



ELSEVIER

Review of Palaeobotany and Palynology 121 (2002) 1–75

**Review of
Palaeobotany
& Palynology**

www.elsevier.com/locate/revpalbo

Distribution and ecology of parent taxa of pollen lodged within the Latin American Pollen Database

Robert Marchant^{a,*}, Lucia Almeida^b, Hermann Behling^c,
Juan Carlos Berrio^a, Mark Bush^d, Antoine Cleef^a, Joost Duivenvoorden^a,
Maarten Kappelle^e, Paulo De Oliveira^f, Ary Teixeira de Oliveira-Filho^g,
Socorro Lozano-García^h, Henry Hooghiemstra^a, Marie-Pierre Ledruⁱ,
Beatriz Ludlow-Wiechers^b, Vera Markgraf^j, Virginia Mancini^k, Marta Paez^k,
Aldo Prieto^k, Olando Rangel^l, Maria Lea Salgado-Labouriau^m

^a *Institute for Biodiversity and Ecosystem Dynamics, Faculty of Science, University of Amsterdam, Kruislaan 318, 1098 SM Amsterdam, The Netherlands^l*

^b *Laboratorio Biogeografía, Facultad de Ciencias, Universidad Nacional Autónoma de México, Apartado Postal 70-296, 04510 México, D.F. Mexico*

^c *Center for Tropical Maritime Ecology, Fahrenheitstrasse 1, D-28359 Bremen, Germany*

^d *Department of Biological Sciences, Florida Institute of Technology, 150 West University Boulevard, Melbourne, FL, 32905 USA*

^e *Instituto Nacional de Biodiversidad (INBio), Apartado Postal 22-3100, Santo Domingo de Heredia, Costa Rica*

^f *Instituto de Geociencias-DPE, Universidade de São Paulo, Caixa Postal 11348, São Paulo, SP 05422-970 Brazil*

^g *Departamento de Ciências Florestais, Universidade Federal de Lavras, CEP 37200-000, Lavras, MG Brazil*

^h *Universidad Nacional Autónoma de México, Instituto de Geología, Apartado Postal 70-296, 04510 México, DF Mexico*

ⁱ *Instituto de Geociencias, Departamento de Paleontología e Estratigrafía, Rua do Lago 562, Caixa Postal 11348, CEP 05422 970, São Paulo, SP Brazil*

^j *Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO, 80309-0450 USA*

^k *Laboratorio Paleocología y Palinología, Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Mar del Plata, Funes 3250, 7600 Mar del Plata, Argentina*

^l *Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia*

^m *Instituto de Geociências, Universidade de Brasília, Brasília, DF Brazil*

Abstract

The cornerstone of palaeoecological research, concerned with vegetation dynamics over the recent geological past, is a good understanding of the present-day ecology and distribution of the taxa. This is particularly necessary in areas of high floral diversity such as Latin America. Vegetation reconstructions, based on numerous pollen records, now exist with respect to all major vegetation associations from Latin America. With this ever-increasing number of sedimentary records becoming available, there is a need to collate this information and to provide information concerning ecology and distribution of the taxa concerned. The existing Latin American Pollen Database (LAPD) meets the first of these needs. Information concerning the ecology and distribution of the parent taxa responsible for producing the pollen, presently lodged within the LAPD, is the focus of this paper. The ‘dictionary’ describes the ecology and distribution of the parent taxa responsible for producing pollen identified within sedimentary records.

^l Participating in The Netherlands Centre for Geo-ecological Research (ICG)

* Corresponding author.

These descriptions are based on a wide range of literature and extensive discussions with members of the palaeoecological community working in different parts of Latin America investigating a range of different vegetation types. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: biome; distribution; ecology; Latin American Pollen Database; pollen

1. Introduction

Latin America comprises the area between 35°N to 65°S, and 35°W to 120°W (Fig. 1), and is characterised by strong environmental gradients. Changes in environment are related with 100° of latitude, approximately 7000 m of altitude range and the transition from maritime- to continentally-dominated climate systems. These environmental gradients, and how they combine, make Latin America biogeographically highly complex; the range of ecosystems encompassing 'alpine', temperate and tropical floras. Indeed, one remarkable characteristic of the Latin American flora is its diversity: vegetation associations range from tropical rainforest to cold desert, from an array of different dry forest associations to temperate rainforest, from hot semi-desert to cold moorland. The high diversity of Latin American vegetation is encompassed by various vegetation maps (von Hueck, 1972; Schmithüsen, 1976; UNESCO, 1981; Olsen et al., 1983), descriptions and divisions of vegetation types. Indeed, each vegetation map of Latin America has a different resolution in terms of the total number of vegetation types identified. These multi-tiered classifications can lead to problems when trying to compare the different biogeographies, these problems being further compounded by the diversity in nomenclature assigned to the vegetation types. For example, vegetation found at mid-altitudes in the Andes may be termed Andean Forest, moist montane forest, montane rainforest, cloud forest and/or montane evergreen forest. For each of the broad vegetation classifications additional adjectives such as moist, dry, disturbed, mesic etc. can be used to describe the character of the vegetation. Complicating the composition and distribution of the potential vegetation is the human impact factor. The longevity of early human settlement in Latin America is a contentious sub-

ject, although by the early Holocene it seems there was considerable cultural diversity and adaptation to a range of different environments (Gnécco, 1999). Human-induced modification has manifested itself as direct influence on vegetation composition and distribution through land-use practices. For example, in excess of 100 plants were under cultivation before the arrival of Europeans in the 15th century (Piperno and Pearsall, 1998) when there was widespread introduction of alien taxa to the Latin American flora, some intentionally and some by accident.

Some of the earliest palaeoecological research in the tropics was carried out in Latin America (Absy, 1979; van der Hammen and González, 1960). Following these pioneering studies, the field has developed rapidly and now includes one of the longest terrestrial records of vegetation change, from the high plain of Bogotá, Colombia (Hooghiemstra, 1984). This long site-specific record has been augmented recently with investigations into the spatial response of Neotropical vegetation to Late Quaternary climate change (Behling and Hooghiemstra, 2001; Farrera et al., 1999; Marchant et al., 2001a, in press). Exciting new techniques of investigating the pollen data are developing rapidly, e.g. the application of vegetation climate response surfaces (Bush and Rivera, 1998), comparisons with vegetation and climate model output (Marchant et al., 2002), and with records from the Northern Hemisphere (Moreno et al., 2001; Markgraf, 2001). The palaeoecological and environmental signals attainable from pollen records are increasingly being used to link fields of archaeology, biogeography as well as climate modelling, and develop our understanding of global change, biotic response (and feedback), and present land management issues. The common denominator of these applications is a comprehensive understanding of the ecology and distribution of the parent taxa, being

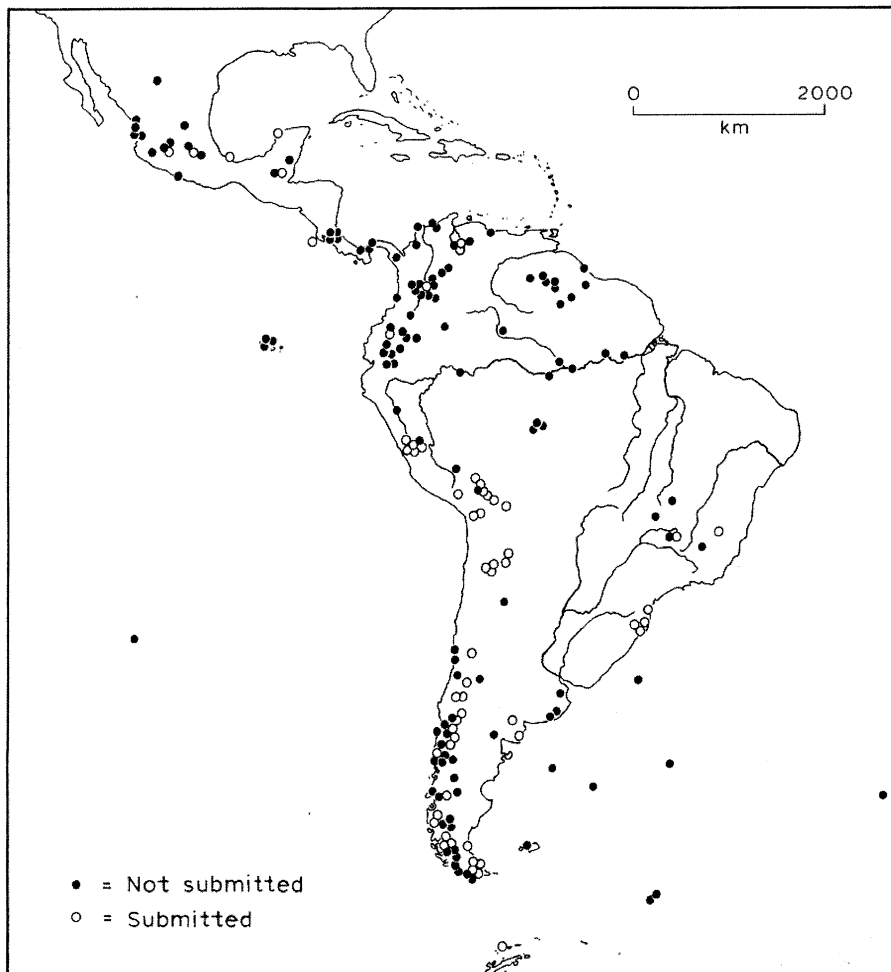


Fig. 1. Latin America showing the location of sites with pollen data used to construct the present dictionary. Additionally, sites from Colombia have been used which are currently being prepared for accession into the LAPD. Sites the pollen data of which have been submitted to the LAPD are shown as well.

the origin of the pollen preserved in sedimentary basins. With this increasing amount of data being produced, and applications made to areas beyond the reconstruction of vegetation history, there is a need to base the reconstructions on solid ecological foundations (Marchant and Hooghiemstra, 2001). Unfortunately, much of the information regarding plant environmental tolerances and the ecological ranges is often fragmented in the quite voluminous literature, and hence difficult to access and compile. Indeed, such an endeavour is not something for the individual, but very much

a collective undertaking. This difficulty is exacerbated for palaeoecologists without direct access to extensive library resources or those researchers new to the discipline. Furthermore, when this fragmented body of information has been assembled, there are many taxa the ecology and distributions of which are not well known (or recorded in the literature). In part, this lack of information stems from the large amount of 'basic' botanical survey work to be undertaken and the enormity of the task. Indeed, it is hoped that the descriptions presented here will spur further study

and allow additional information retained within the ‘grey literature’ to be accessible for the Latin American pollen community.

