., 1,000-2,400 m, Coonoor, Gudalur, Kundhas, Marappalam-Burliar, Mudumalai, Naduvattam, Ootacamund; common, growing in forests and open country; when young it is good fodder for buffaloes.

#*Aristida adscensionis* L., 850-2,400 m, six-weeks triple awn, Avarihalla R.F., Ketu, Ootacamund, Sirur; widely distributed in Old and New Worlds, but probably introduced to Nilgiris; common and widespread except in the wettest of places; eaten by livestock when young, but avoided when in flower.

Arthraxon lanceolatus (Roxb.) Hochst., 2,400 m, Ootacamund; unknown.

Arthraxon quartianus (A. Rich.) Nash, 1,800-2,400 m, Naduvattam, Ootacamund, Pykara; grows in swampy places, by roadsides, a pioneer on land no longer cultivated; often eaten by livestock.

Arundinella ciliata Nees, 900-2,050 m, Cherambadi, Ebanad, Gudalur-Naduvattam, Kotagiri-Aravenu, Pakasuramalai; on slopes by rocky edges.

Arundinella mesophylla Nees ex Steud., mainly above 1,200 m, Bikkapattimund, widespread, especially east of Doddabetta; on bare slopes by rocky edges.

**Arundinella purpurea* Hochst. var. *laxa* Bor, 2,100 m, Sispara, very distinctive and with long pedicels.

**Arundinella purpurea* Hochst. var. *purpurea*, 2,000-2,100 m, Avalanche, Mukerti, Pakasuramalai, Pykara; thus far the only aluminum accumulator known in this family; good fodder grass.

Arundinella setosa Trin. var. *lanifera* Fisch., 1,200-2,400 m., Gudalur Ghat, Naduvattam, Ootacamund, Pykara; a widespread, very variable species, fairly common, good for fodder.

**Arundinella setosa* Trin. var. *nilagiriana* Subbarao et Kumari, 1,850 m, at Koilbetta, near Ebanad; like *A. s. var. lanifera*, but has hirsute glumes instead.

Arundinella vaginata Bor, 600 to 2,100m, with long, villous, basal sheaths; sometimes abundant, on grassy slopes, in marshes.

Arundo conspicua Forst., 2,400 m, Ootacamund; virtually unknown.

#*Avena sativa* L., 2,200 m, Nanjanad; oats introduced from Europe, first a weed there alongside barley and wheat, then domesticated around 1,000 BC; now marginally cultivated in the Nilgiris and often a weed.

#*Avena sterilis* L., 2,400 m, Ootacamund; seldom cultivated, and mainly a weed introduced from the Mediterranean.

#*Axonopus affinis* Chase, 1,000-1,660 m, Coonoor Ghat, Oucherlony Valley; carpet grass introduced from the New World, excellent for fodder.

Bothriochloa bladhii Retz, 2,400 m, Ootacamund; somewhat coarse and good for fodder.

Bothriochloa foulkesii Henr., 1,900-2,400 m, Mudimund, Ootacamund, Porthimund, Pykara; near water and in marshes.

#*Bothriochloa insculpta* A. Camus, 1,650-2,400 m, Kateri Falls, Naduvattam, Ootacamund, Pakasuramalai, Pykara; common on downs; from tropical East Africa, it now grows over the Western Ghats and is used for fodder.

Brachiaria semiundulata Stapf, 1,200-2,00 m, Coonoor, Naduvattam, Nanjanad, Ootacamund, Oucherlony Valley, Pykara; common, on exposed slopes, with large glabrous spikelets.

#*Brachypodium sylvaticum* P. Beauv., 1,800-2,400 m, perennial slender grass, Coonoor, Naduvattam, Ootacamund, Pakasuramalai, Pykara; grows in Europe and on temperate mountains in tropical Asia, but was probably introduced to the Nilgiris.

- #*Briza maxima* L., 1,800-2,500 m, large quaking grass, Doddabetta, Naduvattam, Ootacamund, Pykara, Upper Bhavani; common, from the Mediterranean, but an escape.
- #*Briza minor* L., 1,800-2,400 m, small quaking grass, Coonoor, Naduvattam, Ootacamund, Pykara; common, also introduced from the Mediterranean.
- #*Bromus arvensis* L., 2,400 m, Ootacamund; Hubbard — cultivated for hay on poor soils in Europe; introduced to the Nilgiris and now growing wild.
- # *Bromus catharticus* Vahl., 1,900-2,400 m, Coonoor, Ootacamund, Upper Tiger Shola; native to South America, introduced as a fodder grass, but now a common escape.
- # *Bromus ramosus* Huds., 1,900-2,400 m, Ootacamund and Pykara; common from Europe into mountains of Central Asia, but was probably introduced into the Nilgiris; grows in shola glades and shady places.
- Capillipedium huegelii* Stapf, 1,200-1,800 m, Kariashola, Naduvattam, Sundapatti; common annual or perennial, wide ranging, often aromatic.
- Chrysopogon hackelii* Fischer, 1,000-1,800 m, Gudalur-Nadugani, Naduvattam; a common, robust grass of mountainous areas.
- Chrysopogon orientalis* A. Camus, 1,000-1,800 m, Ebanad, Gudalur, Naduvattam; common, conspicuous owing to its bright red and purple glumes, eaten by livestock.
- Chrysopogon verticillatus* Trin., mainly above 1,200 m, in mountains of Tamil Nadu and Orissa; stout, hardly acceptable to livestock when fully grown, but commonly eaten when young.
- Chrysopogon zeylanicus* Thw., 1,800-2,400 m, Aravankadu, Avarihalla R. F., Kotagiri, Naduvattam, Ootacamund, Pakasuramalai, Parkside R.F., Pykara, Sispara; large, with green and purple spikelets, widespread and common on the downs, higher peaks.
- Coelachne perpusilla* Thw., 2,300 m, Porthimund, may be common; very delicate and trailing marshland lover.
- #*Cortaderia selloana* Asch. & Graebn., 2,400 m, Pampas grass, Ootacamund; an ornamental from South America.
- Cymbopogon flexuosus* Wats. var. *flexuosus* Bor, 700-2,400 m, Burliar, Coonoor, Gudalur-Naduvattam, Mudumalai, Ootacamund, Pakasuramalai, Pykara; common tall (1.5m) perennial, the source of lemon grass oil, sometimes cultivated.
- Cymbopogon martinii* Wats., 1,900 m and below, geranium grass, Pykara; a common perennial, sometimes cultivated for rusa oil in two forms: 1) motia, palmarusa oil and 2) sofia, ginger grass oil.
- Cymbopogon nardus* Rendle var. *confertiflorus* Stapf ex Bor, 800-1,500 m, tall (1.5 m) wild citronella grass, sometimes cultivated; mainly on outer eastern Nilgiri slopes, sometimes dominating on savannas.
- Cymbopogon polyneuros* Stapf, 1,900-2,500 m, Doddabetta, Mukurti, Ootacamund, Pykara; also tall (1.5m), with oil having a pleasant odour, but not used commercially.
- Cynodon dactylon* Pers., 1,400-1,900 m, Bermuda or dog's tooth grass, now worldwide and a troublesome weed in more than 80 countries; Ebanad, Ouchterlony Valley, and Pykara; a common perennial creeping grass, highly nutritious, especially for horses; as a lawn grass it can withstand only moderate grazing.
- Cyrtococcum deccanense* Bor, 1,600-1,700 m, Coonoor, Gudalur Ghat, Kateri Falls; loves damp places, grows well in shade.
- Cyrtococcum longipes* A. Camus, 800-1,800 m, Carcoor Ghat and Naduvattam; in damp and shady places.
- # *Cyrtococcum patens* A. Camus, 800-2,050 m, Pakasuramalai and Segur; widespread in Southeast Asia, probably introduced to the Nilgiris.

#*Dactylis glomerata* L., 2,100-2,400 m, only species in the genus, Nanjanad and Ootacamund; perennial grass in North Africa, Europe, and temperate Asia; introduced, important fodder grass on Government hill farms, now a common escape

Dichanthium oliganthum (Steud.) Cope, 1,900-2,100 m, Avalanche, Bikkapattimund, Mudimund, Naduvattam, Pykara, Sispara; widespread, roadsides, grassy slopes; whole plant villous, with a very aromatic and volatile scent.

**Dichanthium pallidum* (Hook f.) Stapf ex Fisch., elevational factors unknown, rare and collected by Foulkes (no specimen in MH).

Digitaria ciliaris Koel., 850-2,100 m, Anaikatti, Benne R.F., Deepdale R.F., Gudalur, Nanjanad, Northern Hay R.F., Pakasuramalai, Sirur-Ebanad; pan-Tropical weed, common, good fodder grass, alongside roads and on open ground.

Digitaria longiflora Pers., 1,000-2,000 m, Aravankadu, Gudalur, Kunnacombai R.F., Pakasuramalai; another pan-Tropical weed, common creeping grass alongside roads and in open spaces, often eaten by livestock.

Digitaria temata Stapf, 2,100-2,400 m, Nanjanad and Ootacamund; in the wild from Africa to the Far East, common in wastelands, but with little fodder value; a handsome grass with silver racemes and purple fruits.

Digitaria wallichiana Stapf, 1,200-2,200 m, Gudalur Ghat, Kunnacombai R.F., Naduvattam, Ootacamund, Pakasuramalai; commonly eaten by livestock.

#*Ehrharta abyssinica* Hochst., introduced from Africa, collected by Schmidt in about 1830; little is known about it in the Nilgiris.

#*Eleusine coracana* Gaertn., 1,200-1,900 m, still grown widely by the Badagas finger millet cultivated in Africa for over 5000 years and introduced to India about 3000 years ago; harvested grain stores well for a long time, stalks also provide hay for livestock.

Eleusine indica Gaertn., 1,000-2,000 m, Mudumalai and Parkside R.F.; spread from India and now a noxious weed worldwide; annual, rapidly colonizing open spaces, and thus a good soil binder.

Eragrostis gangetica Steud., 850-2,400 m, Anaikatty, Coonoor, Kilkotagiri, Kotagiri, Kunnacombai, Naduvattam, Ootacamund, Pakasuramalai, Parkside R.F., Segur; common annual also spreading in stream beds, eaten by cattle but not good for fodder.

Eragrostis nigra Nees ex Steud., 1,550-2,575 m, Carrington-Kinnakorai, Coonoor, Doddabetta, Kunnacombai R.F., Naduvattam, Ootacamund, Pykara, Sirur-Ebanad, Upper Bhavani; widely common, growing on exposed rocks and in wastelands.

Eragrostis pilosa P. Beauv., 1,800-2,400 m, hairy or Indian love grass, Naduvattam, Ootacamund; common, grazed in some areas but rejected by livestock in others.

Eragrostis tenuifolia Hochst. ex Steud., 1000-2400 m, Gudalur, Kunnacombai R.F., Ootacamund, Pykara; common weed, seeking fallow earth.

Eragrostis unioides Nees ex Steud., 950-2,400 m, Avalanche, Bikkapattimund, Bokkapuram R.F., Coonoor, Ebanad, Gudalur Ghat, Kunnacombai, Mudumalai, Nanjanad, Naduvattam, Ootacamund, Pakasuramalai; common and widely distributed, sometimes growing in water or damp places.

**Eriochrysis rangacharii* Fisch., at 1,830 m, fairly common near Pykara; only Indian representative of an otherwise wholly tropical African and American genus.

Eulalia phaeothrix O. Ktze., 1,500-2,200 m, Kotagiri, Mudimund, Pakasuramalai, Pykara, Sirur-Ebanad; common on the downs, sometimes a dominant.

Festuca ovina L., 2,400-2,575 m, sheep's fescue, Doddabetta, Ootacamund; worldwide temperate and tropical mountains; a hardy and wiry grass relished by sheep.

Gamotia arundinacea Hook., 1,000-1,900 m, Balmadies Estate, Coonoor, Gudalur, Kateri Falls, Naduvattam, Upper Tiger Shola; trailing grass fond of shady places.

Gamotia courtallensis Thw., 1,500 m and above, Adderly Estate; common, in shady woods and nullahs (valleys), on moist ground or attached to rocks.

Gamotia schmidii Hook., 1,400 m, little known perennial with flattened leaf sheaths.

#*Glyceria spicata* Guss., 1,650-2,400 m, Kateri Falls, Nanjanad, Ootacamund; from the Mediterranean and now wild; floating meadow grass, thus seeking wet areas.

Helictotrichon asperum Bor, 1,800-2,500 m, Doddabetta, Kodanad, Mudimund, Naduvattam, Ootacamund, Pykara; common and widespread.

**Helictotrichon polyneurum* (Hook.) Henr., 2,400 m, Doddabetta (Gamble 12993); fairly common, a distinctive looking grass.

Heteropogon contortus P. Beauv., 910-2,400 m, spear grass, Avarihalla R.F., Kodanad-Kotagiri, Ootacamund, Sirur-Ebanad; common, widespread, colonising in wasteland and on the downs, grazed upon when young.

#*Hordeum vulgare* L., mostly above 1,700 m, barley, once widely grown by the Badagas but now very limited in its cultivation. Cultivated in the Middle East before 6000 BC and spread in India after 3000 BC.

Isachne bourneorum Fischer, 1,200-2,500 m, Doddabetta, Gudalur Ghat, Naduvattam; endemic to the Western Ghats; in sholas, rock crevices, on bare slopes.

Isachne deccanensis Bor, 2,440 m, on downs near Ootacamund (no specimen in MH); endemic to the Nilgiris and Palnis.

Isachne elegans Dalz., 1,500-2,400 m, Ootacamund; possibly rare in the Nilgiris, in marshes and moist places.

Isachne globosa Kuntze, 1,000-2,025 m, Coonoor, Ebanad-Anaikatty, Gudalur, Kottaicombai, Pykara; common grass in wet places, gregarious in marshes, readily grazed by livestock; also a troublesome weed in rice fields at lower elevations.

Isachne kunthiana Miq. var. *kunthiana* Bor, 1,900-2,500 m, Avalanche, Doddabetta, Mudimund Kothaban R.F., Ootacamund, Pakasuramalai, Pykara, common in high south Indian marshes.

Isachne kunthiana Miq. var. *latifolia* Hook., 1800-2400 m, Avalanche, Naduvattam, Ootacamund; also common in high altitude marshes.

**Isachne oreades* (Domin) Bor, close to 1,200 m, only in the Gudalur Ghat area, recorded in a swamp within shola.

Isachne walkeri Wight & Arn., 1,800-2,025 m, Carrington-Kinnakorai, Coonoor, Pakasuramalai; a tall perennial grass, common in high Nilgiris.

Ischaemum commutatum Hack., 1,800-2,400 m, Coonoor, Naduvattam, Nanjanad, Ootacamund, Pykara; widely distributed, growing on stream banks and on steep slopes.

Ischaemum indicum Merrill var. *indicum*, 1,000-2,400 m, Bikkatti, Ebanad-Anaikatty, Mudumalai, Kunnacombai-Kundah, Ootacamund, Pakasuramalai, Pykara; sometimes the most common grass on open downs.

Ischaemum nilagiricum Hack., 950-2,000 m, Coonoor, Gudalur-Nadugani, Kalhatti, Kolikarai, Northern Hay R.F., Runneymede, Sirur-Kukkal; often by streams.

Ischaemum timorense Kunth, 700-1,500 m, Gudalur Ghat, in damp places and eaten by livestock.

Jansenella griffithiana Bor, 1,600 m, only species in this genus of India-Burma (Myanmar), Naduvattam; common, on marshes, stream banks, grassy peaks, grazed by livestock.

Leersia hexandra Sw., 2,400 m and far below, throughout Tropics, Ootacamund; common perennial in a variety of moist habitats, often forming extensive colonies; eaten by cattle and buffaloes.

- #*Lolium perenne* L., 2,400 m, introduced worldwide and to Ootacamund; widespread naturally from Europe to temperate Asia, cultivated perennial rye grass and now an escape; valued for grazing and hay, but can be poisonous when infected by fungi.
- #*Lolium temulentum* L., 2,100 m, Nanjanad; genetically developed introduction native to the Mediterranean, now an escape; a weed in cultivated areas, its seeds when infected with a fungus can poison livestock.
- #*Miscanthus nepalensis* Hack., 2,000-2,400 m, Ketu, Ootacamund; introduced from the Himalaya or northeast India; a tall ornamental perennial.
- Oplismenus compositus* P. Beauv., 1,100-2,400 m, Gudalur Ghat, Naduvattam, Nonesuch Estate, Ootacamund, Pakasuramalai, Sirur-Ebanad; perennial, common in moist places within sholas, sometimes in gregarious patches.
- Oplismenus undulatifolius* P. Beauv., 1,875-2,400 m, Avalanche, Ootacamund, T. R. Bazaar; a shola grass.
- Panicum gardneri* Thw., 1,000-2,025 m, Carriot shola, Coonoor, Naduvattam, Sholurmattam; common in sholas, a silvery hyaline margin of glumes and lower lemma is diagnostic.
- #*Panicum maximum* Jacq., 2000-2400 m, Guinea grass, Bengalmattam, Ootacamund; from Africa; commonly cultivated for fodder, an occasional escape.
- #*Panicum repens* L., 1,900-2,00 m, Coonoor, Manjanakora, Ootacamund, Pakasuramalai, Pykara; torpedo grass throughout tropics and subtropics and one of the most widely distributed grasses in the world, in all kinds of habitats, but prefers perennially moist places; sometimes a pest in cultivated fields.
- #*Panicum sumatrense* Roth et Schult., straddling 1,200 m, once cultivated widely by the Badagas for grain and fodder, but now in great decline; little millet, once identified as *miliare* Lam., progenitor a mystery, was a very ancient cultivar from China into Europe.
- Paspalum canarae* Steud., 1,800 m, Naduvattam; common annual, in sandy, moist places.
- #*Paspalum dilatatum* Poir, 1,800-2,400 m, Dallis grass, Carrington, Coonoor, Naduvattam, Ootacamund; introduced from South America; an excellent pasture grass, important for fodder, can withstand grazing and moderate frost.
- #*Paspalum scrobiculatum* L., 600-1,900 m, Pakasuramalai, Pykara, lower eastern and southern slopes; koda or kodra millet, common wild perennial throughout India to 1,600 m, is seldom cultivated now; as a cultivar, seen only among the Kurumbas; often grows wild in wasteland and moist places, grazed by livestock; seedheads liable to ergot infection, making them poisonous.
- #*Pennisetum clandestinum* Hochst., 2,100-2,400 m, Kikuyu grass, Nanjanad, Ootacamund; introduced from eastern Africa in 1926; vigorous, stoloniferous growth; good pasture and fodder grass, used for lawns and as a soil binder on slopes; now a widespread escape.
- #*Pennisetum villosum* R. Br., 2,400 m, Ootacamund; introduced from the Middle East, now growing wild as well; frequently raised as an ornamental.
- #*Phalaris aquatica* Cent., 2,400 m, Ootacamund; native to the Mediterranean, but introduced and cultivated as a pasture grass.
- Poa annua* L., 1,900-2,400 m, annual meadow grass, Aravenu, Coonoor, Ketu, Nanjanad, Ootacamund; fairly common, growing widely in India at higher elevations.
- **Poa gamblei* Bor, above 2,500 m, and therefore on the highest peaks; fairly common.
- #*Rhynchelytrum repens* C. E. Hubb., 1,450 m, Kateri-Kundah; native of tropical Africa, introduced to gardens and now an escape; not a fodder grass.
- Rottboellia exaltata* L., 1,675m, Sirur-Kukalthorai; widely distributed annual, in moist places, provides hay.
- Sacciolepis indica* A. Chase, 1,650-1,925 m, Avalanche, Ebanad-Sirur; Kateri Falls, Ketu, Kodanad; common grass in marshy places, sometimes up to 1 m tall.

Sehima nervosum Stapf, 1,850 m, Ebanad; locally common perennial grass, in dry, sandy, rocky places; good for fodder.

Setaria glauca (L.) P. Beauv., 1,000-2,400 m, Anaikatty, Benne R.F., Devarshola, Doddabetta, Edapalli, Kottai combai, Kunnacombai R.F., Mudumalai, Mukerti, Ootacamund, Pakasuramalai, Pykara, Sirur-Kukkal; fairly common, widely distributed, an acceptable fodder grass.

Setaria italica (L.) P. Beauv., mostly above 1,100 m, once widely cultivated by the Badagas but now in great decline; foxtail millet, progenitor not firmly established, a sacred plant in China by 2,700 BC, and a very early cultivar over a vast region into Europe.

Setaria tomentosa Kunth., 950-2,010 m, Gudalur Ghat, Kundah, Kunnacombai, Kunjapanai, Northern Hay R.F.; widespread in the plains; at higher elevations in ditches near roads, mostly in moist and shady places.

Sporobolus diander (Retz.) P. Beauv., 1,000-2,400 m, Benne R.F., Carrington, Coonoor, Gudalur, Mudumalai, Ootacamund; good pasture grass.

Sporobolus piliferus Kunth, 1,900 m and lower, Bikkapattimund, Coonoor; often colonises broken ground and is grazed by livestock.

Themeda quadrivalvis O. Ktze. var. *quadrivalvis*, 1,500-2,400 m, Anaikatty-Ebanad, Ootacamund; widely distributed, preferred by buffaloes.

Themeda triandra Forsk., 1,000-2,400 m, widespread in grassy areas, very common perennial in the Old World tropics and subtropics; good for grazing livestock when young.

Tripogon bromoides Roem. & Schult., 1,600-2,400 m; common on rocky surfaces, walls, and in crevices.

Tripogon capillatus Jaub. & Spach, 900-1,300 m, widespread in the Western Ghats; often epiphytic amidst the mosses of shola trees and on old walls.

Tripogon jacquemontii Stapf, 2,200-2,600 m, Coonoor Peak and higher; often gregarious, in barren places.

Tripogon wightii Hook., 1,000-1,800 m, endemic to southern India.

Triticum spp. 1,200-2,200 m, once widely cultivated and now rarely so; wheat greatly in need of study, with varieties introduced by the British; domesticated by 6,500 BC in the Middle East.

Vulpia megalura Rydb., 2,400 m, North American grass, now growing near Ootacamund.

Vulpia myuros Gmel., 2,000-2,500 m, mouse-tailed fescue, Doddabetta, Ketu, Nanjanad, Ootacamund, Pykara, Upper Bhavani; widespread from Europe into temperate Asia; introduced, now runs wild and grows as a weed in cultivated areas.

Zenkeria elegans Trin., 1,700-1,930 m, Aravenu-Kotagiri, Bokkapuram R.F., Coonoor, Kodanad R.F., Mandalore R.F.; little known perennial, widespread in southern India; first recorded for the Nilgiris by Gamble.

Zenkeria stapfii Henr., above 1,200 m, southern India and Sri Lanka; earliest record in the Nilgiris by Perrottet and little known there.

Appendix 2: Nilgiri Plants in their International (Generic) and Local (Species) Environmental Settings

The following lists are greatly modified revisions based upon nuclear data and organization in Blasco and Thanikaimoni (1974), Gupta (1971, 1989), Mani (1974), Meher-Homji (1967, 1975), Menon (1966-67), Shankarnarayan (1958), and Vishnu-Mittre and Gupta (1972). The floras by Fyson (1932), Gamble (1967), Mathew (1999), and Sharma *et al.* (1977) were constantly referred to. The international distributions of plant genera were found in Shaw and Willis (1973). There was no attempt to make the lists complete, but an effort was made to cover representative families and genera of plants of the Nilgiris. Different groups of plants focused upon in suggestive listings enable us to consider how the overall vegetation of the Nilgiri upland island has varied through time, and to think about the significance of specific plants in the region. Because they play such a significant role in making the Nilgiris botanically distinctive, there is more coverage of the balsam, orchid and strobilanthes plants.

Note: The number within parentheses following the genus represents the number of species of that genus being covered.

NON-GRASS SPECIES ON GRASSLAND

Some plants and their ancestors probably spread in during the Pleistocene:

ACANTHACEAE

Justicia (300, tropics and subtropics): *latispica*, *nilgherrensis*, *simplex*, herbs growing widely in Indo-Malaya and Ethiopia, common in open grassland of the downs.

BUXACEAE

Sarcococca (about 20, Himalaya to China, Taiwan, and the Philippines): *trinervia*, shrub, very common all over the downs, also on Eastern Ghats.

CAMPANULACEAE

Campanula (300, North Hemisphere, temperate, especially the Mediterranean and tropical mountains): *fulgens*, herb, also in Khasi Hills, Nepal, Sikkim.

CAPRIFOLIACEAE

Lonicera (200, North America, Eurasia, Africa, Himalaya, to Malaysia and the Philippines): *ligustrina*, untidy shrub, also in Nepal, Khasi Hills.

CARYOPHYLLACEAE

Stellaria (120, cosmopolitan): *media* and *saxatilis*, herbs, now common weeds, on grasslands as well.

CHENOPODIACEAE

Chenopodium (about 150, temperate parts of the world): *ambrosioides*, erect or prostrate herb, a common weed, Nilgiris and Shevaroy.

COMPOSITAE

Artemisia (400, mainly in temperate Northern Hemisphere, common in northeast China, western US and on Russian steppes; South Africa, South America): *vulgaris*, tall aromatic herb, shrub, South Indian mountains to Himalaya; apparently truly wild in Nilgiris though commonly cultivated.

Cnicus (about 150, mostly in northern temperate climates): *wallichii*, Common Indian Thistle with stem over 1 m high, open downs, flowers in June, from Himalaya — Nepal, Sikkim and Bhutan.

Senecio (up to 3000, cosmopolitan, varied: climbers, xerophytes, succulents, herbs, shrubs, to trees): *corymbosus*, climber on downs; *lavandulaefolius*, herb on open downs; *wightii*, swamp ragwort, also growing in Khasi Hills.

CRUCIFERAE

Cardamine (160, cosmopolitan, but chiefly temperate): *hirsuta*, Hairy Bitter-cress, annual herb, common on the downs, generally in all temperate Eurasian countries, including England, and all temperate parts of India.

CYPERACEAE

Carex (up to 2000, cosmopolitan, especially in temperate parts of the world, with many alpine and marsh dwelling species): *lindleyana*, herb, sedge, on exposed dry land, Sri Lanka to Khasi Hills, China, Japan; *nubigena*, another sedge, in damp places, not in water, widespread, Malaya, China, Japan, Sri Lanka, Western Ghats to Khasi Hills, Himalaya.

DIPSACACEAE

Dipsacus (86, in Eurasia, especially in the Mediterranean, tropical Africa): *leschenaultii*, teasel, a large herb on the downs.

DROSERACEAE

Drosera (100, tropical and temperate, especially Australia and New Zealand), with enfolding sticky leaves enabling plants to ingest trapped insects): *burmanii*, Common Sundew, all India, tiny herb in damp places, widespread in Nilgiris; *peltata*, moon-leaf sundew, all India, tiny herb, everywhere on damp Nilgiri downs.

ERIOCAULACEAE

Eriocaulon (400, tropical and subtropical, c. 30 in Japan and c. 8 in North America, with *septangulare* in eastern US and the Scottish Hebrides): *collinum*, Hat-pin Flower or small grey-head, small herb, common in wet places, South India and Sri Lanka.