One of the driving forces behind compiling the dictionary of ecological and distributional information presented here has been research translating pollen data held within the Latin American Pollen Database (LAPD) to biomes under the BIOME 6000 project (Prentice and Webb, 1998). Available Latin American pollen data have been transformed to pre-determined biomes at 18 000 and 6000 radiocarbon years before present (^{14}C yr BP) (Marchant et al., in press). One of the steps to achieve these biome reconstructions involved the *a priori* assignment of pollen taxa to a conceptual framework of plant functional types (PFTs) that represent the Latin American flora; these PFTs then combine to form the series of biomes. The methodology and how it can be applied in Latin America has been documented in Marchant et al. (2001b). The compiled information can be viewed as a ‘state-of-the-art’ compression of the information held in a range of floras, biogeographical studies, and palynological research in Latin America. The dictionary presented here is primarily targeted at palynologists working in Latin America, particularly new researchers to the field that require a synopsis of background information regarding the pollen flora. The dictionary is designed without reference to morphological descriptions of the pollen taxa; many of these are already available in a range of pollen atlases. For descriptions of pollen morphology, the recent compilation of pollen atlases by Hooghiemstra and van Geel (1998) is an excellent source of reference. Notwithstanding this range of morphological reference materials, there is still a requirement to improve the morphological description of a number of large groups that are currently only identifiable to family level under light microscopy. Given the enormity of the task, it is urged that morphological work be focused on relatively small families, such as the Bombacaceae or Theaceae, which are important components in the tropical lowland vegetation. These targets may enhance the resolution of palaeoecological study in this vegetation type where there remains a relatively large percentage of non-

identified pollen grains encountered during a pollen count.

2. Methods

The following dictionary is based on all pollen taxa recorded at sites that have been submitted to the LAPD at early December 1999, and those data currently being prepared for entry at the University of Amsterdam. The synthesis focuses on all pollen taxa and the most commonly encountered fern spores. The nomenclature for the pollen taxa follows that of the original analyst involved in production of the pollen data. Indeed, no subjective decisions were made on the ability of the original analyst to identify the pollen taxa. Where there are monospecific genera the species name is given. The taxonomy of the family assignments follows that of the Index Kewensis (1997) and the International Plant Names Index (IPNI, 1999). Where there are multiple family assignments of the genus, the families most commonly encountered in Latin America are provided. Each entry is followed by information relating to growth form, distribution and ecology of the parent taxa thought to be responsible for producing the pollen, and an indication of the vegetation formation to which it belongs. A fully annotated glossary of the variety of terms used in Latin American vegetation is provided by (Huber and Riina, 1997). Just as the list of pollen atlases, this is an excellent source of reference. Where available, anecdotal information on the local use of a taxon or particularly distinguishing features of the vegetation are also included, these often providing aid memoirs. To enhance the value of the distributional information, where possible we have indicated which taxa form associations with other taxa.

2.1. Background to the Latin American Pollen Database

Palynologists have collected numerous pollen-based records over the past five decades, the number of which are increasing rapidly as palaeoecological research groups expand and new groups

develop. With this ever-increasing number of sedimentary profiles with associated pollen data there is a need to collate them. The LAPD provides a framework to support this. The LAPD was initiated by Vera Markgraf and Eric Grimm in August 1994, following funding from the NOAA Paleoclimatology program. An organising workshop in November 1994 brought together 20 scientists that at that time represented major palynological research activity in Latin America. The database was constructed at the World Data Center-A (WDC-A) for Paleoclimatology at Boulder, CO, where data are lodged for access by the global pollen community. This data storage is also linked to regional pollen database mirror sites to allow for relatively local access to the data. For example, there are mirror sites located at Toulouse (France), Mendoza (Chile) and Nairobi (Kenya). By mid-1998 data from 87 sites had been submitted to the database (Fig. 1). Although this collection shows significant progress, there are considerably more sites that could be contributed (Fig. 1). In October 1999, the database co-ordinator's torch was passed to Robert Marchant and Guido van Reenen at the University of Amsterdam. This development followed funding of a 3-yr project by The Netherlands Organisation for Scientific Research (NWO) in order to investigate Latin American vegetation dynamics, the forcing mechanism on these and to engender data-model comparisons. Following funding by the National Science Foundation (NSF), USA, workshops were held at Porto Seguro, Brazil, and Lovenholm, Denmark. The aim of these workshops was to establish a more inclusive database, making participation by Latin American colleagues central, in order to provide a forum where people feel able to contribute data and develop the LAPD in ways that will bring direct benefit to the palaeoecological community. An advisory board was established incorporating Juan Carlos Berrio, Henry Hooghiemstra, Socorro Lozano-Garcia, Vera Markgraf, Patricio Moreno, Aldo Prieto and Guido van Reenen.

The preferred format for supplying data to the LAPD is as a *Tilia* file with the associated descriptive forms filled out in full. However, if all the information is not available, or is not in *Tilia*

format, this does not prevent the record being accepted, but it may slow down its accession to the database. Indeed any format is acceptable, from paper count sheets to institute-specific computerised records. When possible the following information should be supplied to the co-ordinator:

- (a) Site name, latitude/longitude, country, elevation
- (b) Additional site information, such as surrounding vegetation
- (c) Raw pollen counts
- (d) Dating information and chronology
- (e) Lithology of the core
- (f) Loss-on-ignition data
- (g) Principal investigators
- (h) Contact information (address, telephone number, e-mail)
- (i) Publications
- (j) Funding source (name and country).

Following submission, the data are processed to include as much of the above information as possible in the required format and then sent to the WDC-A for Paleoclimatology to be lodged on the server (and mirror sites) for access by the pollen community. Wherever possible, the role of the original data provider is indicated, both as co-author on resultant publications that use the data, and through referencing to original publications that pertain to the site-specific study.

Data can be accessed and retrieved by anyone by means of the following four methods: through the World Wide Web (<http://www.ngdc.noaa.gov/paleo.html>), gopher (gopher.ngdc.noaa.gov), anonymous FTP (ftp.ngdc.noaa.gov), and mail (the present database co-ordinator is the point of contact). This combination ensures that no member of the palynological community should be excluded from the use of this resource. The World Wide Web site incorporates a convenient search engine that allows for the retrieval of data by combination of country, latitude/longitude, analyst, age range and elevation. The current search engine can enter multiple queries, for example it is possible to search for pollen data from Argentina in an age range of 17 000–21 000 yr BP from alti-

tudes between 1500 and 2500 m. Pollen data are available in the following formats: complete data in *Paradox* and *Tilia* tables, as well as a summarising percentage pollen diagram (the 15 numerically most important taxa). The *Tilia* and associated *Tilia* Forms files are zipped into a single file to increase speed of data transfer. Software required to enter pollen and associated data and read the retrieved data sets is provided free of charge to all participants.

In addition to being a safe-house for pollen data storage and retrieval, the LAPD aims to provide a platform to promote scientific exchange and inter- and intra-disciplinary development of Latin American palynology. The LAPD can engender the strategic setting of future palaeoenvironmental investigations, provide a forum to disseminate the use of data in the LAPD and determine new research initiatives. Indeed, at the very heart of the LAPD is the understanding that ‘the whole can be greater than the sum of all the parts’, and that by collating pollen records we will be able to gain new insights, and formulate new research questions, not likely to arise from the study of individual sites. These aims can only function if the community is willing to contribute data, use them and become involved in the wider application and development of the LAPD.

Acknowledgements

The LAPD has been funded with support from the NSF, the NOAA Paleoclimatology program and the NWO under Award No. 750:198:08 to Henry Hooghiemstra and R. Marchant. Numerous people offered support and commented on the research that led to this dictionary at various stages of its development. In particular we thank Sandy Harrison for discussions throughout the development of the Latin American biomisation. Particular thanks are due to Eric Grimm and John Keltner for their energies over the past five years in establishing and developing the LAPD. The library staffs at the University of Amsterdam, the University of Colorado at Boulder (INSTAAR), the University of Hull, the Royal Botanical Gardens at Kew, the Linnean Society and the

British Library are thanked for their assistance in accessing the literature listed here. Numerous researchers contributed to this work, especially those who deposited their pollen data in the LAPD. Without these contributions the LAPD would not exist and the development of palynological research would be considerably more fragmented.

Appendix

Notes on ecology and distribution of parent taxa for pollen currently held within the Latin American Pollen Database

Abatia (Flacourtiaceae). Montane shrub [117] and evergreen tree [3] restricted to highland areas [3], e.g. *A. parviflora* is common in Andean forest (2300–2800 m) on the high plain of Bogotá [54] and in secondary Costa Rican montane rainforest (2500–3000 m) [163].

Abies (Pinaceae). Trees distributed from México to Guatemala [117], can dominate in areas characterised by mean temperatures of 7–15°C and high humidity (2400–3600 m), e.g. *A. religiosa* is characteristic of central México, extending to Guatemala [92] and other parts of México where it is present in valleys from 2600–3500 m, forming monospecific forest in association with *Cupressus lusitanica* and *Roldana angulifolia* [241]. *A. concolor* grows in the northern Baja, California, *A. hickelii*, *A. oaxacana* and *A. guatemalensis* are frequent in south and southeast México [238].

Abutilon (Malvaceae). Trees and shrubs of lowland rainforest [164], e.g. *A. rufinerve* is a shrub of moist forests (Brazil) [205]. Various species in dry enclaves along river valleys, e.g. River Patia in Colombia [22].

Acacia (Leguminosae). Trees and shrubs, locally dominant in dry regions [164], a xerophytic shrub in Mexican thorn forest, particularly at lower altitudes [165], the Caribbean [261], Costa Rican [230] and Brazilian [205] dry forest, e.g. *A. farnesiana* is present in México up to 2000 m [204], it can dominate savanna [142,147]. Important pioneer taxa where nitrogen is limiting, e.g. desert soils [168]. *A. viscosa* is common in north-west Argentina at 1000 m, particularly along river

courses [195]. *A. furcatispina* can form large shrubs in puna [165], *A. spinosa* is common in desert areas of Cuba [47]. *A. tortuosa*, a thorny shrub from the Caribbean coast of Colombia, often associated with *Cordia curassavica* and *Opuntia wentiana* [253].

Acalypha (Euphorbiaceae). Weedy herbs [117] found in many dry vegetation types. Common in sub-Andean forest [140], particularly in a narrow altitudinal range (1500–1800 m) [54] of the Costa Rican undisturbed lower montane rainforest [137], e.g. *A. ferdinandi*. Present in lowlands, Atlantic rainforest [17], savanna [84], cerrado [254], e.g. *A. communis* is present in Brazilian dry forest [205]. Can be common in moderately disturbed areas, e.g. hillsides and riverbanks [165]. *A. diversifolia* and *A. villosa* are present in Colombia from arid to moist forest, the latter particularly common from 700 to 1300 m in the Colombian Andes [215].

Acanthaceae. Shrubs and herbs with a wide ecology [117], more than 200 genera and 2000 species distributed throughout Latin America, few species in temperate areas [20], can be prominent in Costa Rican montane rainforest [163]. Present in Colombia up to 3300 m in upper montane rainforest [3], also present in Chocó [116]. This family has several types of pollen; the type *Ruellia-Distictella*, including both genera, occurs in Brazilian cerrado [255]. See also *Aphelandra*, *Hygrophila*, *Justicia* and *Ruellia-Distictella*.

Acrostichum (Pteridaceae). Fern found on moist soils in disturbed areas [117], also characteristic of mangroves [168,265], floating on swamp substrate in Pacific Costa Rica [163] and Colombia [277]. Common in *Avicennia*-dominated forest (the two pollen curves are often parallel) [290]. Present in freshwater swamps; not an obligate halophile [168], growing in brackish water, occasionally on cliffs and open saltmarsh, distribution is more restricted on the Pacific than on the Atlantic coast [285]. *Acrostichum* dominates disturbed mangroves [277].

Actinostemon (Euphorbiaceae). Trees present in southern Brazilian seasonal forest, e.g. *A. brasiliensis* and *A. concolor* [129].

Adesmia (Leguminosae). Shrubs and herbs [164], present in montane areas of the Patagonian

cordilleras [180], puna [165] and high altitudes of northern Chilean Andes [13]. Common in central Chile [11], particularly under dry climates [261], e.g. *A. atacammensis* and *A. spinosissima* are present at high altitudes of the Atacama Desert [226]. Present above the upper forest line of southwest Argentina [303], e.g. *A. burkartii* [14], *A. subterranea* cushion-forming from 3000 to 3700 m [64]. *A. elegans* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103]. *A. glomerula* and *A. corymbosa* are herbs, *A. obcordata*, *A. obovata*, *A. rigida* and *A. pinifolia* are shrubs in Patagonian steppe [303].

Aegiphila (Verbenaceae). Trees and shrubs, a few lianas, present in lowland moist forest [117], recorded in Ecuadorian humid forests [288], upper montane rainforest as a single tree species [3], common in well-drained uplands [168], e.g. *A. odontophylla* is present in Costa Rican lower montane rainforest [163]. Present in dry forest, e.g. *A. hotskiana* is common in cerrado [124].

Aeschynomene (Leguminosae). Herbs and shrubs in savanna, very diverse genus (50 species) particularly common in disturbed areas [117,168].

Aetanthus (Loranthaceae). Parasitic lianas [3] restricted to páramo and high altitude Andean forest [117].

Aextoxicon punctatum (Aextoxicaceae). Trees present in temperate rainforest, coastal fog forest [117], to Chilean coastal and Andean forests [11,299], common in Valdivian rainforest [297], e.g. *A. punctatum* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103]. A northern Patagonian element [300] where it can be co-dominant in coastal forests with *Luma apiculata* (Myrtaceae) [77].

Agave (Agavaceae). Succulents present in tropical and warm regions, particularly arid areas [164], e.g. *A. desertii* is present in Sonoran Desert, México, *A. subsimplex* extends to Mexican coastal desert [2], *A. tubulata* is common in dry areas of Cuba, such as limestone hills (mogote) [47]. *A. cocuy* is present in stone deserts of northern Colombia, can be associated with *Prosopis* and *Castela* [253].

Alchornea (Euphorbiaceae). Mostly large trees sometimes dominating along rivers [117] on igapó [208], Amazonian *terra firme* forests and várzea

[84], in mature forests [129] such as Atlantic rainforest [80], also a pioneer taxon. Can be common in sub-Andean forest (1000–2500 m) [311] particularly from 1500 to 1800 m [54], and in *Quercus*-dominated Costa Rican lower montane rainforest (1800–2300 m) [163], where it can dominate [54], e.g. *A. grandiflora* occurs in the Cordillera de la Costa of Venezuela [255] and in montane rainforest near Mérida [191]. *A. iricurana* is present in dry forest of central Brazil [205], *A. triplinervia* occurs in cerrado [254], *A. latifolia* in savanna gallery forest of Belize [143], *A. schomburgkii* is present on margins of Atlantic rainforest [53].

Alfaroa (Juglandaceae). Trees and shrubs found from México to Colombia [164], abundant in Costa Rican lower montane rainforest (1500–2400 m), e.g. *A. costaricensis*, a compound leafed tree of the walnut family, with relation to Tertiary relicts like *Oreomunnea* [163], is present at Monte Verde [122], often present as shade tree in pasture lands [163], extending to Guatemalan mid-altitude forest [37]. *A. williamsii* can dominate in Andean humid forest (2200–2700 m) [225].

Alibertia (Rubiaceae). Shrubs, occasionally small subcanopy trees [117], common in well-drained uplands [168] and cerrado [205], e.g. *A. edulis* is common [124], and invades Costa Rican savanna when fire regime is controlled [230]. *A. triflora* is important in Brazilian gallery forests [124] and lowland moist forest. *A. curviflora* and *A. latifolia* are present on poor soils in Amazonian *terra firme* forest [209].

Alismataceae. Herbs in shallow water [117,129], found on well-drained Amazonian floodplains [168], e.g. *Echinodorus* is abundant on Brazilian brejos [205]. See also *Sagittaria*.

Allium (Alliaceae). Herbs, occur naturally in southern Brazilian highlands [129], mostly an introduced taxon (onion) [3].

Allophylus (Sapindaceae). Shrubby low stature [117] trees present in southern Brazilian highlands [129], e.g. *A. sericeus* occurs in Brazilian dry forests [205].

Alnus (Betulaceae). Trees in mature forests, pioneer, particularly on marshy grounds [133], covering large wetland areas [54]. Mainly Andean distribution, particularly in marshy areas in high Andean forest [140,265] (2550–3100 m) [54], upper

limit may be restricted by temperature [58]. In México, Guatemala [3], Panama and Costa Rica [168] quite common in upper montane *Quercus*-dominated forests [141], extending to northern Argentina [299]. Can dominate Mexican gallery forest [251], found in association with *Quercus/Pinus*-dominated forests [241], e.g. *A. oblongifolia* is restricted to northeast México, *A. acuminata* and *A. jorullensis* have a wider distribution [29]; *A. acuminata* extending from northern Argentina to México [3]. Dominates canopy in Colombian gallery forest and upper montane rainforest [3], common following landslides, along river beds and in open rocky terrain [13,163]. Can be associated with *Clethra*, *Bocconia*, *Myrica*, *Tournefortia* and *Vallea* [146].

Alsophila (Cyatheaceae). Tree fern [117], pantropical, usually growing in understory of cloud forests and wet montane forests. Common in Atlantic rainforest [80] and lower montane Andean forest [3], e.g. *A. erinacea* is common in half shade and small forest gaps of Costa Rican montane rainforest [163].

Alstroemeriaceae. Herbs with wide ecology [265], found in Pacific coastal desert of Chile, particularly towards the southern extent [270], e.g. *Alstroemeria haemantha* is present in *Nothofagus alessandrii*-dominated forests of central Chile [33], *A. patagonica* is a rhizomatous perennial herb present on sandy soils in Patagonian and sub-Andean steppe [41], extending to *Nothofagus pumilio*-dominated forests and the southern Brazilian highlands [129].