GENTIANACEAE

Exacum (40, palaeotropical, at least 20 in India): *perrottetii* and *wightianum*, both herbs.

Gentiana (400, cosmopolitan, excluding Africa, chiefly alpine): *pedicellata*, common herb on Nilgiri downs, also in Himalaya (Kashmir to Bhutan), Khasi Hills to Java and China.

GERANIACEAE

Geranium (400, cosmopolitan, especially temperate parts of the world): *nepalense*, Crane's Bill, common herb on downs, Kashmir, Himalaya and Khasi Hills.

GUTTIFERAE

Hypericum (400, in tropical and temperate mountains): *mysorensis*, St. John's Wort, shrub on grasslands, abundant everywhere on the downs, especially on poorer soils, sometimes covering entire slopes, only in South Indian mountains.

HAEMODORACEAE

Ophiopogon (20, Himalaya to Japan and Philippines): *intermedius* [founded on a Nepal plant and indistinguishable from it?], Lily of the Wood, herb, at lower levels, Kotagari included, Western Ghats, Himalaya and Khasi Hills.

HYPOXIDACEAE

Curculigo (10, tropical up into temperate mountain regions): *orchioides*, Yellow Ground Star, small perennial herb in moist places, Himalaya, Khasi Hills and Western Ghats.

Hypoxis (100, Africa, Indo-Malaya, East Asia, Australia, America): *aurea*, small herb scattered in grasslands, Kashmir to South India, Java, China and Japan.

Molineria (7, Indo-Malaya): *trichocarpa*, another small herb, common on the higher downs, especially in loosened soil areas.

LABIATAE

Micromeria (100, cosmopolitan): *biflora*, Lemon-scented Thyme, herb, common over higher grassy slopes, Himalaya, Kashmir to Bhutan and on higher mountains of South India; *capitellata*, has taller stem and larger leaves, western Himalaya to mountains of South India.

Teucrium (300, cosmopolitan, but especially the Mediterranean): *wightii*, thick stemmed herb in rocky places on higher downs.

LENTIBULARIACEAE

Utricularia (120, tropical and temperate regions, all in the latter being aquatic; many species remarkable for small bladders which trap and then enable digestion of small creatures): *graminifolia*, Common Blue Bladderwort; *scandens*, Yellow Bladderwort, both common small herbs in marshes within the downs.

LILIACEAE

Lilium (80, mainly in northern temperate regions): *nilgherrense*, the Nilgiri Lily, once common on downs, stems to 1 m, white flowers, only in extreme southern India — Anamalai, Biligirirangan, Nilgiri, Palni and Tinnevely Hills.

LOBELIACEAE

Lobelia (about 250, cosmopolitan, mostly tropical and subtropical, especially America; giant lobelias in Africa and Asia): *leschenaultiana*, giant lobelia, biennial subshrub with pale yellow flowers, common everywhere, higher grasslands as well, but also in shola fringes; Sri Lanka, Indian Peninsula into Southeast Asia.

OLEACEAE

Ligustrum (about 50, Europe to northern Iran, East Asia, Indo-Malaya to New Guinea and Australia): *perrottetii*, privet, usually a shrub but a tree in eastern areas, in clumps on the western downs, doing well near water.

ORCHIDACEAE

The international distributions of the genera in this section are provided later under Shola Species.

Aerides crispum, an epiphyte in sholas, especially near Coonoor, called the Pink Rock Orchid because it is so often seen growing on exposed rocks, Western Ghats, Palnis as well.

Habenaria cephalotes, *heyneana*, and *longicomulata*, ground orchids amidst grasses.

Peristylus richardianus and *spiralis*, ground orchids, widespread on grasslands.

Satyrium nepalense, ground orchid, on grasslands and in marshes, abundant during westerly monsoon; widespread from Sri Lanka northward to the Himalaya and east into Burma.

Spiranthes sinensis, Lady's Tresses, terrestrial orchid, on open dry grasslands and in swamps; *sinensis* var. *wightiana*, especially in the Kotagiri area.

PAPILIONACEAE

Crotalaria (550, 100 undescribed?, at least 80 in India, tropics and subtropics, variable — procumbent creepers, to erect herbs, to shrubs and trees), genus named after the way seeds rattle in ripened pods [Gk. *krotalon* = a child's rattle]; on the higher downs, these species are liable to be encountered with attractive yellow flowers: *leschenaultii*, small bush with long flower spikes; *scabrella*, procumbent herb to shrub with flower spikes; *wightiana*, bushy shrub with rising flower spikes.

Indigofera (700, warm parts of the world, but especially South Africa): *cassioides*, shrub on open downs; *pedicellata*, common prostrate herb on higher downs; both species in Peninsula mountains, including the Western Ghats.

Sophora (50, tropical and warm temperate regions): *glauca*, shrub on downs, and especially on drier hillsides; mountains of South India, but not in the Palnis or Maharashtra State.

POLYGALACEAE

Polygala (about 550, cosmopolitan, excluding New Zealand, Polynesia and the Arctic): *sibirica*, milkwort, a common herb on the higher downs, sometimes dominant, Mudimund and Ootacamund; Himalaya, Kashmir eastward to Khasi Hills, China, Siberia and Japan.

PORTULACACEAE

Portulaca (200, tropics and subtropics): in Nilgiris(?), none now.

PRIMULACEAE

Lysimachia (200, cosmopolitan, especially East Asia and North America): *candida* subsp. *obovata*, a slender herb amidst grasses; *deltoides*, in Kundah grasslands; *leschenaultii*, small perennial herb, on higher downs, prefers open marshy meadows; *procumbens*, creeping Jenny, a trailing herb, closely allied to a European species.

RANUNCULACEAE

Anemone (150, cosmopolitan): *rivularis*, a perennial herb, all over the Nilgiris, luxurious in damp places and dwarfed with dryness, to 4,000 m in Sikkim.

Ranunculus (400, cosmopolitan, temperate and cold regions, tropical mountains): *reniformis*, a common perennial herb in damp places on open downs, showy bright yellow flowers, only in mountains of south India.

RHAMNACEAE

Rhamnus (110, cosmopolitan): *virgatus*, Indian Buckthorn, spiny and stunted shrub, uncommon in upper Nilgiris; in temperate Himalaya and from China to Japan.

ROSACEAE

Cotoneaster (50, mainly North Hemisphere, temperate regions): *buxifolia*, small tree to shrub, hard and tough wood, sometimes amidst grasses; in Western Ghats and Palnis.

Potentilla (500, nearly cosmopolitan, but mostly in Northern Hemisphere, temperate to Arctic areas): *leschenaultiana*, herb, yellow flowers, common in open grassland; *sundaica*, herb, bright yellow flowers, higher grasslands, especially in moist areas.

Rosa (250, Northern Hemisphere, temperate realms and tropical mountains): *leschenaultiana*, Nilgiri Dog Rose, abundant and often found in shola fringes as well.

Rubus (250, cosmopolitan, especially in temperate areas of Northern Hemisphere, with about 3000 segregates and forms of *fruticosus*, the Blackberry): *ellipticus*, Yellow Raspberry, in Western Ghats but not Maharashtra, also in temperate - tropical Himalaya, Khasi Hills, Burma and Yunnan; *rugosus*, Purple Raspberry, rare on Bombay Ghats, but in Himalaya, Nepal, Sikkim, Burma and Malaya; both species widespread on downs and in shola borders.

SANTALACEAE

Osyris (6 or 7, Mediterranean and Africa to India): *wightiana*, evergreen shrub on open downs and in sholas, only in higher mountains of India and Sri Lanka.

Thesium (325, Europe, Africa and Asia to Australia): *wightianum*, yellow procumbent perennial herb, parasitic on roots of other plants, common in higher grasslands.

SCROPHULARIACEAE

Pedicularis (500, mostly Northern Hemisphere, especially in mountains of Central and East Asia): *perrottetii*, Nilgiri Lousewort, perennial herb, remarkable for its large white flowers to 10 cm, mainly in the Kundah grasslands, seen in the vicinity of Avalanche, Mukerti and Nilgiri peaks, also in the Anamalais, not the Palnis; *zeylanica*, Pink Rattle, perennial herb, semi-parasitic, red flowers, in damp places on higher grasslands, near Kotagiri and Ootacamund, only in Sri Lanka and South India mountains, Palnis included.

SOLANACEAE

Solanum (1,700, tropical and temperate regions): *violaceum* subsp. *multiflorum*, prickly low bush, common on the downs, from Ootacamund to Pykara; *wightii*, erect herbaceous plant with large lavender blue flowers, easily seen near Coonoor, also living up to higher downs.

UMBELLIFERAE

Bupleurum (150, Europe, Asia, Africa, and North America): *distichophyllum*, short herb, grass-like, common on higher downs; *mucronatum*, common hare's ear, stout, branched herb, also over downs; *plantaginifolium*, Giant Hare's Ear, tall perennial herb to over 1 m high, only in mountains of South India, on Doddabetta, Elk Hill and Snowdon.

Heracleum (70, temperate areas in Northern Hemisphere and tropical mountains): *candolleum*, large leafy herb, common on higher grasslands; *ceylanicum*, tall herb, attractive Queen Anne's lace with white flowers, in the higher low-lying marshes, spreading during monsoonal rains, and on the highest peaks; *hookerianum*, erect herb with leaves flat on the ground, widespread in higher grasslands and on to highest peaks; *rigens*, tall herb, common on drier high grasslands.

Pimpinella (150, Africa, Eurasia, 1 sp. Pacific North America, a few in South America): *candolleana*, Cow Parsnip, common herb on open downs, crushed leaves faintly smelling of anise, Nilgiris and Palnis.

VALERIANACEAE

Valeriana (over 200, Eurasia, South Africa, temperate North America, Andes): *hookeriana*, herb, common on higher downs; *leschenaultii*, herb, also on highest downs, Doddabetta to Lakkadi and Pykara.

VIOLACEAE

Viola (500, cosmopolitan, chiefly northern temperate regions, but many in the Andes): *hamiltoniana*, Marsh Violet, prefers wet areas; *betonicifolia* subsp. *betonicifolia*, Spear-leaved Violet, amidst grasses; *pilosa*, Common Wood Violet, in sholas as well; all small perennial herbs on the downs.

XYRIDACEAE

Xyris (250, tropical and subtropical, but mostly American): *capensis* var. *schoenoides*, common herb in sunny and moist areas within grasslands, Nilgiris, Palnis and Shevaroy.

NOTE: BECAUSE SOME OF THE PLANTS OR THEIR ANCESTORS MAY HAVE COME FROM MADAGASCAR BEFORE THE INDIAN PENINSULA SPLIT AWAY AND MOVED NORTHWARDS IN THE CRETACEOUS PERIOD, THE WORD MADAGASCAR SUGGESTS A POSSIBLE AFFINITY. SOME OF THE PLANTS LISTED BELOW PROBABLY EVOLVED IN THE NILGIRIS.

ACANTHACEAE

Andrographis (20, tropical Asia, mostly in India): *affinis*, *neesiana*, *producta*, subshrubs, widespread on Nilgiri grasslands, often abundant in steep, rocky places; Nilgiris a center of evolution.

Strobilanthes (over 400, Asia, Sri Lanka to Japan, the Philippines and Australia, prominently in Western Ghats of India): *kunthianus*, common multi-branched compact shrub to 2 m tall, on open grassland in flowering years, pale blue to mauve flowers, a multiennial with recorded flowerings in approximately 12 year intervals causing spectacular floral displays and its absence during the long intervals; people who have seen flowering Kurunji displays on mountain slopes remember them with awe, in Palnis as well; *sessilis*, small erect herb with stems only 30 to 45 cm tall, blue-purple to mauve flowers, a perennial flowering each year, Ootacamund to Pykara, Avalanche and into the Kundahs, not in Palnis.

ASCLEPIADACEAE

Ceropegia (160, Canary Islands, tropical Africa and South Africa, notably Madagascar, tropical and subtropical Asia): *ciliata*, small herb amid grasses, climber on shrubs, also in Palnis; *elegans*, herb, runs in grass or climbs on to shrubs, mostly east of Doddabetta to Kotagiri, southward from Nilgiris to Sri Lanka; *pusilla*, common, larger herb amid grasses of the downs, roots are called Toda potatoes, also in Anaimalais but not Palnis.

BALSAMINACEAE

Impatiens (about 550, both tropical and temperate, Eurasia and Africa, especially Madagascar and mountains of Sri Lanka, southern India): *chinensis*, Chinese Balsam, herb, stem unbranched to 50 cm tall, opposing leaves, mauve-pink to white flowers, common and widespread all over Nilgiris, also on the downs, but especially in damp places, perhaps the most widely distributed of all the balsams, higher areas in Western Ghats and down to 900 m, Bhutan, Assam, Khasi Hills and eastward to Burma and into China; *tomentosa*, annual erect herb with red-tinged stems, small rose-pink flowers, sometimes abundant in marshes on the downs, also thriving next to streams, widespread, Thalakundah, Pykara and Upper Bhavani — Western Ghats, Palnis as well.

COMPOSITAE

Anaphalis (35, Europe, Asia and Americas), 10 species in Nilgiris, herbs: *aristata*, aromatic flowers and sticky leaves, on downs, in drier places; *lawii*, common everywhere, often on poorer soils; *leptophylla*, white everlasting, in damp places on the downs; *wightiana*, common on downs, in damp and cooler niches.

Youngia (about 40, temperate and tropical Asia; originally from temperate Southeast Asia?): *fuscipappa*, more primitive herb, Avalanche, Sispara and south into Sri Lanka; *japonica* subsp. *genuina*, Japanese Hawk's Beard, herb, Western Ghats to Ashambu Hills in India — Indo-Malaya to Japan and Korea.