Alternanthera (Amaranthaceae). Herbs [117], common in the savannas [140] and espinar of Venezuela [257]. This ruderal genus is present in the Chaco intersarrano of Argentina [165], present on seasonally inundated lake margins and other disturbed Amazonian sites [168]. *A. regelii* occurs in cerrado [254], *A. helleri* is a shrub in the Galápagos pampa [264], *A. halimifolia*, also present on the Galápagos Islands, extends throughout western South America [264] under tropical and warm conditions [168]. *A. nesioties* is endemic to the Galápagos Islands [139,146]. *A. philoxeroides* is frequent in floodplains and river margins from Colombia to Argentina [62].

Ammonia (Euphorbiaceae). Large rainforest

trees [129], primarily present in well-drained areas [168].

Amaranthaceae/Chenopodiaceae. Mostly herbs, present in a range of environments, good indicator of human disturbance [3,140], often found in open areas [129], present on seasonally inundated lake margins and other disturbed, bare ground sites in Amazonia [168,192], e.g. *Amaranthus cannabinus* is present in savanna/seasonal dry forest around Lake Valencia, Venezuela [30]. Present in Andean xerophytic bush (2250–2650 m) [54]. Can dominate southern South America grasslands [299], pampa [265] e.g. *Chenopodium antarcticum* can be locally dominant in saline grasslands on Tierra del Fuego [181], *Salicornia ambigua* is common in salty soils in the Atlantic shore of Argentina [63,193]. Present in moist forests, e.g. *Chenopodium ambrosioides* is present in the Atlantic rainforest [273]. See also *Alternanthera*, *Gomphrena*, *Iresine* and *Pfaffia*.

Amaryllidaceae. High Andean to lowland herbs and lianas, particularly common in inter-montane valleys [117]. *Bomarea*, a species-rich genus, common as a herbaceous liana in Costa Rican montane rainforest, much visited by hummingbirds [163]. See also *Hippeastrum*.

Ambrosia (Asteraceae). Introduced from Central America [129] (ragweed), present mainly in agricultural situations [3,166]. Forty species in México, common in disturbed areas [121], e.g. *A. dumosa* (white bursage) dominates Mexican open desert scrub [293]. Common in coastal deserts [2], e.g. *A. hispida* is common in Cuban coastal areas [47].

Anacardium (Anacardiaceae). Mainly tropical forest trees including fire resistant [124] pioneer taxon [129], common in well-drained floodplains [168], also present in Brazilian caatinga, cerrado and restinga [129], e.g. *A. occidentale* [265]. *A. humilis* is common in cerrado extending to Amazonian *terra firme* forest [124], *A. curatellaefolium*, *A. humile*, and *A. nanum* are common shrubs of central Brazilian campos and cerrado [205,254], where *A. humile* is affected by fire [203]. Present in lowland rainforest, e.g. *A. giganteum* ('Caju') is an emergent in lowland Brazilian forest [88], originating from northeastern Brazil [167]. *A. excelsum* is present in Venezuelan lowland forest near

Mérida [191], and lowland Darien forest, Panama [28], also can be very common in Colombian dry inter-Andean valleys associated with *Acalypha*, *Alnus* and *Hura* [215]. *A. parvifolium* and *A. spruceanum* are present on poor soils in Amazonian *terra firme* forest [209] and can dominate upland rainforest in central Amazonia [4], e.g. *A. giganteum* in Guyanese lowland rainforest [81]. Forty species in 16 genera are recorded in México [184]. A source for cashew nuts, it has been extensively cut for timber in Costa Rica and Panama [168].

Anarthrophyllum (Leguminosae). Shrubs present in open vegetation from 250 to 2500 m, Mendoza to Tierra del Fuego [40].

Andira (Leguminosae). Fire resistant [208] trees [117] important in cerrado [36,205,254], e.g. *A. humilis* is a common taxon of savanna, also found in Amazonian *terra firme* forest [208], e.g. *A. micrantha* and *A. unifoliolata* are present on poor soils in Amazonia [209]. *A. inermis* is present in Costa Rican tropical dry forest [230].

Anemia (Piperaceae). Creeping and upright herbs mainly of warm, tropical environments [168].

Anthodiscus (Hippocrateaceae). Large canopy and emergent trees of mature lowland forest [117], common in well-drained Amazonian uplands [168].

Anthurium (Arecaceae). Hemi-epiphytic [117] tropical Andean forest taxon [311] also recorded in campo rupestre and cerrado [3], e.g. *A. solitarium* is important in open rosette savanna dominated by *Vellozia glochidea* in campo rupestre [53]. A species-rich genus, common epiphytes in understory of Costa Rican montane rainforest, e.g. *A. concinatum* is particularly common, both as an epiphyte and a terrestrial plant [163]. *A. cubense* is common in dry areas of Cuba, such as the limestone hills (mogote) [47].

Antidaphne (Loranthaceae). Parasitic shrubs [117] common in Costa Rican upper montane rainforest, particularly *Quercus*-dominated forest [137].

Apeiba (Tiliaceae). Large trees common in mature and secondary lowland rainforest [117], common in Costa Rican primary swamp forest [105]. Commonly found in well-drained floodplains, occasionally swamps [168], e.g. *A. tibourbou* is a

typical pioneer tree of brejos [210]. *A. membrana- cea* is present around margins of lowland fresh-water swamps [230], Costa Rican lowland moist forest [230], Panamanian and Amazonian *terra firme* forest [168], Guyanese lowland rainforest [81] and Brazilian dry forests [205].

Aphelandra (Acanthaceae). Shrubs [117] common in Costa Rican tropical dry forests [230] and Amazonian mesic forests [168].

Apiaceae. Herbs common in Costa Rican upper montane rainforest [137]. *Myrrhidendron* is common in Costa Rican páramo, found along small creeks in humid alpine environments [163]. *Bolax* is a perennial herb forming compact cushions. *B. gumnifera* and *B. cespitosa* are characteristic species in Santa Cruz, Tierra del Fuego, Islas Malvinas and Chile (Magellanes), from sea-level to 3500 m [65,180]. See also *Apium*, *Azorella*, *Berula*, *Eryngium*, *Hydrocotyle* and *Mulinum*.

Apium (Apiaceae). Herbs with a wide ecology [164], fifteen aquatic genera [112] common in temperate areas, becoming rare in the tropics [112], commonly growing on lakes and marsh margins [168], e.g. *Apium australe* is found just above the high water mark on Tierra del Fuego, tolerating saline conditions [181]. Can be used as a spice, some are poisonous [20].

Apocynaceae. Trees, shrubs and lianas [117] with a wide ecology [3], common family in Chocó [116], lowland Darien forest, extending to Panama [28]. Present in dry vegetation types, several genera occur in cerrado [205].

Apuleia (Asteraceae). Trees and shrubs of dry areas [117], typical of lower Atlantic rainforest [3].

Arrabidaea (Bignoniaceae). Trees of lowland forest, e.g. the eastern Amazonian floodplain forest [302].

Arecaceae. Herbaceous lianas often associated with *Anthurium* [117], common in sub-Andean forests (1060–2530 m) [214,311], also found in lowland situations [129], the most dominant family in Chocó extending to the Pacific coast [38,116]. This family includes *Montrichardia arborescens*, an emergent aquatic growing to 4 m and forming monospecific fringes in Amazonian swamps [168]. See also *Anthurium*, *Astrocaryum*, *Euterpe*, *Geonoma*, *Iriarteia*, *Monstera*, *Oenocarpus*, *Scheelea* and *Socratea*.

Aragoa (Scrophulariaceae). Shrubs present in moist and cool páramo environments in Colombia and Venezuela, particularly in boggy areas [117], can be diagnostic of shrub-páramo (3000–3400 m) [54], common from 3800 to 3750 m, particularly under acidic conditions, often in association with *Gaultheria* and *Escallonia* [117,140], e.g. *A. lycopodioides* can dominate in subpáramo and open páramo (2300–3500 m) [54]. Can form small woody communities within the páramo in Colombia and Venezuela [222,262,308].

Araliaceae. Mostly trees and shrubs [117], some lianas [168] common in Chocó [116], *Oreopanax* and *Schefflera* are very species-rich, occupying both subcanopy, and canopy environments in northern Andean and Costa Rican montane rainforest [163]. See also *Didymopanax*, *Oreopanax* and *Schefflera*.

Araucaria (Araucariaceae). Trees forming a specific forest type in Chile and Brazil between 800 and 2000 m in permanently humid areas (1400 mm yr⁻¹) with a short dry season (<1 month) [129]. The ground flora of *Araucaria*-dominated forests contains a series of cool temperate species, often with Andean affiliations [307]. Mature individuals are fire and frost tolerant [297]. *A. angustifolia* grows above Atlantic rainforest at low latitudes (16–17°S) and at lower altitudes between 25 and 30°S [141]. However, it needs good insulation of the soil to allow for germination [307]. There is a smooth transition from Atlantic rainforest to *A. angustifolia*-dominated forests [307], sandwiched between southern open grasslands, giving way to semi-deciduous forest [141] not extending to the sea [307]. In Chile, *A. araucana* is recorded in cool temperate *Nothofagus*-dominated forests [296], in the coastal Cordillera from 37°20'S to 38°40'S mainly from 1000 to 1400 m, extending slightly farther southwards along the Andean Cordillera [296]. In the Chile–Argentina border (38°S) at 1550 m, small coppices of *A. araucana* develop on rocky substrates [233]. Low competitive ability may explain the relatively restricted range of *Araucaria* in Chile and Brazil [169]. An export ban of *Araucaria* timber in Chile since 1975 has resulted in range extension and increased tourism value [296].

Arbutus (Ericaceae). Trees and shrubs common

in México, particularly in *Quercus/Pinus*-dominated forest, occasionally extending to *Abies*-dominated forest [245].

Arceuthobium (Loranthaceae). Trees and shrubs restricted to mixed forests of Central America [117] and mountains of central México [248] from 2800 to 3800 m [117] where it is parasitic on *Pinus* and *Abies* [269].

Arcytophyllum (Rubiaceae). Shrubs common in páramo [117] (3100–4100 m) [279] on wet and dry slopes, e.g. *A. nitidum* and *A. muticum* are common in lower páramo [3,140] but with different ecologies: *A. nitidum* is common with *Calamagrostis effusa* [222], can dominate in dwarf-shrub páramo (3200–3600 m), attaining a coverage of 70% [54], also present in the bunchgrass páramo (3600–3800 m) [54]. *A. lavarum* is a Costa Rican páramo herb with a creeping habit, found in moist places [163], *A. caracasana* locally may develop shrub/dwarf tree communities [20]. Present in dry lowland areas, e.g. *A. thymifolium* is present in Pacific coastal desert [270].

Areaceae. Wide growth form and distribution but common in lowland and submontane Neotropics [168], from Belize to Guatemala and southwards throughout Central America towards Colombia, Venezuela, Perú and Brazil [126]. Usually found in low-lying wet locations, extending to 1200 m, particularly on wetter slopes [127], frequent in wet tropical Amazonia [117,129], common in Chocó [3] and understorey of Costa Rican lower montane rainforest, e.g. *Geonoma*, *Chamaedorea* and *Prestoea* [163]. See also *Attalea*, *Bactris* and *Geonoma*.

Arenaria (Caryophyllaceae). Herbs [140] common above 3500 m [307], locally dominant genus in South American high areas [170] and páramo, e.g. *A. rivularis* is present at high altitudes of Atacama Desert [226] and in puna where it is a common food of the Vicuña [309]. Present in Guatemalan mid-altitude *Pinus*-dominated forest [37] and within the Basin of México, e.g. two hydrophytic species *A. bourgaei* and *A. paludicola* [23,112].

Aristotelia (Elaeocarpaceae). Evergreen shrubs common in temperate *Nothofagus*-dominated rainforest of Chile and Argentina [180], forming an association with *Fuchsia* [299] throughout the

coastal ranges of Chile [11], e.g. *A. chilensis* is present in *Nothofagus alessandrii* and *N. dombeysi*-dominated forests of central Chile [103,297].

Armeria (Plumbaginaceae). Herbs found at high and low elevation locations [299], e.g. *A. maritima* can be important in Patagonian steppe, and about the upper forest limit of the Fuego-Patagonian cordilleras [180], often associated with *Empetrum*-dominated heath [181]. Associated with montane habitats, the creeping growth form is very common in Costa Rican montane rainforest gaps and pasture lands [163].

Arrabidaea (Bignoniaceae). Liana and shrub [117] common in savannas from México to Paraguay, e.g. *A. corallina* [48]. Present in Amazonian *terra firme* forests [168] and cerrado [254], e.g. *A. sceptrum* is a common cerrado shrub [205].

Artemisia (Asteraceae). Herbs and shrubs recorded in a wide range of environments; high altitudes in southern South America [117,180] to dry, temperate areas [20], *A. artemisifolia* is a common shrub in Amazonia; locally dominant under grazing pressure [208] and in secondary forest [93].

Aspidosperma (Apocynaceae). Large tropical trees [129] often an upper emergent in subtropical rainforest [265], present in lowland Venezuelan forest near Mérida [191], e.g. *A. carapanauba* and *A. excelsum* are present on poor soils in forest [209]. *A. olivaceum* dominates, with *Ocotea*, at high altitudes in Atlantic rainforest [80]. Many species are present in dry forests [82,205], e.g. *A. discolor* is a tree in Brazilian seasonally dry forests, also present in Amazonia [142], also found in association with *Hura* and *Pseudobombax* [82]. *A. tomentosum* is present in cerrado where it is adversely affected by fire [203], *A. quebracho-blanco* is present in central Chaco [120,165,265].

Aspilia (Asteraceae). Mostly shrubs and small trees present in cerrado [129] e.g. *A. tomentosa* [124], some ruderal taxa in the genus [168]. *A. pyricollum* is an indicator species of brejos [124].

Asplenium (Aspleniaceae). Ferns mainly terrestrial and epiphytic [140], occasionally tree-forming [117]. Recorded throughout most of South America and Central America [263], can be important on upper Andean slopes (1500–3200 m) [54], particularly in moist forests [275] and upper montane

Quercus-dominated forests of Central America [141] e.g. *A. serra* [163]. *A. dareoides* forms part of understorey in *Nothofagus pumilo*-dominated forest [181], although with a wider distribution [179].

Astelia (Liliaceae). Herb, typical of moorland [180] in southernmost South America and south-eastern Brazil [263]. *A. pumila* forms understorey beneath *Pilgerodendron*-dominated forest [181], also important in Magallanic moorland, particularly in cushion bogs [181].

Asteraceae. Lianas [117], herbs, shrubs and small trees with a wide ecology [112,140], mostly Andean distribution [168], also present from dry vegetation formations [261,270] to Chocó [116]. Can be the dominant family above the forest line in highland Argentina, accounting for approximately half of the species present [303], also common in Costa Rican ‘subalpine’ zone [137] and Ecuadorian upper montane rainforest [288]. Together with Poaceae and Ericaceae, the most important plant family in Costa Rican páramo; with numerous endemics e.g. *Westoniella* [163]. One of the dominant families in cerrado [281] and pampa grasslands, e.g. *Baccharis*, *Eupatorium*, *Hypochoeris* and *Vernonia* [213]. *Baccharis magellanica* is a prostrate shrub common in clearings in *N. pumilio*-dominated forest [41] and in arid and sunny sites or on stony soils of high slopes along the Andes, from Mendoza to Tierra del Fuego [152]. *Lepidophyllum*, comprises only one species in southern Patagonia, *L. cupressiforme*, an endemic shrub on brackish soils [43], forming thickets in coastal slopes, it is not obligatory halophyte but tolerates high content of salt [193]. *Nardophyllum bryoides* is a shrub forming dense cushions, dominate in sub-Andean locations [41]. In Argentina more than 270 species of *Senecio* are present, in Andes and Patagonia, e.g. *S. perezii* is endemic to southern Mendoza and west Neuquén, *S. baccharidifolius* is present in the mountainous region of southern Chile, *S. bracteolatus*, *S. neaei* and *S. subumbellatus* are endemic to northern Patagonia, *S. flaginoides* is common in arid regions from Tucumán to Santa Cruz, *S. pachyphyllos* is endemic to Andes south of Mendoza to Rio Negro, *S. subulatus* is frequent on sandy soils of the Monte [43]. *Cichorium*, *Lactuca*, *Lapsana*, *Picris* and *Sonchus* have

the Liguliflorae pollen type, can be distinguished from other Asteraceae, these were introduced from Europe [246]. *Hieracium*, *Pinaropappus*, *Pyr-rhopappus* found above 2200 m in México, particularly in pastoral or disturbed areas [20]. See also *Aspilia*, *Baccharis*, *Bidens*, *Caltha*, *Carduus*, *Chiquiragua*, *Dasyphyllum*, *Espeletia*, *Junga*, *Mutisieae*, *Nassauvia*, *Pamphalea*, *Perezia*, *Senecio*, *Trichocline*, *Trixis* and *Vernonia*.

Astragalus (Fabaceae). Herbs, several species in Andes, Patagonia [64] and puna [117], e.g. *A. arnottianus*, recognisable by a very bulbous flower [307], found in northern Chile above 3000 m [13,301], *A. curvicaulis* is present between 2200 and 2600 m [15] in the Mexican Hornaday Mountains [293], *A. peruvianus* is present in puna, the Chimbarazo in Ecuador [3]; a common food of the Vicuña [309].

Astrocaryum (Arecaceae). Palms of flooded areas [117], particularly prevalent in várzea [140,208], e.g. *A. vulgare* is present in prehistoric Amerindian mounds in the Amazon estuary, *A. jauari* is present in eastern Amazonian floodplain forest [302] and along black water river margins [126], *A. maripa* is present at archaeological sites on the Rio Xingú, Amazonia [126]. Present in Atlantic rainforest, usually in well-drained areas, e.g. *A. aculeatissimum* and *A. chambira* are particularly common [168,273]. *A. aculeatum* can be a common regenerating taxon of abandoned pasture in Brazilian Amazonia [88]. Present in Central America, e.g. *A. alatum* and *A. confertum* are found in Costa Rican lowland swamps [140,230], *A. alatum* in primary swamp forest [105]. *A. mexicanum* is present in Mexican lowland rainforest [118]. *A. sciophilum* comprises two varieties described by different stem characteristics either side of the ‘dry Amazonian corridor’ [126].

Astronium (Anacardiaceae). Strongly aromatic subtropical trees [117], mostly present in Brazilian dry forests [117,129], also found in liana-dominated forest [208], e.g. *A. balansae* is important in seasonal rainforest [120] and other mesic forest types [168], present in Argentinean Chaco. Typical tree in dry forest associations of Colombian Caribbean area, e.g. *A. graveolens* is present with *Capparis*, *Tabebuia* and *Trichilia*, particularly on calcareous substrate [218,253].

Atamisquea (Capparaceae). Desert shrubs [299], often in association with *Larrea* and succulents, e.g. found in Monte Desert, Argentina [165].