CYPERACEAE

Fimbristylis (300, tropical and subtropical, especially Indo-Malaya and Australia): *uliginosa*, common sedge on open downs, Ootacamund to Pykara and on tallest peaks, only Nilgiris and Palnis; look for dew glistening on the white styles in the early morning.

Kyllinga (60, tropical and subtropical, especially Africa): *melanosperma* (or *Carex melanospermus*?), perennial sedge on downs, Ootacamund to Pykara and Upper Bhavani, South Africa and Madagascar, Sri Lanka, Indo-Malaya.

Pycreus (109, tropical and subtropical): *unioloides* var. *angulatus* (or *Carex unioloides*?), sedge, prefers marshes, stem to 1 m, Nilgiris and Palnis.

EUPHORBIACEAE

Glochidion (300, Madagascar and tropical America [few], tropical Asia to Australia and Polynesia [many]): *neilgherrense*, small and untidy tree, male flowers with strong honey scent and female flowers with no scent, common species on downs, but also grows in sholas.

HALORAGACEAE

Laurembergia (4, tropical South America, tropical Africa, Madagascar, Indo-Malaya): *brevipes*, a small marsh herb, widespread on higher downs, Western Ghats, Nilgiris and Palnis; *hirsuta*, hairy herb on damp banks in grassy areas, Doddabetta to Sispara, Western Ghats, Nilgiris but not Palnis.

MELASTOMACEAE

Osbeckia (100, tropics from Africa to Australia; India with a large share of the species): *brachystemon*, small herb, widespread, amidst grasses; *leschenaultiana*, Red Osbeckia with red branches, purple flowers, a common shrub from Ootacamund to Pykara and Sispara.

PRIMULACEAE

Anagallis (28, mainly western Europe, Africa, Madagascar): *arvensis*, Common Pimpernel, widespread on downs, flowers close in dull or cold weather.

RUBIACEAE

Hedyotis (150, tropical Asia): *articularia*, widespread shrub on downs, from Ootacamund to Bangitapal and Mudimund, concentrating near streams; *stylosa*, shrub on downs, Ootacamund to Pykara and Sispara; *verticillaris*, herb on higher western downs, sometimes abundant near streams, plant often stemless and flat on the ground, long parallel-ribbed leaves forming a rosette.

COMMON PLANTS PROBABLY INTRODUCED BY HUMANS

COMPOSITAE

Eupatorium (1200, mostly America, a few in Europe, Asia and Africa): *glandulosum*, Goat Weed or the Curse of the Nilgiris, first introduced to a garden in Ootacamund after 1900, but now an escape all over.

DENNSTAEDTIACEAE

Pteridium (1, cosmopolitan, and thus all over the world): *aquilinum*, bracken, possibly introduced by the British.

OXALIDACEAE

Oxalis (800, cosmopolitan, but mainly Central and South America, South Africa, herbaceous weeds, troublesome in cultivated areas and elsewhere): *latifolia*, from Mexico to Peru, now a widespread escape; *pes-caprae*, native of the Cape of Good Hope and probably introduced early by settling British, now a curse amid cultivated potatoes because of its tubers; *purpurea*, native of South Africa, probably introduced for British gardens in the early 1800s and now a weed in gardens; *spiralis*, from the Chilean Andes, another garden escape; *tetraphylla*, from Mexico, widespread garden escape, most troublesome in gardens.

PAPILIONOIDEAE

Cytisus (about 30, Atlantic Islands, Europe, Mediterranean): *multiflorus*, White Broom, bush, native to Algeria but introduced from the Iberian Peninsula; *scoparius*, Yellow Broom, another bush, introduced from Scotland and England.

Ulex (20, Europe, North Africa): *europaeus*, Common Gorse, probably introduced from Britain.

PLANTAGINACEAE

Plantago (265, cosmopolitan): *lanceolata*, Ribwort Plantain, a scattered weed.

VERBENACEAE

Lantana (150, tropical America, West Indies, tropical Africa and South Africa): *camara*, thorny tropical American shrub, common from plains to 2,100 m, gregarious and typically growing in patches, possibly the most widespread problem plant of India.

SHOLA FRINGE (FOREST — GRASSLAND ECOTONE) SPECIES

ACANTHACEAE

Strobilanthes asper, erect shrub to 6 m tall, purple-white flowers with a strong scent, within sholas but often more abundant in their borders, no defined period for dying off, Oucherlony Valley into the precipitous western edge and higher downs beyond, not in, Palnis; *foliosus*, large gregarious shrub to 4 m tall, sometimes forming extensive masses, with pale blue flowers, often in flower and apparently a perennial, not dying out at set intervals, common in sholas and their borders, Coonoor to Ootacamund, Naduvattam and Sispara, also in Palnis; *urceolaris*, an erect shrub to 1 m tall with long internodes when in sholas, very low shrub with low branching in open grassland, sometimes abundant in borders, pale blue flowers, periodicity of dying remains unknown, near Ootacamund and in higher areas, also in Palnis; *zenkerianus*, gregarious shrub, mauve to pale violet flowers, periodicity of dying remains unknown, thrives within sholas and is locally abundant in borders and out into grasslands, bright green leaves larger on plants in shade, recorded at Coonoor and Doddabetta and mostly living in higher sholas, in Palnis as well.

AQUIFOLIACEAE

Ilex (400, cosmopolitan, except North America): *wightiana*, common tree in sholas, sometimes a dominant, near streams everywhere, flourishes in the open, forming small rounded trees; only on South Indian mountains, recommended for shola regeneration.

BALSAMINACEAE

Impatiens henslowiana, shrub to 2 m high, flowers white tinged pink, gregarious and forming clumps in moist shady places, also in shola borders and alongside streams, only in Sri Lanka and mountains of extreme southern India; *leschenaultii*, common balsam shrub, well-branched and very leafy to 1 m high and taller within darkened shola interiors, white flowers with a pink tinge, flowering year-round, common near Ootacamund within sholas and in their borders, widespread in area and elevation, Doddabetta to Pykara and the Kundahs, down to the Oucherlony Valley, only in the Western Ghats, not the Palnis.

BERBERIDACEAE

Berberis (450, widespread in Eurasia, North Africa, North and South America): *tinctoria*, Common Nilgiri Barberry, within and bordering sholas, variable in size and form, thorny shrub to 3,200 m in the temperate Himalaya.

Mahonia (70, Indo-Malaya, mainly Himalaya to Japan, North and South America): *leschenaultii*, Holly-leaf Barberry, common large shrub in shola borders, higher elevations, closely related to *nepalensis* in the temperate Himalaya.

CAPRIFOLIACEAE

Lonicera (200, North America, Eurasia, South to North Africa, Himalaya, Malaysia, and to Philippines): *leschenaultii*, common, tangled climber, especially abundant in shola borders; *ligustrina*, compact shrub, uncommon, preferring shaded parts of shola borders; both being honeysuckles.

Viburnum (200, temperate and subtropical, especially Asia and North America, 16 in Malaysia): *cylindricum*, common small evergreen tree in shola borders, widely distributed from Sri Lanka to the Himalaya and western China, Southeast Asia; *erubescens*, shrub with forked white-barked branches and crimson leaf stalks, common in shola borders, higher elevations, including Doddabetta and Ootacamund.

COMPOSITAE

Senecio (covered already, see above): *neelgherryanus*, Nilgiri Ragwort, herb, spreading from shola borders into nearby grasslands; *walkerii*, with vines growing up into shola trees bordering grasslands.

Vernonia (1000, America, Africa, Asia and Australia, very common in grassy areas): *bourdillonii*, small shrub; *conyzoides*, sturdy herb; *malabarica*, stout shrub; *pectiniformis*, shrub; while all may grow on grasslands, they commonly thrive in shola borders.

DAPHNIPHYLLACEAE

Daphniphyllum (10, Indo-Malaya to Taiwan and Japan): *neilgherrense*, widespread tree, common in sholas and their borders, but sometimes spreading into degraded open areas nearby; in Sri Lanka, Western Ghats, to Java and Korea as well.

ELAEAGNACEAE

Elaeagnus (45, mainly Northern Hemisphere, Eura to North America): *kologa*, undershrub to climber over tall trees, common in shola borders; mountains of Sri Lanka, Indo-Malaya and China.

ERICACEAE

Gaultheria (200, circum-Pacific and west to western Himalaya and south Indian hills): *fragrantissima*, very common shrub in shola borders, but spreading into grasslands, with leaves crushed for its oil; in Nepal and Bhutan to 2,600 m.

Rhododendron (over 1,000, mainly in northern temperate regions, with South China into the Himalaya being the world's main region of diversity; a lesser centre in North America; about 300 in highland New Guinea): *arboreum* subsp. *nilagiricum*, the ideal small tree coloniser and pyrophyte in the mountains of South India, spreading from sholas and their borders into grasslands.

ICACINACEAE

Gomphandra (33, tropical Asia to Solomon Islands): *coriacea*, small tree or shrub, common within sholas and in their borders.

MALVACEAE

Abelmoschus (15, tropical Africa and Asia, Australia): *angulosus*, Hill Mallow, tall and coarse perennial herb, often near streams, in shola borders, flowering in the coldest months, also spreading on to grasslands, Ootacamund to Kotagiri and below Kodanad; only in higher mountains of Sri Lanka and extreme south India.

MYRTACEAE

Rhodomyrtus (20, in mountains from Sri Lanka to Philippines, New Caledonia and Australia): *tomentosa*, hill guava, bush to small tree, thriving best on to open terrain from shola borders in mountains from Sri Lanka to Singapore.

OLEACEAE

Jasminum (300, Old World tropics and subtropics, over 50 in India, wild jasmine): *bignoniaceum*, erect shrub with bright yellow flowers, near sholas and all over the downs; *breviloban*, large climbing shrub, far up on to tree crowns, with terminal bunches of white flowers; *cordifolium*, shrub climbing up small trees, has large leaves and scentless white flowers; all adapted to shola borders.

POLYGALACEAE

Polygala (about 550, cosmopolitan, excluding New Zealand, Polynesia and the Arctic): *arillata*, Red-eye or Common Milkwort, yellow flowers, abundant shrub in shade of sholas, especially along borders, Coonoor, Kodanad and Ootacamund; at higher elevations from Sri Lanka to Bhutan, southern China and the Philippines.

RANUNCULACEAE

Clematis (250, cosmopolitan, chiefly in temperate regions): *munroana*, gregarious climber with vines reaching up into tree crowns, shola border the ideal niche with solar energy promoting growth, Sispara area; *wightiana*, woody climber with vines forming intertwined masses, Sholurmattam, near Ootacamund and to Avalanche; both only in southern India.

Ranunculus (400, cosmopolitan, temperate and cold regions, tropical mountains): *diffusus*, erect glossy herb with large yellow flowers, in moist exposed ground, stream banks and shola borders; also lives from the Himalaya to Burma and China.

RHAMNACEAE

Rhamnus (110, cosmopolitan): *wightii*, a large shola shrub or tree also growing on the downs, yellow flowers, common in shola borders, widespread over the higher Nilgiris; only in Sri Lanka and southern India.

ROSACEAE

Photinia (60, Indo-Malaya, mainly Himalaya to Japan, North America): *integrifolia* var. *sublanceolata*, large evergreen tree in sholas and smaller on grasslands, a pioneer species inclined to spread out from shola borders.

Potentilla indica, small prostrate perennial herb, yellow flowers and ripened red berries, flowering all year, locally abundant on shola floors, especially in borders and moist places, common all over Nilgiris; Sri Lanka, Western Ghats, Afghanistan, India, Himalaya, east to Malaysia, China and Japan.

RUBIACEAE

Psychotria (700, mostly warm regions): *nilgiriensis* var. *nilgiriensis*, shrub to small tree, at higher elevations, on Doddabetta, common in sholas and spreading from their borders on to the downs; restricted to South Indian mountains.

SAPINDACEAE

Dodonaea (60, widespread in tropics and subtropics, especially Australia): *viscosa* var. *angustifolia*, shrub to small tree, all over India, from plains high into the mountains, increasing in size with upward elevation, in shola borders and out onto drier grasslands.

TERNSTROEMACEAE

Ternstroemia (100, in the tropics): *japonica*, common, evergreen tree to shrub, in sholas and their borders, but also a shade tree on open grassland; in parts of the Western Ghats, but not in the Palnis or Maharashtra, also in mountains from Khasi Hills to Sumatra, China and Japan.

OUT FROM SHOLA BORDERS, THERE MAY BE VARIED MIXES OF FRINGE (FOREST-GRASSLAND ECOTONE) SPECIES AND SHOLA SPECIES TO PRODUCE A TRUE SAVANNA (SABANA) WITH TREES WELL REPRESENTED. HOWEVER, AN ABRUPT SHIFT FROM SHOLA FRINGE TO GRASSLAND IS CHARACTERISTIC OF NILGIRI VEGETATION, AND SAVANNAS THUS TEND TO BE LIMITED IN AREAL EXTENT. WHEN ANNUAL FIRINGS OF LANDSCAPES WERE PREVALENT, FIRE (AND ATTENDANT DEGENERATION OF DAMAGED TREES THROUGH DISEASE) TENDED TO SLOWLY DESTROY TREE SPECIES UNTIL GRASSLAND DOMINATED. BECAUSE RHODODENDRONS WERE SUCH EXCEPTIONAL PYROPHYTES, THEY OFTEN BECAME LONE SENTINELS ON THE GRASSLANDS. THEY COULD EVEN SURVIVE WHEN OVER EIGHTY PERCENT OF THEIR TRUNK DIAMETERS WERE BURNED AWAY BY FLAMES. WITH THE ELIMINATION OF ANNUAL FIRINGS, SAVANNAS OF LIMITED AREAL EXTENT MAY RAPIDLY DEVELOP INTO SHOLAS.