Attalea (Arecaceae). Palms widely distributed throughout Central and tropical South America [126,140], mainly western Amazonian [117], usually on well-drained land [168], e.g. *A. butyracea* is present along white water river margins [126]. Present in dry forests, e.g. *A. herbert-smithii* is present in Costa Rican tropical dry forests [230], *A. cubensis* is common in Cuba and Yucatán [47]. *A. maripa* fruits are an important source of protein [161].

Austrocedrus chilensis (Cupressaceae). Conifer important in southern South America although scattered populations reach 32°N, fire intolerant [296]. Where the precipitation is less than 1700 mm yr⁻¹, it can form pure stands [297]. *A. chilensis* is found in cool temperate forests co-dominated by *Nothofagus* although it can withstand more xeric conditions than *Nothofagus* spp. [297]. Near 40°S this taxon will form the forest line to steppe ecotone. *A. chilensis* has been extensively used for dendrochronological work, particularly useful for calculation of annual precipitation [207].

Avicennia (Verbenaceae). Mangrove tree [117] of coastal scrub-lands, occurring behind the *Rhizophora* fringe, usually disappearing upstream before *Rhizophora* [290]. *A. schaueriana* is found in Atlantic mangrove [80], *A. nitida* (white mangrove) can be found a long way upriver, as far as the freshwater zone [208], the dominant mangrove tree species in lowland Atlantic Costa Rica [163]. *A. germinans* (black mangrove) is found in littoral zone of the Galápagos Islands, a very high salt tolerance [264], often associated with *Batis maritima* and *Coccoloba uvifera* [27]. Plant interaction with *Rhizophora* has been focus of forest dynamic models [26].

Ayenia (Sterculiaceae). Shrubs, can be common in dry vegetation associations [117].

Azara (Flacourtiaceae). Herbs present in coastal Chile [11], particularly in wet montane *Nothofagus*-dominated forest [299], e.g. *A. lanceolata* is present in *Nothofagus obliqua*-dominated forest [296], *A. celsastrina*, *A. integrifolia* and *A. serrata* are present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Azolla (Salviniaceae). Aquatic (duckweed [168]) floating fern with wide distribution from 0 to 3600 m throughout Latin America [129], also on the Galápagos Islands [285], and high Andes [265], around recently formed mountain lakes [314]. Microspores embedded in massulae [285].

Azorella (Apiaceae/Hydrocotylaceae). Perennial cushion-forming herbs and shrubs in the high Andes [265], around recently formed mountain lakes [275,299,314], extending to Patagonian steppe [117,180], e.g. *A. caespitosa* is found in association with *Empetrum*-dominated heath [181], *A. crenatae* found in the Andes of Peru to Venezuela [56]. Often used as fuel [299]. *A. antarctica* present as a cushion form at the highest altitudes in Argentina [120], from 2700 to 3100 m in central Chile [13], *A. lycopodioides* can be common in frost hollows in *Nothofagus*-dominated forests, also present just above forest line [181], extending to high plateau of Costa Rica, Colombia and Venezuela [65]. *A. fillculoides* is recorded from the Magallanic Moorland [179], *A. compacta* grows as a dark cushion form in the high Andes, up to 4700 m in Chile [301], common at high altitudes of Atacama Desert [226], *A. ameghinoi*, *A. caespitosa* and *A. multifidae* are common in high Andes [65,66]. Can form dominant association with *Agrostis* and *Lachemilla* [146].

Baccharis (Asteraceae). Frequent in southern Brazil highlands, an important Andean taxon [117,129], extending to subpáramo [140] as a pioneer tree and shrub [168], also important in campo rupestre [124], subtropical saltmarshes [168], and Mexican highlands (2300–3600 m) [269], e.g. *B. salicifolia* is found along streams in the Basin of México [130]. Several species are found in *Pinus/Quercus*-dominated forests, e.g. *B. conferta* is common at forest margins [269]. Several varieties of *B. tricuneata* occur as low shrubs throughout the high Andes; e.g. *B. procumbens* is common in Colombian and Venezuelan páramos [256], *B. prunifolia* can be common in high Andean shrub/dwarf tree forests (3200–3450 m) [54], *B. petiolata* [15] and *B. tricuneata* can dominate dwarf-shrub páramo (about 3150 m) [54], *B. petiolata* and *B. juncea* are present at low altitudes of the Atacama Desert [226], *B. microphylla* is present in the puna where it is a common food

of the Vicuña [309]. *B. pedicellata* and *B. racemosa* are present in *Nothofagus alessandrii*-dominated forests of central Chile [103], *B. patagonica* can be scrub-forming in sheltered, relatively mesic, locations around forest margins [181]. *B. flexuosa* has a wide distribution from north-western Argentina to southern Brazil [195], also present in moist forests, *B. trimera* is present in Atlantic rainforest [273]. *B. halimifolia* is present in desert areas of Cuba [47]. In Colombia can form *Baccharis nitida* a specific type of matorral, e.g. *B. caespitosa*, *Baccharis nitida*, *B. revoluta* and *B. tricunata* found in volcanic areas, e.g. free-draining areas around Caldas to Tolima [260]. *B. revoluta* is present in the dry paramo (3500–4000 m) [279].

Bactris (Palmae). Trees present in dry vegetation formations, e.g. *B. cuspidata* is common in caatinga, *B. simplicifrons* is restricted to the Roraima complex of Guiana highlands [48]. Present in Amazonian rainforest and montane rainforest, e.g. *B. mexicana* is present in Costa Rican montane rainforest, at Monte Verde [122].

Balfourodendron (Rutaceae). Subtropical forest trees of north-western South America, common in Chaco thorn forest [117].

Banara (Samydaceae). Shrubs and herbs found mostly in Chile [117], also present in Brazil [129] within secondary forests [117].

Banisteriopsis (Malpighiaceae). Mostly lianas [168] of dry forest and Amazonia high river terraces [117], e.g. *B. angustifolia* and *B. malifolia* are important in cerrado [124], *B. muricata* in Costa Rican tropical dry forest [230].

Banksia (Proteaceae/Lythraceae). Fire resistant trees mainly restricted to Australiasia, present on Easter Island [164].

Bartsia (Scrophulariaceae). Herbs, sometimes woody [117] present in subpáramo and grasspáramo [3,54].

Bauhinia (Caesalpiniaceae). Mostly lianas [168] present in lowland and drier forest types of north-western South America, extending to Brazil and Argentina [117], recorded in cerrado [124,254].

Begoniaceae. Epiphytic lianas and herbs [3,117]. *Begonia* is a species-rich genus of flowering plants, epiphytes and terrestrial plants of Costa Rican lower montane rainforest, abundant in secondary

forests [163] and after landslides [168]. Rare in Amazonia, present on Brazilian brejos [205].

Berberidaceae. Shrubs and small trees found mostly above the forest line [117,129], e.g. *Polylepis*-dominated forests (2900–4200 m) of the northern Andes [54]. *Berberis* and *Mahonia* are important shrubs in montane Costa Rica [163], the former also in upper montane rainforest and subpáramo of northern Andes [3], e.g. *Berberis empetrifolia*, is a gorse-like shrub of montane areas (2300–3500 m) [307]. Present in dry forest, e.g. *B. trifoliolata* can dominate subtropical savanna [147]. Common in southern South America, e.g. *Berberis empetrifolia* can form coastal scrub on Tierra del Fuego [181], *B. ilicifolia* can form understorey beneath *Nothofagus pumilo*-dominated forests, whereas *B. buxifolia* is a shrub of Patagonian steppe [265], forming an understorey beneath *Nothofagus antarctica*-dominated forests, both of these scrub-forming around forest margins [181]. Of the 50 genera in Latin America, 32 are present in México, particularly in *Pinus* and *Quercus*-dominated forests [174]. *B. buxifolia*, due to the very tasty berries, can be either locally dominant (or absent) because of human influence [265].

Bernardia (Euphorbiaceae). Mainly herbs and small sub-shrubs restricted to coastal and southern Brazil [129].

Berula (Apiaceae). Aquatic herbs, some emergent, two species present in South America, common around lake margins [112].

Betula (Betulaceae). Introduced trees mainly confined to plantations [3].

Bidens (Asteraceae). Herbs and lianas with a pan Latin American distribution, mainly weeds in cultivated fields [256]. Present in moist forests, e.g. *B. pilosa* in Atlantic rainforest [273], and as a climber in upper montane rainforest of the northern Andes [3]. Can be locally dominant at mid-altitudes in Colombia, e.g. *B. laevis* is present around the high plain of Bogotá [314].

Bigoniaceae. Lianas and trees with wide ecology [117], normally associated with lowland rainforest, absent from Chocó [116], 203 species recorded in Amazonian forest around Manaus, Brazil [196,283]. *Jacaranda puberula* is present in the Atlantic rainforest [273], *Jacaranda copaia* is

present on poor soils in Amazonian *terra firme* forest [209]. See also *Arrabidaea*, *Jacaranda*, *Tabebuia* and *Tecoma*.

Blechnum (Blechnaceae). Mostly herbaceous ferns, occasionally trees [117,230], extending from lower páramo to savanna [285] mainly present in sub-Andean and Andean forests (1500–3200 m) [54], forming an understorey beneath *Alnus jorullensis*-dominated forests (2500–3100 m) [54]. *B. occidentala* is a tree fern found in dry Andean forests (2600–2750 m) [54], *B. buchtiinii* is a non-cytheaceous-like tree fern, common around the margins of montane bogs in Costa Rica [230], also common in paramillo [163], e.g. *B. loxensis* and *B. columbiense* are present from 3200 to 3380 m in Colombia [157]. *B. blechnoides* and *B. chilense* are present in understorey of *Nothofagus alessandrii*-dominated rainforest of southern and central Chile [103,300].

Bocconia (Papaveraceae). Trees often found in montane rainforest [117], restricted to altitudes above 1000 m [54], e.g. *B. frutescens* is common at high altitudes (2600–2750 m), often associated with *Miconia* and *Weinmannia* [54]. *B. frutescens* is an important source of dye with a shrubby habit, occurring in Costa Rican montane rainforest gaps and open areas, a rapid-growing pioneer [163]. Present in Guatemalan and Mexican lower montane rainforest [3].

Bombacaceae. Large bat-pollinated [168] rainforest trees [116,117] present in upland areas and in floodplains [168], important in Chocó [116], *Bombacopsis nervosa* is present on poor soils in Amazonian *terra firme* forest [209]. The genus *Ceiba* occurs in dry forests, *Pseudobombax*, *Eriotheca* and *Chorisia* are trees in cerrado and Brazilian dry forest [205], *Bombax emarginatum* is common in dry areas of Cuba, such as the limestone hills (mogote) [47]. *Bombacopsis fendleri* is present in mature lowland rainforest on the Barro Colorado Islands, Panama [46]. See also *Pseudobombax*, *Quararibea*, *Rhodognaphalopsis*, *Scleronema* and *Spirotheca*.

Bonamia (Convolvulaceae). Lianas [117] mainly from tropical lowlands [168].

Boraginaceae. Wide growth form and ecology, usually present as herbs [117] in extra-tropical dry areas [117]. *Cordia* is an important genus [3], me-

dium-sized trees common in Panamanian and Costa Rican lowland rainforest [168]. See also *Cordia*, *Mattia*, *Moritzia* and *Tournefortia*.

Borreria (Rubiaceae). Herbs with a wide ecology [59], from open savannas [140] to lower páramo [3], e.g. *B. laevis* is very widespread in Colombia; found from the Llanos Orientales to dry matorral in the Andes [69]. Can be indicative of human impact [117,140], e.g. present as a sprawling weed on bare ground around Amazonian lake margins [168]. Can form understorey beneath *Alnus jorullensis*-dominated forests (2500–3100 m) [54], often being found in upper Andean forest clearings [54]. Several species occur in cerrado [254] and campo [53,205], e.g. *B. latifolia* is a drought-adapted taxon common in savanna areas [210], *B. laevis* is a herb of Galápagos pampas [264].

Bougainvillea (Nyctaginaceae). Lianas occurring along coastal Perú and in dry forest types [140], e.g. inter-montane Andean valleys [117], *B. stipitata* is important in Argentinean montane rainforest (ca. 1000 m) [195], *B. speciosa* can dominate in Monte Desert, extending to Chaco thorn forests [165].

Bowdichia (Leguminosae). Shrubs found in savanna from Venezuela to southern Brazil [48], e.g. *B. virgiliodes* is present in cerrado where it is fire intolerant [203].

Brassicaceae. Widely introduced [140], comprising mainly Andean taxon, can be common in southern South America [117,129]; represented in the pampa grasslands by about 50 species, of which 60% are introduced, common in disturbed sites [42]. Native as well as introduced taxa occur on dunes, sandy (e.g. *Diplotaxis muralis*, *Cakile maritima* and *Lepidium bonariense*) or halomorphic soils [42,62]. Can often dominate several communities, encouraged by frequent disturbance [132]. Brassicaceae are found in high percentages in several fossil pollen samples of the Late Glacial–Holocene transition of the pampa grasslands [234]. Three genera have aquatic species, e.g. *Cardamine* is present around lake margins in México and Colombia [3,20,112].

Bromeliaceae. Predominately epiphytes from Andean and lowland habitats [117]. Numerous speciose genera, e.g. *Catopsis*, *Greigia*, *Pitcairnia*,

Puya, *Tillandsia* and *Vriesea* grow on trunks and branches of canopy species in Costa Rican montane rainforest [163,230]. Present in Chocó although rare [116] but relatively common in Atlantic rainforest [17] in moist, shaded locations, e.g. *Aechmea* [168]. Can be extensive in dry areas such as caatinga [261], e.g. *Bromelia hieronymi* is present on sandy soil in Monte Desert [165], *Pitcairnia aracaensis* is present on sandstone tepuys in Brazil [48]. See also *Greigia* and *Puya*.

Brosimum (Urticaceae). Large tropical trees, the latex is used for chewing gum [164]. *B. utile* is present in Chocó [116], extending to Costa Rican lowland moist forest [230], *B. lactescens* is present in well-drained floodplains of Colombian Amazonia [83], *B. alicastrum* can be dominant in Chocó, extending to southern México [229], *B. utilae* is present from Darién to Ecuador [313]. *B. guianense* and *B. lactescens* are common in Costa Rican primary swamp forest [105], *B. alicastrum* is present in Mexican lowland rainforest in Chiapas [197] and *B. guianense* in Guyanese lowland rainforest [81]. Present in dry forest associations, e.g. *B. gaudichaudii* is a common shrub in cerrado [254]. *B. alicastrum* is common in Cuba and Yucatán [47]. *B. alicastrum* forms associations with *Eugenia* *Randia* [190] and *Clathrotropis* [280], *Cecropia*, *Tococa* and *Vochisia* along the Cordillera Occidental, Colombia [221].

Brownea (Leguminosae). Medium-sized cauliferous trees [117], often present in Amazonian floodplains [168], e.g. *B. grandiceps* is abundant on well-drained Colombian Amazonia floodplains [83], *B. latifolia* is present in lower montane rainforest in the Lake Valencia catchment, Venezuela [30]. *B. grandiceps* forms associations with *Iriartea deltoidea* in Colombian Amazonia [87].

Brunellia (Simaroubaceae). Single genus distributed from Panama to Bolivia, also in Central American and Greater Antilles [158]; secondary forest/light-gap trees of northwestern South America [117] usually found in mesic montane rainforest [198]. Often associated with *Quercus humboldtii* (2300–2800 m) [54], e.g. *B. costaricensis* is a common tree species of late secondary Costa Rican montane rainforest [163,230]. Two species are also found in lowland forests [117], e.g. Chocó, where it is present all the way to sea-level

[116]. *B. goudotii*, *B. occidentalis* and *B. macrophylla* are frequent about the tropical to sub-Andean transition (2200–2400 m), often in association with *Clethra revoluta*, *Hedyosmum* and *Weinmannia* [216,219] *Brunellia macrophylla* is a 20-m tall tree [198], often characterised by numerous epiphytes, particularly common in areas of good drainage (2900–3000 m) [222]. There is a continuous geographical distribution throughout the western Andes from Ecuador to Costa Rica, although named as different species (*B. acostae* in Ecuador, *B. diversifolia* in Colombia and *B. dariensis* in Panama) they are the same species [158].

Buddleja (Buddlejaceae). Shrubs, forming monospecific stands [90] in subalpine dwarf forest of 6- to 12-m stature in Costa Rican upper montane rainforest, particularly at the upper forest limit bordering páramo shrubland [163]. Common in upper montane *Quercus*-dominated forests of Central America [141], and upper Andean dwarf forest [54,175], e.g. *B. cordata* is found on fresh lava flows in the basin of México [45], *B. incana* can form dense forest of small trees along the Cordillera Oriental [216]. Present in *Pinus*-dominated forests and ‘matorral xerófilos’ [248]. *B. globosa* is common in open forest of Argentina and Chile [152].

Bulnesia (Zygophyllaceae). Tropical trees and shrubs [164] important in dry plant formations of South America, extending to northern-central Chile, common in Argentina [164,261], e.g. the Monte Desert, particularly around 900 m [165]. In Colombia, *B. arborea* forms associations with *Arrabidaea*, *Capparis*, *Prosopis* and *Machaerium* [253,284,286].

Bumelia (Sapotaceae). Subtropical trees common in drier forests [117], can dominate subtropical savanna [147].

Bursera (Burseraceae). Trees and shrubs found throughout western coastal Central America, a few records in the Pacific areas of México and in Amazonia [3] – a well distributed genus [58,166,248,269]. Important in the dry plant associations [261], e.g. *B. microphylla* is present in Mexican Sonoran Desert scrub [293], extending to coastal deserts [2] and Costa Rican tropical dry forests [230], *B. gummifera* is common in dry coastal areas of Cuba [47], *B. graveolens* in

the dry forest zone of the Galápagos Islands [264]. *B. glabra*, *B. graveolens*, *B. simaruba* and *B. tomentosa* are characteristic of Colombian semi-desert and dry forest formations around the Caribbean coast and in dry inter-Andean valleys such as the Magdalena and Cauca [222,253], where they can form communities with *Bactris*, *Bombacopsis*, *Capparis*, *Castela*, *Prosopis* and *Pseudobombax* [224,284,286]. *B. simaruba* is used as live fencing in México [118] and is present in savanna/seasonal dry forest around Lake Valencia, Venezuela [30].