SHOLA SPECIES

ACANTHACEAE

Strobilanthes luridus, extensive straggling giant shrub to 6 m tall, remarkable lurid purple to blue, sometimes white, flowers in erect spikes to 25 cm long — at bases, lateral on old wood, flowering every year, forming dense undergrowth in sholas, widespread from Coonoor (Lamb's Rock road) to Naduvattam and Sispara, also in Palnis; *micranthus*, giant shrub to 10 m tall, with thick branches, stems so soft as to be almost herbaceous, large leaves, dark purple flowers, periods to dying off 15 years(?), within higher sholas (most likely seen in Governor's Shola and near Ootacamund), also in Palnis; *perrottetianus*, large shrub, soft with red-purple hairs, pale blue-pink or lilac flowers, dies in 10 year periods (?), Coonoor, Doddabetta, Pykara and Sispara down to the Oucherlony Valley, not in the Palnis.

AQUIFOLIACEAE

Ilex denticulata, Nilgiri Holly, sometimes a large tree, common in sholas; only in mountains of South India and Sri Lanka.

ARACEAE

Arisaema (150, East Africa, tropical Asia, Atlantic North America to Mexico): *leschenaultii*, Common Cobra Flower, herb, in shady and cool places, thus mostly in sholas, Western Ghats; *tortuosum*, Rat's-tail Cobra Flower, widespread herb, in shade, mountains of India, from Shimla southward.

ARALIACEAE

Pentapanex (15, Himalaya to Taiwan, Java, Australia, South America): *leschenaultii*, well-branched tree or shrub, occasionally epiphytic, at higher elevations, widespread from Western Ghats to Himalaya, Burma and western China.

Schefflera (200, tropics and subtropics, including cloud forests): *racemosa*, medium-sized tree, common, often near streams, only in the Indian Peninsula and Sri Lanka.

BALSAMINACEAE

Impatiens campanulatus, shrub to 1.5 m high, white flowers with red throats, sometimes forming clumps on floor in very moist and shady places, also grows where water drips on rocks, near Coonoor — only in the Western Ghats, Palnis as well; *fruticosa*, erect, much branched shrub to 2.5 m tall, pink flowers with long spurs to 4 cm, particularly near streams within sholas, widely distributed from Coonoor to Kotagiri, Bikkapatti, Ebanad, Pykara and Naduvattam — Western Ghats, not the Palnis; *latifolia*, a herb up to 50 cm tall, grooved stems, deep rose to purple flowers, on moist shaded ground within sholas, also doing well next to streams, widespread from Doddabetta to Coonoor and Naduvattam — only in Sri Lanka and mountains of the Indian Peninsula; *modesta*, Sweet Seventeen, small herb, mauve-pink flowers, in shaded interiors, Pykara and Naduvattam — restricted to portions of the Western Ghats, not the Palnis; *pusilla*, small herb, only 10 to 17 cm high, flowers white with purple marks, widely distributed, from Doddabetta to Naduvattam, Mudimund and Bangihalla, highly variable, distinct form *rosmarinifolia* being bushier with broader leaves and greenish thin flowers, in contrast to the commoner form with longer and narrower leaves — only in southern Western Ghats, not the Palnis; *scabriuscula*, small herb, only 10 to 26 cm tall, branched from the base, white to pink flowers, no vestige of a spur, Naduvattam, Pykara and Sholur — from South Canara and Coorg to the Wynaad and upper Nilgiris only.

Like some orchids, there are balsams which prefer to live on rocks, e.g. *Impatiens acaulis*, small herb with stems from 5 to 30 cm, pink or white flowers to 4 cm wide, on wet rocks in western escarpment zone, Naduvattam to Sispara, near Avalanche and in the Kundahs, the Nilgiris and also Shevaroyas below Shevaroyan; *scapiflora*, small herb with flowers near the top of the stem and leaves from the base, pink flowers, on wet rocks, widespread from Pykara to Mudimund and along the western escarpment south from Naduvattam — only in the Western Ghats, not Palnis.

CAPRIFOLIACEAE

Viburnum punctatum, small evergreen tree, white to light yellow flowers, common in lower parts of the Upland Island, not Ootacamund but lower downs to the west, Western Ghats from Karnataka south, Palnis as well.

CELASTRACEAE

Euonymus (176, with greatest numbers in the Himalaya, China and Japan): *crenulatus*, Spindle Tree or shrub, common near ground in shola interiors, especially near Pykara, red flowers at lower and pink flowers at higher altitudes.

Microtropis (70, Indo-Malaya to China, Mexico and Central America): *microcarpa*, shrub to tree, Ootacamund to Kotagiri, Western Ghats and Palnis; *ramiflora*, medium-sized evergreen tree, common, excellent for shola regeneration, also in Sri Lanka.

COMPOSITAE

Vernonia (1000, America, Africa, Asia and Australia, very common in grassy areas): *conyzoides*, herb, in Ootacamund and at higher levels; *monasis*, tree, conspicuous in April and May when its abundant flowers give off a scent; *pectiniformis*, common shola shrub, from Ootacamund to the Kundahs.

CRUCIFERAE

Cardamine (160, cosmopolitan, but chiefly temperate): *africana*, small perennial herb, common on shady and moist shola floors, higher mountains of Sri Lanka and India; in tropical mountains of Africa, Asia and America.

CYATHEACEAE

Cyathea (600, tropical and subtropical regions, but especially in mountains of wet tropics): *schmidiana* and *spinulosa*, two representative tree ferns living in the Nilgiris, typically in moist, darker shola interiors; the first recorded at Avalanche, Coonoor, Kilkotagiri and Ootacamund, the second at Bikkapattimund and Coonoor.

ELAEocarpaceae

Elaeocarpus (200, from Indo-Malaya to East Asia, Australia and into the Pacific; in tropical cloud-forests as well): *glandulosus*, Nilgiri Mock-olive Tree, often planted near villages, edible green fruit, in mid-level evergreen forests at Coonoor and Kotagiri, example of a species growing at subtropical mountain levels; *munronii*, Stately Tree, dark green fruit, Coonoor Sholurmattam, Naduvattam, Kinnakorai, i.e., lower portions of the Upland Island; *recurvatus*, tree, dark green fruit, common within sholas from Doddabetta to Avalanche and Mukerti.

ERICACEAE

Vaccinium (400, mainly temperate North Hemisphere, but also in tropical mountains, in South Africa but not the rest of Africa, Madagascar): *leschenaultii*, common shola tree with purple young leaves in April and May, only in mountains of Sri Lanka and South India.

EUPHORBIACEAE

Macaranga (280, tropics, Madagascar, Indo-Malaya to Australia and Pacific, many species having hollow stems inhabited by ants): *indica*, tree, another mid-level evergreen species, Devala and Sholurmattam, fast growing and often in secondary forest, scattered from Sikkim to the Nilgiris.

FLACOURTIACEAE

Hydnocarpus (40, Indo-Malaya to Australia): *alpina*, tree in dense mid-level evergreen forest, dark green to almost black foliage and brilliant red young leaves, often forming solid stands in moist valleys, as in forest below Coonoor.

ICACINACEAE

Nothapodytes (4, Sri Lanka to Taiwan and western Malaysia): *nimmoniana*, common in higher sholas everywhere, compact shrub to tree, excellent for shola regeneration; Sri Lanka, Western Ghats, Nilgiris, Palnis, also Assam, Burma to Thailand and Taiwan.

LAURACEAE

Actinodaphne (65, Indo-Malaya and East Asia): *salicina*, small evergreen tree, in Sispara area and Kundahs.

Cinnamomum (250, Indo-Malaya to East Asia; tropical cloud forests as well): *wightii*, large and tall shola tree, brown flowers, coppery new growth, common, from Doddabetta to Kollimund; only in Western Ghats, Palnis as well.

Cryptocarya (250, tropical, except Central Africa and subtropics): *lawsoni*, widespread in higher sholas, stout tree in the Kundahs; mostly in Western Ghats and not in the Palnis.

Litsaea (400, warm Asia and to Korea, Japan; Australia and America): *quinqueflora*, small tree, scattered in sholas, Avalanche to Coonoor and Sholurmattam; *wightiana*, large evergreen tree, everywhere in higher sholas, young leaves reddish, later develop characteristic galls; both species confined to the Indian Peninsula, Palnis as well.

Persea (150, tropics): *macrantha*, large tree, leaves often with characteristic galls, black to dark green fruit, widespread in lower sholas, to 2,100 m, Coonoor and below; Eastern Ghats, Palnis to Ashambu Hills.

Phoebe (70, Indo-Malaya, tropical America and West Indies; tropical cloud forests as well): *wightii*, common tree in higher sholas, sometimes a dominant, fresh foliage copper coloured, flowers and fruit all year; southern Indian hills, including the Palnis.

MAGNOLIACEAE

Michelia (50, tropical Asia and China): *nilagirica*, common tree, widespread in higher sholas, beautiful cream-coloured and fragrant flowers in August-September, Kotagiri to Ootacamund and the Kundahs; southernmost mountains, including the Palnis.

MELIOSMACEAE [= SABIACEAE]

Meliosma (100, warm Asia and America; in tropical cloud forests as well): *pinnata* subsp. *amottiana*, deciduous tree in borders, 12 m tall in shola interiors but only 6 m on open grasslands, cream coloured flowers with a sweet honey smell – en masse and covering trees when in bloom, Ebanad to Ootacamund and Sispara Ghat, also in mid-level evergreen forests near Coonoor, Kotagiri and Pykara; *simplicifolia* subsp. *pungens*, Spiraea Tree, widespread evergreen, higher elevation replacement of the prior species, usually small, but larger in shola interiors, cream coloured fragrant flowers; both only in Western Ghats, Palnis as well.

MYRSINACEAE

Myrsine (7, Azore, Africa to China): *wightiana*, common tree in higher sholas, usually small but occasionally large; Western Ghats, Nilgiris and Palnis, also in Nepal, Bhutan, Assam and the Khasi hills.

MYRTACEAE

Syzygium (500, palaeotropical): *cumini*, wild tree and sometimes cultivated for its fruit, at lower, elevations, in sholas near Coonoor and Kotagiri, fruit gathered and sold, also spread from Indo-Malaya to Australia; *densiflorum*, common tall tree, sometimes dominant, Nilgiris, Palnis and Shevaroy; *calophyllifolium*, only in Nilgiris and on Adam's Peak in Sri Lanka, mainly over higher western Nilgiris, one of the largest shola trees, eventually [at over 18 m] an emergent; *montanum*, numbered among the largest of shola trees, widespread.

OLEACEAE

Ligustrum (c. 50, Europe to northern Iran, East Asia, Indo-Malaya to New Guinea and Australia): *perrottetii*, small evergreen tree, Kotigiri, Kalhatti to Upper Bhavani; only Nilgiris, Palnis and Shevaroy.

ORCHIDACEAE

Nilgiri orchids are herbaceous plants that may be terrestrial (rooted in the ground), sometimes requiring shade far in the interiors of sholas, or epiphytic (roots supported by host shrubs or trees, but not exploiting them for sustenance). Epiphyte orchids often do well amidst mosses on branches that are moistened or even drenched by incoming clouds and mist, thus living in what are generally called cloud forests. Some species of terrestrial or epiphytic orchids also occupy exposed rock surfaces. Few people realize that it is in rainy periods during the westerly monsoon and the reverse monsoon, reaching a climax in some areas during September, that many flowering orchids present magnificent floral displays that are beyond imagination in the dry period. What seems barren and colourless then has vividly coloured palettes inspiring awe and reverence after the rains have come. The Nilgiri Upland Island has a host of orchids, only the related genera of these orchids will in their international distribution be covered under three corresponding headings: 1) terrestrial orchids, 2) epiphytic orchids, and 3) orchid genera having at least one species that may inhabit rock surfaces.

Terrestrial Orchids: *Anoectochilus* (25, tropical Asia, Australia, Polynesia); *Brachycorythis* (32, tropical and South Africa, tropical Asia); *Calanthe* (120, warm parts of the world); *Cheirostylis* (22, tropical Africa, Asia, Pacific); *Coeloglossum* (2, temperate Asia, North America); *Cymbidium* (40, tropical Asia, Australia); *Disperis* (75, tropical and South Africa, Indo-Malaya); *Eulophia* (200, pantropic); *Habenaria* (600, tropical and warm countries, Old and New Worlds); *Pachystoma* (11, China, Indo-Malaya, North Australia, New Caledonia); *Pecteilis* (4, Indo-Malaya, East Asia); *Peristylus* (60, China, Taiwan, India to Australia, Polynesia); *Satyrium* (115, tropical Africa and South Africa, Indo-Malaya, Tibet, and China); *Seidenfia* (300, cosmopolitan, except New Zealand); and *Spiranthes* (25, cosmopolitan, except Central and tropical South America, tropical and South Africa).

Epiphytic Orchids: *Aerides* (40, India, Japan, Vietnam, Malaysia, not New Guinea); *Bulbophyllum* (900, tropical and temperate Southern Hemisphere); *Cirrhopetalum* (70, tropical Africa, Indo-Malaya to Tahiti); *Coelogyne* (200, West China, Indo-Malaya, Pacific); *Cymbidium* (see above); *Dendrobium* (1,400, tropical Asia to Australia and Polynesia); *Diplocentrum* (2, only in India); *Eria* (375, tropical Asia, Australia, Polynesia); *Gastrochilus* (20, India, East Asia, West Malaysia); *Liparis* (250, cosmopolitan, except New Zealand); *Luisia* (30, tropical Asia to Japan and Polynesia); *Oberonia* (330, palaeotropical); *Porpax* (10, India into Thailand); *Robiquetia* (20, India, Southeast Asia, Malaysia, to Solomons and Fiji); *Schoenorchis* (20, China, Indo-Malaya, Solomons, Fiji); *Sirhookera* (2?, probably only 1, India, Sri Lanka); *Thrixspermum* (100, Indo-Malaya, Southeast Asia to Taiwan, Australia and Polynesia); *Trias* (6, India, Southeast Asia); *Trichoglottis* (60, Taiwan, Indo-Malaya, Polynesia); *Vanda* (60, China, Indo-Malaya, Mariana Islands).

Orchid Genera with at least one species that may inhabit Rock Surfaces: *Aerides*, *Coelogyne*, *Cymbidium*, *Gastrochilus*, *Habenaria*, *Schoenorchis*, *Vanda*.

Orchids Living Within Sholas: *Aerides ringens*, Rose Tree Orchid, always in shade, pink flowers before the westerly monsoon, all over the Nilgiris; Western Ghats.

Calanthe sylvatica, Ground Orchid, deep purple flowers, in deep shade, widespread to above 2,000 m, eastern Africa to Western Ghats, including the Palnis, Himalaya eastward to Japan; *triplicata*, Big Wood Orchid, ground orchid with tall racemes of white flowers, in deep shade, sometimes common and forming large patches, Kotagiri and Kodanad, in Longwood Shola, Coonoor and Doddabetta to Avalanche and Naduvattam, Sri Lanka, Western Ghats, Palnis, to Malaya, Australia and the Pacific.

Cheirosotylis flabellata, Small Ground Orchid with white flowers, lover of shade, where there is decaying organic matter, common on Snowdon, near Ootacamund, Coonoor to Kalhatti and Pakasuramalai; Sri Lanka and southern India, including the Palnis.

Cirrhopetalum gamblei, flowers are yellow-green with purple spots, epiphyte in the Kundahs and Naduvattam, near western escarpment, Kalhatti, Naduvattam and Pakasuramalai; Sri Lanka, Western Ghats, also the Palnis.

Coelogyne nervosa, Lesser Plantain Ground Orchid, white flowers, Coonoor to Sispara, Kotagiri to Ootacamund and Naduvattam; *odoratissima*, Sweet-scented Plantain Ground Orchid, yellow flowers, commonly growing in dense masses on trees, widespread, Doddabetta to Avalanche, Bangitapal and Lakkadi; Sri Lanka, Western Ghats, but not in the Palnis.

Dendrobium nanum, epiphyte with white flowers, in Naduvattam area; Western Ghats.

Disperis neilgherrensis, ground orchid with purple flowers, Coonoor and Ootacamund to Avalanche and Naduvattam; South India generally, extinct in the Palnis?

Eria nana, especially common on tree boughs with damp moss, transparent flowers, on slopes of Snowdon near Ootacamund, to Avalanche and Naduvattam, in Western Ghats and Palnis; *polystachya*, pale yellow flowers, Devarshola and Naduvattam; *reticosa*, orange yellow flowers with white tips, common in sholas, Coonoor and Kodanad to Ootacamund and Pykara; last two are epiphytes in Sri Lanka and Western Ghats, but not in the Palnis.

Eulophia spectabilis, large ground orchid with leaf blades 30 to 40 cm long, yellow flowers, in the Catherine Falls valley; tropical Himalaya to Western Ghats and Sri Lanka, eastward to Indonesia and New Guinea.

Gastrochilus acaulis, green-blotched purple flowers, epiphyte near Kotagiri and in the Catherine Falls valley; Sri Lanka, Western Ghats, Palnis as well.

Liparis atropurpurea, epiphyte in darkened interiors, dark purple flowers, higher elevations, Pykara, Avalanche, Mukerti and the Kundahs — Sri Lanka, Western Ghats, Palnis; *elliptica*, epiphyte in shade, ascending white, green or yellow flowers, Kotagiri and Doddabetta — Sri Lanka, Western Ghats, Palnis, Nepal eastward to Indonesia and Taiwan.

Oberonia brunoniana, pale yellow flowers, from Ootacamund to Pykara, Naduvattam and Bangitapal; platycaulon, white or pale yellow flowers, Mukerti Peak area and in the Kundahs, Ootacamund to Naduvattam; *verticillata*, light orange flowers, common, Bikkapattimund, Pykara to Avalanche; *wightiana*, common on trees, sometimes forming dense masses, pale yellow-green flowers, all over the higher Nilgiris; all are epiphytes, Western Ghats, Palnis as well, two latter species also in Sri Lanka.

Pecteilis gigantea, Robust Ground Orchid, to over a metre tall, fragrant white flowers, Ootacamund to Nadgani; tropical Himalaya to Western Ghats, Palnis as well, and as far as China.

Seidenfia densiflora, in deep shade, purple flowers, from Kotagiri and Ootacamund to Pykara and Bison Swamp; *rheedii*, Common Ground Orchid, thriving on humus in deep shade, yellow to rusty flowers, in the Naduvattam area; both ground orchids, Sri Lanka, Western Ghats, Palnis as well, and Indian Peninsula.

PEPEROMIACEAE

Peperomia (over 1000, tropics and subtropics, especially America, many being epiphytes): *tetraphylla*, Pepper-elder, abundant, small epiphytic herb on branches, often amidst mosses and in shade, Coonoor, Kotagiri, Pykara and Upper Bhavani; Himalaya, Khasi Hills and into Burma, China, Australia, Africa and America.

PIPERACEAE

Piper (2000, tropical): *mullesua*, Ootacamund, common in Longwood Shola, near Kotagiri; *schmidtii*, Toda Pepper, prefers shade like the others, in sholas near Ootacamund, widespread; *wightii*, Coonoor and lower places; wild pepper species, rooting in host trees as vines spread upwards, Western Ghats.

PITTOSPORACEAE

Pittosporum (150, tropical and subtropical Africa, Asia, Australia, New Zealand, Pacific): *neelgherrense*, small tree, widespread; *tetraspermum*, Common Yellow Sticky-seed, small tree, widespread; Western Ghats, Palnis as well.

RANUNCULACEAE

Ranunculus (400, cosmopolitan, temperate and cold regions, tropical mountains): *wallichianus*, Common Buttercup, gregarious herb spreading by runners, in moist and shaded ground, especially within shola interiors, flowers orange to yellow, Kotagiri, Ootacamund and Naduvattam; only in hills of southern India and Sri Lanka.

RHAMNACEAE

Rhamnus virgatus, Indian Buckthorn, normally erect but a spiny and stunted shrub in dry places, a part of forest undergrowth, widespread; southern India, temperate Himalaya and to western China.

ROSACEAE

Fragaria (15, North America, Chile, Eurasia and South India): *nilgerrensis*, White Strawberry, white to yellow flowers, common in shady places, mainly sholas, Kotagiri to Ootacamund, Pykara and Upper Bhavani; India, eastern Himalaya to western China.

Photinia lindleyana, Lindley's Rowan, small tree with crooked branches, Ootacamund, Pykara and the Kundahs, not in Palnis.

RUBIACEAE

Ixora (400 sp., tropical) *notoniana*, short and slender tree, white tinged with pink to red flowers, common from inner darkened parts to shola borders, widespread over lower parts of the Upland Island; only in mountains of extreme southern India.

Lasianthus (150, Indo-Malaya; 15 sp., trop. Africa): *acuminatus*, shrub, like coffee bushes, to 6 m from shola floor, abundant and sometimes dominant, widespread with distribution paralleling that of the following species: *venulosis*, well-branched shrub, common in the shade of trees, sometimes dominant, yellow white flowers, widespread and into highest areas as well; both only in the mountains of extreme southern India.

Pavetta (400, palaeotropical) *breviflora*, small tree to shrub, to 8 m tall, white flowers, undergrowth on shola floors, widespread in higher areas; only in Western Ghats.

Psychotria (700, mostly warm regions): *bisulcata*, shrub, starry green flowers, in shade, next to Lamb's Rock Road, Kodanad and widespread, to tops of peaks; *glandulosa*, large shrub to small tree, green-white flowers, in shade, widespread but at lower elevations; both only in the Western Ghats.

RUTACEAE

Euodia (45, tropical Africa, Asia, Australia and Pacific): *lunur-ankenda*, small tree, yellow-green flowers, everywhere in sholas, in places to high elevations; Sri Lanka, southern Indian hills, Khasi Hills and east to Java.

Toddalia (1, tropical Africa, Madagascar, tropical Asia): *asiatica* var. *floribunda*, rambling woody climber, as thick as a human arm at ground level, twigs armed with curved prickles, cream coloured flowers, common in sholas, Coonoor, Pykara to the Kundahs; widely in India and to China and Java.

SAPOTACEAE

Isonandra (10, Sri Lanka, southern India, Malay Peninsula, Borneo): *perrottetiana*, tree, yellow and fragrant flowers, locally abundant in sholas at higher elevations, particularly in the Kundahs; confined to Western Ghats.

Xantolis (100, Tropics): *tomentosa*, tree with thorns, cream coloured flowers, sometimes a dominant in sholas, flushing a blaze of scarlet when leaves are young in December; var. *elongioides*, over a wide elevation range, from Sirur to Ootacamund, confined to southern India.

STAPHYLEACEAE

Turpinia (about 35, Sri Lanka, Indo-Malaya to Japan, central and tropical South America): *nepalensis*, one of the commonest shola trees, sometimes dominant, small pale yellow to cream coloured flowers, sometimes part of a substorey but also an emergent, all over and thriving in the higher elevations, ideal for shola regeneration; Western Ghats, southeast Himalaya, Assam, Burma to Malaya, Yunnan in China.

SYMPLOCACEAE

Symplocos (350, tropical and subtropical, Asia into Australia, Polynesia and America, often at higher altitudes): *foliosa*, tree with smooth grey bark and silky young leaves, white flowers, mainly in higher western sholas from Doddabetta to Pykara and Avalanche — only in Western Ghats and into southern Kerala; *laurina*, a carpet of yellow leaves below the small tree or shrub reveal its presence in a shola, white flowers with a yellow tinge, mainly east of Doddabetta and into mid-level evergreen forests near Coonoor and Kotagiri — South India mountains and from Sikkim to the Khasi Hills and on to China, Japan and Australia; *obtusata*, moderate sized to large tree, white flowers, around Doddabetta and over the higher southwestern Kundahs, only on southern Indian hills.

TERNSTROEMACEAE

Eurya (130, Indo-Malaya to East Asia, and into the Pacific): *nitida*, perhaps a shrub near Ootacamund, but also a large interior shola tree, white flowers, common over higher areas; mountains in Sri Lanka, India and to Southeast Asia, China and Japan.

THEACEAE

Gordonia (40, Indo-Malaya to Taiwan; 1 sp. in southeastern US): *obtusata*, moderate-sized evergreen tree; beautiful large cream to white flowers with many yellow stamens in middle, reminding one of tea flowers, showy, forming carpets on ground below when falling; fairly common and especially near water, Ootacamund — in the swamp below Havelock Road and in sholas on the downs, Coonoor and Pykara, but more common east of Doddabetta; only in Western Ghats, Palnis as well.

THYMELEACEAE

Gnidia (100, tropical Africa and South Africa, Madagascar, southwestern Arabia, western portion of Indian Peninsula and Sri Lanka): *glauca*, well-branched shrub or small tree, yellow flowers, in Nilgiri sholas, widespread, with considerable elevation range, but more common in the lower parts of the Upland Island; var. *sisparensis*, shrub, mainly the Kundahs, Palghat Hills just to the south of the Nilgiris, Ebanad - Sirur and into old Mysore just to the north; widely ranging in Sri Lanka, peninsular India and in Africa, from Malawi to Ethiopia, the Sudan and Mozambique.

URTICACEAE

Chamabaina (2, Indo-Malaya to Taiwan): *cuspidata* herb with male and female flowers, flowering in August, uncommon, only from Naduvattam to Terrace Estate and along the western escarpment with moist sholas, also on moist ground next to streams.

Droguetia (12, tropical Africa and South Africa, Madagascar, Arabia, South India, Java): *iners* subsp. *urticoides*, herb, cream flowers green-tinged throughout the year, gregarious, forming dense mats in moist and shady places on ground within shoals, widespread and in highest areas; mountains of South India and Java.

Elatostema (200, tropics, Old World): *acuminatum*, in gorge opposite Bangitapal bungalow, also Coonoor and Sispara, Sri Lanka, South India, Khasi Hills into Malaya; *lineolatum*, Naduvattam and western escarpment to Sispara, Sri Lanka, South India, tropical Himalaya to Khasi Hills; *sessile*, in sholas from Ootacamund to Coonoor, Naduvattam and Avalanche — southern India, Himalaya, from Chamba to Sylhet (Bangladesh) and much farther eastward to Malaya and Japan, also tropical Africa; *surculosum*, sometimes epiphytic on tree trunks, widespread from Coonoor to Doddabetta and Naduvattam to Avalanche — Sri Lanka, southern India, Himalaya from Shimla (Himachal Pradesh) to Nagaland; all four are herb to undershrub species, with cream flowers, thriving in deep shade within moist evergreen sholas and on moistened rocks in stream valleys.

Girardinia (8, tropical Africa, Madagascar, Indo-Malaya, East Asia): *palmata*, Nilgiri Nettle, herb to shrub, spreading on ground in shade, avoid long stinging hairs on leaves, flowers also armed with numerous stinging hairs, widespread and common, Kotagiri, Coonoor and Ootacamund to Naduvattam; confined to hills of extreme southern India.

Laportea (23, tropical and subtropical, South Africa, Madagascar, temperate East Asia, eastern North America): *crenulata*, Elephant or Fever or Devil Nettle, stout shrub to small tree with soft stems, bark white and smooth with fibres useful for cordage, sting from hairs on leaves very painful and lasting, more so when plant is flowering, sometimes also induces violent sneezing and fever — only in Western Ghats(?); *terminalis*, Milder Stinging Nettle, herb in deep shade, locally abundant, green-white flowers, stingers on stems and leaves, Kotagiri, Ootacamund to Naduvattam and Avalanche — in mountains of Sri Lanka, South India, Kumaon to Bhutan in the Himalaya, Tibet and to Malaysia and Central China.

Lecanthus (1 tropical Africa, 1 Indo-Malaya into East Asia, 1 Fiji): *peduncularis*, low-lying succulent herb, in moist and shaded places, Ootacamund to Pykara and Naduvattam; Africa, India, Southeast Asia, into Java, southern China and Taiwan.

Pilea (400, Tropics): *wightii*, Soft Nettle, annual or perennial herb forming mats on deeply shaded evergreen shola floors, without stinging hairs, flowers cream with green tinge, locally abundant, highest areas Doddabetta and Bikkapattimund; Sri Lanka, southern Indian hills, temperate Himalaya and mountains to Java.

Appendix 3: Nilgiri Endemic Species and Endemic Varieties

Based upon listings or first descriptions in Abraham and Mehrotra (1982); Balasubramanian (1972); Bhargavan and Mohanan (1982); Blasco (1970); Fyson (1932); Gamble (1967); Henry, Vivekananthan, and Nair (1978); Joseph and Vajravelu (1981); Karunakaran (1991); Manilal and Kumar (1984 a,b); Mohanan and Balakrishnan (1991); Nair (1991); Nair *et al.* (1982); Nayar (1980); Rathakrishnan and Chithra (1984); Shetty and Vivekananthan (1981); Subbha Rao and Kumari (1975); Subbha Rao, Kumari, and Chandrasekharan (1973); and Vajravelu, Rathakrishnan, and Bhargavan (1983).

MH = Madras Herbarium, Coimbatore; CNH = Central National Herbarium, Kolkata (= Calcutta).

(*) Endemic to the Kundah hills in the western Nilgiris (+) Nilgiri endemics elsewhere which also live in the Kundahs

ACANTHACEAE

**Andrographis lawsoni* Gamble, low shrubs in grassland, dark brownish-purple flowers, fairly common; Upper Bhavani to Bangihalla, Toda hamlet of Koshti, 2,000-2,300 m.

Andrographis lobeloides Wt., procumbent herb, small leaves, large brown flowers; fairly common on grassland, Coonoor and Ootacamund to Pykara, 1,800-2,400 m.

Andrographis stellulata Cl., erect herb, leaves stigose above and tomentose below, pale pink flowers, rare, at about 1,800 m.

+*Strobilanthes amabilis* Cl., sticky shrub, pink flowers, (?)10-year period, fairly common, 1,000-1,800 m.

+*Strobilanthes lanatum* Nees, beautiful erect shrub, green parts covered with yellow wool, pale blue flowers, dying-off intervals of perhaps 6 or 7 years, on higher Kundah grasslands, spectacular in spreading out on to sheer rocky cliffs of the western escarpment, Ootacamund to Sispara.

+*Strobilanthes papillosus* T. Anders., large shrub with big blue flowers, dying out periodicity unknown, only in the higher sholas and perhaps best known from flowerings at Doddabetta and Sispara in 1883, now rare.

+*Strobilanthes wightianus* Nees, low gregarious shrub, pale blue flowers every year, fairly common, 1,800-2,400 m.

+*Strobilanthes sessilis* Nees var. *sessiloides* Wt., small undershrub, flowering annually or at short intervals throughout the year, mauve flowers, 2,000-2,600 m.

**Strobilanthes violacea*, large shrub with beautiful blue to purple flowers, common but rarely in bloom and therefore believed to have long periods (13 years?) before dying out, only thriving within the highest sholas and on grasslands near Bangitappal and Sispara (in MH).

**Thunbergia bicolor* (Wt.) Lindau, large climber, little known, Sispara Ghat, c. 1,500 m.

APIACEAE

+*Heracleum hookerianum* Wt. & Arn., large herb with leaves on the ground, fairly common on grasslands, Snowdon to Avalanche.

AQUIFOLIACEAE

**Ilex gardneriana* Wt., Sispara Ghat, a scarce shrub or small tree, at c. 1,800 m (no specimen in MH).

ARACEAE

**Arisaema translucens* Fisch., herb, Thaishola, at c. 1,600 m (in MH).

Arisaema tuberculatum Fisch., rare and virtually unknown, 2,100-2,250 m.

+*Arisaema tylophorum* Fisch., fairly common, 1,800 m and above.

ARALIACEAE

**Schefflera rostrata* Harms., shrub to large tree in sholas, fairly common, above 2,100 m.

ASCLEPIADACEAE

+*Baeolepis nervosa* (Wt. and Arn.) Decne, climbing undershrub, the only endemic genus of the Nilgiri montane flora and the only species in the genus, fairly common; easterly Nilgiris, in forests below Coonoor and from Wellington to Kotagiri and Kodanad, 1,500-2,250 m.

Caralluma nilagiriana Kumari and Subbha Rao, between Ebanad and Anaikatti, near 900 m.

ASPLENIACEAE

Asplenium exiguum Bedd., fern collected from the river bank above Kalhatty Falls (1,100 m), in c.1860 by Beddome, later collected again on rocks close to the original site; also found on way to Adaripatti, at 1500 m.

BALSAMINACEAE

+*Impatiens clavicornu* Turcz., white orchid balsam, small herb to c. 30 cm high, single stem and leaves from the base, white flowers, sometimes abundant in the grasses of the downs, flowering July to September with monsoonal rains, like so many of the balsams and orchids; widespread, Coonoor to Doddabetta, Pykara and Mudimund, 1,800-2,400 m.

Impatiens cuspidata Wt., well-branched shrub, often over 1 m tall, stem and branches covered with blue-white powder, pale pink flowers, common alongside Lamb's Rock Road from Coonoor, widely distributed within sholas to Kodanad and Sispara, 1,500-2,100 m; also, according to Dr. Tarun Chhabra, "a variety with brighter pink flowers in the Sispara area."

Impatiens debilis Turcz., herb with small pink flowers, rare; rediscovered lately by Chhabra in the Sispara area.

**Impatiens denisonii* Bedd., herb, pink flowers, on wet rocks, Sispara Ghat, rare, 900-1,500 m; rediscovered by Chhabra in 2002.

**Impatiens laticornis* Fisch., very small herb to 15 cm tall, white flowers with yellow to orange hairs or pink with magenta hairs, to 4 cm across, now an epiphyte on wet rocks or tree trunks, still thriving best in deep shade of sholas, Naduvattam to Sispara and particularly in the western escarpment zone, elsewhere in Kundahs above 2,400 m, rare; rediscovered by Chhabra near Mukerti and in the Western Catchments, and seen by him many times over the years.

**Impatiens lawsoni* Hook, a small herb, remarkable for surviving on wet rocks in the dense shade of wet sholas, only in the Kundahs, rare; "with many, many variations" according to Chhabra, who has found this species in the areas of Bangitappal, Mukerti and Nilgiri peaks, and in the Western Catchments.

**Impatiens levingei* (Hook.) Gamble, small herb, with leaves and stems rising from the base, leaves nearly round, carmine flowers, prefers living on wet rocks, seen next to Lamb's Rock Road near Coonoor, Hulikal and slope below the Toda hamlet of Pishkwasht, widespread in the lower levels of the Upland Island.

**Impatiens munronii* Wt., undershrub in the dense shade of sholas, sparingly branched and up to 60 cm tall, flowers a mixture of green, white and pink, Sispara Sholas, but Chhabra also found it past Nadgani, off the path from Bangitappal to Sispara, 1,500-1,900 m.

**Impatiens neo-barnesii* Fisch., most extraordinary of the balsams, having evolved into an epiphyte on moss-covered tree trunks and branches exposed to heavy rain and mist from Malabar, leaves and flowers hanging down, very fragile cream to white flowers, wing petals curled into a tube from which water drips, in deep shade of very wet sholas or scattered trees in the Kundahs — only in a limited portion of the western escarpment zone (start looking from near the top of Mukerti), typically ranging to 2,450 m, rare; more recently (1970) recorded in Nilgiri Peak R.F. and also rediscovered by Chhabra in 2001, near Bangitappal and Pandiar, and in the Western Catchments; he notes that this species "has an earlier climax in flowering, in August rather than September" (no specimen in MH).

**Impatiens nilgirica* Fisch., very small herb, stem and leaves rising from base, stems from 16 to 30 cm tall, leaves rounded, pink flowers, in grass on the Kundahs, Avalanche to Mukerti Peak, also on rocks, up to the tops of peaks, rare; rediscovered by Chhabra (photograph of the flower by Chhabra on the front cover of *Sanctuary*, 1997, No. 2; in MH).

+**Impatiens orchioides* Bedd., very small herb with white flowers, normally on ground in wet sholas, but occasionally epiphytic on a mass of branches — only at high elevations near Avalanche and in the western escarpment zone of the Kundahs, fairly common to 2,450 m; found by Chhabra near Mukerti, Bangitappal and in the Western Catchments.

**Impatiens rufescens* (Wt. & Arn.) Benth., Pink Marsh Balsam, small herb, stems rising and forming clumps, rose pink flowers, on Wenlock Downs, banks of the Pykara River and in swamps within the downs, rare; "its range extends to the Mukerti area" Chhabra.

+**Impatiens tenella* (Wt. & Arn.) Heyne, slender small herb, flat pink to rosy flowers, growing in moist sholas from Naduvattam and in the western escarpment zone to Sispara, at c. 1,800 m.

BERBERIDACEAE

Berberis nilghiriensis Ahrendt., rare and hardly known.

CAPRIFOLIACEAE

+*Viburnum hebanthum* Wt. & Arn., a small spreading tree with bright green foliage, in the same habitats as *erubescens*, often on the outskirts of sholas; known from Ootacamund to Pykara, 1,800-2,400 m.

CELASTRACEAE

Microtropis densiflora Wt., mostly on outer slopes of the far western Nilgiris, below Sispara and in dense forest; found near Pykara in 1971.

+*Microtropis ovalifolia* Wt., fairly common shrub, Coonoor, Pykara, and generally near streams in the western Nilgiris, 1,800-2,400 m.

COMPOSITAE

- +*Anaphalis neelgerryana* (Sch.-Bip. ex DC) DC., low, much-branched shrub with small leaves, preferring dry and exposed places, fairly common, above 2,100 m.
- +*Anaphalis notoniana* DC., herb with thick soft leaves, fairly common; Church Hill in Ootacamund, Doddabetta, hill behind Avalanche, above 2,100 m.
- **Helichrysum wightii* (Hook.) Cl. ex Hook., herb with woody rootstock in grasslands between Bangitappal and Sispara, its woolly leaves sometimes colouring the landscape a silvery white above Sispara, at about 2,200 m (Specimen in MH).
- **Myriactis wightii* DC var. *bellidioides* Hook. f., scapigerous herb in grassland within the Bangitappal Valley, Bangihalla (in MH).
- **Senecio kundiaceus* Fisch., herb in grasslands, rare (no specimen in MH).
- **Senecio lawsonii* Gamble, slender herb in grasslands, fairly common; Bangihalla, between Avalanche and Sispara, Bangitappal, Sispara; collected by Shetty at Bangihalla and Sispara after 85 years, 2,000-2,300 m (in MH).
- +*Senecio lessingianus* (Wt. & Arn.) Cl., in the western escarpment zone and above Neduvattam, fairly common, above 1,800 m.
- +*Senecio polycephalus* (DC.) Cl., erect herb, fairly common on grasslands, Snowdon slopes, above 1,800 m.
- **Youngia nilgiriensis* Bab., herb in grasslands, a more primitive species, apparently a relict, possibly ancestral type from which Section Meomeris arose, known from Sispara area at c. 2,060 m, rare (no specimen in MH).

CONVOLVULACEAE

- +*Argyreia nellygherya* Choisy, a large climber, to 1,800 m.

CYPERACEAE

- Ascopholis gamblei* Fisch., erect herb, collected at Ootacamund, rare (no specimen in MH).
- Carex pseudo-aperta* Boeck ex Kuek., at about 1,800 m, rare.
- Fimbristylis latinucifera* Govindarajulu, near Pykara, at c. 1,950 m.

ERIOCAULACEAE

- Eriocaulon pectinatum* Ruhl., rare, only in the collection of Perrottet(?).
- + *Eriocaulon robustum* Steud., White-tailed Hatpin Flower, Coonoor and banks of the Pykara River, mostly above 1,500 m.

EUPHORBIACEAE

- **Glochidion sisparens* Gamble, tree, Sispara, at c. 1,500 m (no specimen in MH).
- **Phyllanthus fimbriatus* (Wt.) Muell. Arg., glabrous shrubs in evergreen forests, Carrington to Kinnakorai, Sispara Ghat, at c. 2,000 m (in MH).
- Phyllanthus megacarpa* (Gamble) Kumari and Chandrabose, rare, near Devala in the Wynaad, at c. 900 m (not located since type collection).

GENTIANACEAE

- +*Swertia trichotoma* (Wt. & Arn. ex Wt.) Wall., ex. Cl. Wall., tall leafy herb, fairly common, to 2,150 m.

GRAMINEAE (Smaller Grasses)

- Agrostis schmidii* (Hook. f.) Fisch., at Ootacamund (no specimen in MH).
- Andropogon longipes* Hack.
- +*Andropogon polytychus* Steud., in upper Nilgiri marshes, mainly in far west.
- **Arundinella purpurea* Hochst. ex Steud. var. *laxa* Bor, very distinct variety with long pedicels, Sispara.
- Arundinella purpurea* Hochst. var. *purpurea*, the only aluminum accumulator in the family.
- Arundinella setosa* Trin. var. *nilagiriana* Subbarao et Kumari, at Koilbetta, near Ebanad; like *A. s.* var. *lanifera*, but has hirsute glumes instead (in MH).
- +*Cymbopogon polyneuros* (Steud.) Stapf, Doddabetta, Mukurti, Ootacamund and Pykara, this grass contains an oil with a pleasant odour but is not used commercially, 1,900-2,500 m.
- Dichanthium pallidum* (Hook. f.) Stapf ex Fisch. (no specimen in MH).
- Eriochrysis rangacharii* Fisch., fairly common near Pykara; only Indian representative of an otherwise wholly tropical African and American genus (in MH).
- Helictotrichon polyneurum* (Hook. f.) Henr., Doddabetta, distinctive looking, fairly common, 2,400 m.
- Isachne deccanensis* Bor, on downs near Ootacamund (no specimen in MH).
- Isachne oreades* (Domin) Bor, only in the Gudalur Ghat area (in a swamp within woods).
- Poa gamblei* Bor, fairly common, above 2,500 m.

GUTTIFERAE

Hypericum japonicum Thumb. var. *major* Fyson, a trailing weak-stemmed herb, on western grasslands, rare (no specimen in MH).

LABIATAE

Leucas rosmarinifolia Benth., a fairly common bush with a flat top, often on roadsides, northeastward from Ootacamund, to Kotagiri, including the area with the Toda hamlet of Pishkwasht.

Orthosiphon rubicundus Benth. var. *hohenackeri* Hook. f., a herb with many branches, at about 1,850 m.

LAMIACEAE

Pogostemon nilagiricus Gamble, rare, soft herbaceous plant, on outskirts of sholas and on neglected broken ground, from Coonoor to Lovedale and Ootacamund (no specimen in MH).

+*Pogostemon paludosus* Benth., in wet places near Ootacamund and at Sispara, rare, 1,800 m and above, rare.

+*Teucrium wightii* Hook. f., fairly common, a stout-stemmed herb with thick, soft leaves, from Ootacamund to Dodabetta, mostly above 2,100 m.

LAURACEAE

Actinodaphne lanata Meisn., tree with lanceolate leaves, in sholas, 1,500-1,800 m.

+*Cinnamomum perrottetii* Meisn., fairly common shrub or small tree in sholas near Bangitappal and Avalanche, above 1,800 m.

LORANTHACEAE

Dendrophthoe neelgherrensis (Wt. & Arn.) Tieghem., Scarlet Loranthus, named after the dense bunches of slender crimson-scarlet flowers, Ootacamund to Naduvattam, 1,050-2,400 m.

MELASTOMACEAE

**Memecylon flavescens* Gamble, tree or large shrub with many branches, in sholas near streams, Avalanche and Sispara; collected by Vivekananthan from the type locality after about 83 years, 2,000-2,300 m (in MH).

Memecylon lawsoni Gamble, near Devala in southeast Wynad, at c. 900 m (in MH).

**Memecylon sisparens* Gamble, large shrub or small tree, from Sispara Ghat, at about 1,500 m (in MH).

+*Sonerila elegans* Wt., an erect herb with thick stems and mauve flowers, at Sispara and in other parts of the western Nilgiris, 1,800 m and above.

MIMOSACEAE

+*Acacia hohenackeri* Craib., a climbing shrub with small recurved prickles, Coonoor, Kundahs, collected at Bimka Shola in 1970, rare.

MYRSINACEAE

**Embelia gardneriana* Wt., a climbing shrub, Sispara Ghat, at about 1,600 m (in MH).

MYRTACEAE

**Syzygium benthamianum* (Wt. ex Duthie) Gamble, small tree or large shrub, Sispara, 1,800 m (no specimen in MH).

ORCHIDACEAE

Eria albiflora Rolfe, pure white flowers, Ootacamund and T. R. Bazaar, 2,000-2,400 m, collected in 1899 by Barber, at Ootacamund, and more recently from the Nilgiris and the Silent Valley, rare (in MH).

+*Eria mysorensis* Lindl., small epiphyte, white flowers tipped with pink, flowering peak in September, Kodanad shola, western slopes of the Nilgiris, Naduvattam, 1,800 m.

Habenaria denticulata Reichb., very rare (no specimen in MH).

Habenaria fimbriata Wt., white flowers, 1,500-2,100 m, rare (no specimen in MH).

Habenaria polydon Hook., now extinct? (no specimen in MH).

Liparus indiraii Manilal et Kumar, in Silent Valley, named after Indira Gandhi (in CNH).

Oberonia bisaccata Manilal et Kumar, found near Research Centre, Silent Valley (in MH).

Porpax chandrasekharanii Bhargavan et Mohanan, discovered in Silent Valley (in MH).

+*Robiquetia josephiana* Manilal & Sathish, Chembotti, Naduvattam and Silent Valley; according to Chhabra, also in the Sispara area.

**Spiranthes sinensis* (Pers.) Ames var. *wightiana* Lindl., terrestrial and endangered, flowers in a dense cylindrical spike, in the Bangitappal to Sispara area (in MH).

Thrixspermum muscaeflorum Rao & Jos. var *nilagiricum* Jos. & Vaj., very small epiphytic orchid, common on slender branches of small trees, near Kundah River in Tamil Nadu, first discovery of the genus in South India (in CNH and MH).
Trias stocksii Benth. ex. Hook.f., Silent Valley and Chandanathode in the Western Ghats.
Vanda wightii Reichb. f., the type location remains unknown, very rare (no specimen in MH).

OXALIDACEAE

**Biophytum polyphyllum* Munro, in sholas, herb with very long leaves having minute leaflets (30 to 50 pairs), fairly common, above Sispara, Thaishola, Carrington to Kinnakorai, 1,800-2,200 m.

PAPILIONACEAE

Alysicarpus beddomei Schindl., on Pakasuramalai, at about 2,030 m, rare.
 +*Crotalaria barbata* (Wt. & Arn.) Grah. ex Wt. & Arn., sturdy shrub with erect flower spikes, bright yellow flowers, in sholas, fairly common, near Pykara and on Snowdon slopes, above 2,000 m.
Crotalaria candicans Wt. & Arn., erect tree, 3 to 4 m tall, very leafy, regular upward-sloping branches ending in large panicles of pure yellow flowers, thrives on steep slopes and on the downs, creating spectacular sights with mass bloomings, as seen on top of Sigur Ghat in July to September, fairly common, Coonoor, Kateri, Kodanad, Kottabetta and Madinad, to about 1,850 m.
 +*Crotalaria formosa* (Wt. & Arn.) Grah., low-growing shrub with dense, short, thick flower racemes, yellow flowers, fairly common in sholas and on grasslands, on Snowdon slopes near Ootacamund, Doddabetta to Avalanche and Pykara, above 2,100 m.
Dalbergia gardneriana Benth., fairly common, a climbing shrub with white flowers, Coonoor, Kalhatti and Sholurmattam, 1,500-2,150 m.

PIPERACEAE

**Piper pykarhense* C. DC., presumed found near the Pykara River, biotic disturbance due to dam building may have caused this species to become extinct.

POACEAE [BAMBUSEAE = LARGER GRASSES]

+*Arundinaria wightiana* Nees var. *hispida* Gamble, widespread, growing next to shola streams at higher elevations, essential for final roofing phase of Toda hut construction, 2,100-2,300 m.
Silentvalleya nairii Nair, new genus, tufted perennial grass, discovered in the Silent Valley (in MH and CNH); related to genera *Diplachne* P. Beauv., *Gouinia* in America and *Lophacme* in Africa.

ROSACEAE

**Photinia serratifolia* (Desf.) Kalkman var. *tomentosa* (Gamble) Vivek and Shetty, small tree in sholas; Avalanche, Bangitappal, Lakkadi, toward Sispara, in the highest southwestern Kundahs; collected by Shetty from the type locality after 80 years, 2,000-2,200 m.
 +*Rubus rugosus* Sm. var. *thwaitesii* Focke, a large prickly shrub with purple-black fruit, common on Doddabetta and other high elevations, often above 2,400 m.

RUBIACEAE

**Hedyotis hirsutissima* Bedd., low-growing, shrub with stout stems and branches, in rock crevices and on southwestern grasslands, pale lilac flowers, fairly common, Bangitappal to Sispara and the Kundahs, collected by Shetty at type location after 80 years, 2,000-2,300 m (in MH).
Hedyotis silent-valleyensis Vaj., Rath. and Bharg., on one grassy slope, Silent Valley (in MH and CNH).
 **Hedyotis sisparensis* Gage, an undershrub with quadrangular branches and pale leaves, near Sispara, at about 2,200 m, rare (no specimen in MH).
 +*Lasianthus ciliatus* Wt., a stout shrub, with prominent leaf-nerves, in deep shade of sholas edging the western escarpment, also below Kodanad and next to Lamb's Rock Road, to about 2,200 m (in MH).
Ophiorrhiza incarnata Fisch., in pandanus swamp, near Nadgani in the Wynaad, about 900 m (no specimen in MH).
Ophiorrhiza pykarensis Gamble, erect and slender undershrub with small leaves and pale blue or lilac flowers, in a shola at Pykara Falls, rare, possibly extinct, about 1,900 m (not collected since the type collection).
Pavetta breviflora DC. var. *ciliolata* Gamble, Coonoor, Thai Shola and Snowdon R.F. 1,500-2,100 m.
 **Pavetta hohenackeri* Brem., glabrous shrub near Sispara, 2,200 m, rare (no specimen in MH).

RUTACEAE

**Melicope indica* Wt., shrub to small tree with opposite leaves, in sholas and near streams, fairly common, Avalanche and Kundahs, Toda hamlet of Koshti, Lakkadi (collected there by Shetty after 80 years), Sispara, 2,000-2,300 m.

SYMPLOCACEAE

**Symplocos microphylla* Wt., shrub on grasslands, tree in sholas, beyond Avalanche, Kudiakad, Sispara, Upper Bhavani to Bangihalla, 2,000-2,300 m (in MH).

Appendix 4: Record of Fires and Grassland Formation

Hough 1829: 72-73.

.... During the dry season, i.e. from December to May, they [Todas] burn the grass, which, in the darkness of the night, presents a grand spectacle, the sides of the entire hill being illuminated at the same time; but it greatly disfigures the scenery by day, as in a few hours a verdant mountain is transformed, in appearance, to a barren, sombre rock. This improves the grass for the buffaloes, making it coarse, and causing it to grow in tufts: but it is hereby rendered unfit for smaller cattle and sheep, of which, however, the Thodawurs [Todas] keep none....

Harkness 1832: 62.

After nightfall, the scenery around us was grand beyond description. Much of the grass, fern and heather, being frost bitten and withered, the Tudas [Todas] had taken this opportunity, before the setting-in of the rains, to fire it; and many of the ridges of mountains now presented an undulating and apparently endless line of flame.

Ouchterlony 1848: 56.

.... The grass upon which they [Todas] pasture their buffaloes is of coarse rank description, fit only for those hardy and powerful animals; but by burning it down, as is their practice, just before the rains set in, when they are about to migrate to another *mund* [common name for a Toda hamlet], a fine tender young grass, highly nutritious as pasture, has replaced the ashes of the old grass by the time they return to the *mund*, round which they have set their fires.

King 1870-71: 25.

.... During the dry season — that is, from the beginning of January to the end of April — they [Todas] are in the habit of setting fire to the grass, with a view of promoting its better growth; another Kaffir [African name for livestock keepers] custom, and one, moreover, the beautiful effect of which at night will be remembered by all who have ever seen it on so large a scale.

Marshall 1873: 53.

.... Wherever, in fact, rich soil and a perennial supply of moisture may be found, there are the ever silent woods; for the periods of annual drought are long: the monsoon rain flows quickly off the hard surface of the exposed hills, and the scorched grass containing the young saplings is yearly fired.

Duff 1876: 17

We waited to give the weather time to reconsider itself, but in vain, and then slowly descended [down the side of Mukerti Peak] ... and crossing great tracts of hillside over which a fire had just passed — the wasteful custom of burning the surface with a view to obtain a good bite of grass being in full force here.

Grigg 1880: 10.

.... It is, however, to be remembered that the present park-like appearance of the higher plateau, with its down and woodlands, is also, in a great measure, due to the annual recurrence of fires which sweep over the hills, burning the grass and outlying shrub and even the smaller sholas, and checking the larger woods in their persistent efforts to extend their domain further along the sides of the valleys.

Jennings 1881: 8-9.

The country [between Ootacamund and Neduvattam] is undulating and grassy, bare of timber except in such hollow places as afford the necessary moisture and shelter. In these spots there are lovely groups of trees, and often a delicious undergrowth of ferns — veritable oases in a desert of uninteresting slopes, covered at this season with burnt-up grass.

Francis 1908: 212.

In the case of the Kundahs and the Downs, an exception to the usual forest rules was made, after much discussion, in 1905, in that the annual burning of the grass was permitted. These areas are chiefly of value as great grazing grounds; and it was considered that burning was essential to the production of the young green grass so desired by the grazers and did no appreciable harm to the sholas as long as it was done early in the year while the undergrowth and bracken in and round them was still green and if precautions were taken to prevent the fire from spreading to an inflammable growth which ran up into them.

Champion 1935: 141.

In the dry season in February-March the grasslands get very dry and inflammable and the greater part of them are burnt annually. This has happened as far back as we have any information and has unquestionably exerted a very great influence on the present distribution of the very fine tender evergreen forest. Burning completely stops regeneration of practically every tree species except *Rhododendron* and every fire eats in a little all along the periphery of the sholas.... Grazers (Pastoralists) have occupied the plateau for a very long time and have burnt the grass for the sake of the early flush of new growth that follows a fire, and it is unquestionable that the forest occupies a far smaller proportion of the area than it once did.

Ranganathan 1938: 527-528.

Burning the grass is an immemorial custom of the Todas which has been officially recognized and is now being officially regulated.

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