Byrsonima (Malpighiaceae). Small trees characterised by typically xeromorphic features, forming monospecific stands in savanna-scrub associations [117], can withstand the invasion of more closed forest [305], also a good and fire resistant pioneer [305]. Usually found in grass/savanna habitat, common from Venezuela to South Brazil [48], also in tropical rainforest on the Brazilian Shield, particularly in areas characterised by poor soils [117,129] and dry settings [168], forming an open treelet/shrub savanna in Carajás, Brazil [53], e.g. *B. sericea* and *B. stannardii* [124]. *B. crassifolia* is a common taxon in campo rupestre [167], also in Brazilian coastal restinga [208]. Can form a savanna association with *Curatella*, but it can form monospecific stands, particularly under more humid conditions from Cuba to Brazil [305], e.g. *B. coccolobaefolia*, *B. dealbata* [124] and *B. verbascifolia* [48] are found in dry tropical forests of northern Colombia [54], occasionally extending to swampy areas [168]. *B. crassifolia* and *B. verbascifolia* can be indicative of locally humid conditions in dry savanna of the Llanos Orientales [30], these taxa can dominate in seasonally inundated savannas of a wide geographical range [48]. Found in association with *Ilex*, *Mysine* and *Podocarpus* at higher elevations (> 1000 m), *B. crassifolia* is common on exposed ridge-tops (drier areas) in the derived savannas of Costa Rica [230], it is also quick to re-invade abandoned lowland pasture of Brazil [88]. Can be present in moist forests, e.g. *B. amazonica* is present in the eastern Amazonian floodplain forest [302], *B. arborea*, *B. duckeana* and *B. fernandezii* on poor soils in Amazonian *terra firme* forest [209]. *B. japurensis* can form associations with *Inga* in Co-

lombian Amazonia, particularly along clear water rivers [87].

Byttneria (Sterculiaceae). Shrubs and lianas [117] common in dry areas [117], e.g. *B. catalpiifolia* is present in Costa Rican dry forests [265].

Cactaceae. Epiphytic rainforest lianas, also present in coastal and semi-arid areas [117,165], e.g. a *Cactus*-dominated forest is present on the Galápagos Islands, *Opuntia* and *Jasminocerus* forming a dense undergrowth [264]. Common in xerophytic bush on drier Andean slopes (2250–2650 m) [54], an important component of caatinga [261]. Several genera (*Cylindropuntia*, *Mammillaria*, *Myrtillocactus* and *Opuntia*) are present in dry parts of México [269], being important in xerophytic shrubs and desert [248], very high rate of endemism with some 73% of genera and 78% of species being endemic [123]. See also *Echinopsis*, *Heliocereus*, *Opuntia* and *Rhipsalis*.

Caesalpinia (Caesalpiniaceae). Herbs and shrubs important in dry forest associations of central and southern South America [117,261], e.g. caatinga [261]. Some taxa extend to wetter forests [3,175], e.g. *C. bonduc* is an important taxon of the transition zone, from seasonal to dry forest, on the Galápagos Islands [264], *C. violaceae* is common in Cuba and Yucatán [47], *C. bahamensis* is common in driest areas of Cuba [47].

Calceolaria (Scrophulariaceae). Herbs and shrubs common in steppe, particularly at low elevations [117], extending to the northern Chilean Andes at relatively high altitudes [13], forming an understorey beneath *Alnus jorullensis*-dominated forests (2500–3100 m) [54]. Can be characteristic of low wet páramo, upper montane rainforest, subpáramo and páramo [140], e.g. *C. luxurians* is found from 2600 to 3500 m [307], *C. trilobata* is a common herb of secondary shrubland, pasture and roadsides in Costa Rican montane rainforest [163]. *C. ascendrus* is found in dry sclerophyllous vegetation of the South America Pacific coast [265] and Patagonian steppe [180,265], *C. stellarifolia* is present in Atacama Desert at high altitudes [226], *C. biflora* can be locally important in sheltered locations (mesic) along forest margins [90], also being recorded in the Patagonian cordilleras [181], *C. picta* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Calliandra (Mimosaceae). Small shrubs to trees common in montane areas of northwestern South America [117], widespread pioneer in Atlantic rainforest [80], extending to Argentinean subtropical rainforest [265]. Can be particularly common along fast-flowing streams. Present in dry areas [117,299], e.g. *C. erubescens* and *C. parviflora* [254] are commonly recorded in cerrado [124,205], occasionally present in Amazonia [168], the open shrubby vegetation of northern-central Chile [152,165], and the Monte of Argentina [165]. *C. galapagosa* is endemic to San Cristóbal (Galápagos Islands) where it is common in the arid zone [139].

Caltha (Ranunculaceae). Herbs characteristic of high altitude areas [181], present northward along the Andes to Ecuadorian páramo [138], e.g. *C. appendiculata* forms cushion heath just above the southern South America forest line, widespread throughout Tierra del Fuego [181].

Calycera (Calyceraceae). Southern temperate steppe and Andean herbs [117,299], can be common in puna [299], present along the Andean eastern flanks [181], e.g. *C. crassifolia* is frequent in coastal dunes of pampa grasslands [62].

Campanula (Campanulaceae). Herbs common above the treeline, particularly in late secondary forest [117], Costa Rican mature montane rainforest [163], particularly in upper Andean valleys [275], also frequent in dry Brazilian forests [205].

Campomanesia (Myrtaceae). Trees mainly from lowland areas of northwestern South America [117].

Caperonia (Euphorbiaceae). Aquatic and semi-aquatic herbs [117] mainly with a tropical lowland distribution [168].

Caraipa (Ternstroemiaceae). Trees and shrubs present in tropical South American lowlands and in floodplains [168], e.g. *C. punctulata* is present in poorly drained uplands of Colombian Amazonia, particularly on podzolised soils [83]. Can be common in seasonally inundated savanna of the Llanos Orientales [30], particularly where the water is 20–30-cm deep [30], also recorded in Belize gallery forests [296] and Costa Rican primary swamp forest [105]. Present in dry vegetation types, e.g. *C. aracaensis* is present on sandstone tepuys in Brazil [48].

Cardiospermum (Sapindaceae). Lianas common in lowland rainforest [164], Amazonia [168].

Carduus (Asteraceae). Herbs (thistles) common in mountain areas [164]. Numerous species are introduced and common in human-induced disturbed habitats, e.g. the pampa grasslands [234]. *Carduus*-type appears in pollen records of the Late Glacial–Holocene transition of the pampa grasslands suggesting some species are native and not introduced by Europeans [234].

Carpinus (Cupuliferae). Trees, monospecific in México, extending throughout North America from Mexican mountains (1750–2500 m), often in association with *Quercus*-dominated forests [29].

Cariniana (Myrtaceae). Emergent trees of mature lowland rainforest [117], extending to well-drained Amazonian uplands [168] e.g. *C. estrellensis* is a canopy emergent of Atlantic rainforest, occasionally rising to 50 m [80], present in southern Amazonia, particularly in gallery forests and brejos [210]. *C. pyriformis* forms a low altitude humid tropical forest association in Colombia with *Carapa*, *Cedrela*, *Inga*, *Lecithys*, *Matayba*, *Protium* and *Trichilia* [221,280].

Caryocar (Ternstroemiaceae). Bat-pollinated [168] trees and shrubs with a wide ecology but predominated in lowland Amazonia [48], e.g. *C. microcarpum* is present in eastern Amazonian floodplain forest [302]. Associated with *Araucaria*-dominated forests [59], forming large trees of tropical seasonal forest [58], e.g. *C. glabrum* is present in well-drained floodplains of Colombian Amazonia [83], and on poor soils in Amazonian *terra firme* forest [209]. Community characterised by *Caryocar glabrum*, *Guatteria* and *Xylopia amazonica* is quite common in Colombian lowland tropical forest [85]. Can be an important tree in savanna, extending to cerrado [117,129], e.g. *C. brasiliense* [124,205,254], and caatinga, e.g. *C. gracile* [48]. However, it does not presently occur in most savannas, as it is easily dispersed it can migrate rapidly during drier climate periods [48].

Caryophyllaceae. Mostly herbs, cosmopolitan, frequent under dry conditions [117,129], e.g. *Polycarpaea corymbosa* occurs in cerrado [205]. A few taxa are present in tropical lowlands [117, 129], specifically on open, sandy beaches [3]. Can dominate on dry exposed slopes [14] in upper

páramo as a cushion plant in southern Chile and the Venezuelan Andes [133,112,255] extending to México, e.g. *Arenaria borgaei*, *A. lycopodiodes* and *A. reptans* grow in Mexican highland alpine grasslands [23]. See also *Arenaria*, *Cerastium* and *Stellaria*.

Casearia (Flacourtiaceae/Samydaceae). Wide ecology and growth form [117], present in Costa Rican tropical dry forests [230] and montane rainforest [288], e.g. *C. tacanensis* is present at Monte Verde, Costa Rica [122], *C. sylvestris* is an infrequent tree of Amazonian rainforest [117], locally common in seasonal savanna [50] and Costa Rican primary swamp forest [105], *C. arborea* is common on brejos [124]. Present in dry forest associations, e.g. in Cuban semi-xerophytic vegetation [13,35], *C. commersoniana*, *C. grandiflora*, *C. rupestris* and *C. sylvestris* are common shrubs of cerrado [124,205,254], where the latter species is affected by fire [203], *C. zizyphoides* is found on free-draining soils in the Llanos Orientales [30], *C. petraea* is a shrub, often associated with *Curatella americana* in the Llanos Orientales [30].

Cassia (Caesalpinaceae). Trees common in dry areas [80,265] e.g. Monte Desert [18,180], extending to cerrado [36], the Chaco thorn forests [165,270] and as a shrub in the prepuna (2000–3400 m) [165], *C. aphylla* is common in montane dry steppe, *C. moschata* is common in Roraiman dry forests [208], *C. picta* is important shrub of the Galápagos Islands dry forest [264], also recorded in Ecuador and Perú [264]. *C. tetraphylla* is present in the Llanos Orientales, particularly on dunes of the aeolian plain, whereas *C. flexuosa* is more common in the piedmont region and on alluvial fans [30], *C. biflora* is an invasive taxon of Costa Rican derived savanna areas and into México [93]. Several species occur in cerrado, e.g. *C. rugosa*, it being particularly affected by fire [203,230], its pollen cannot be distinguished from those of cerrado species of *Hymenaea*, *Indigofera* and *Tephrosia*; forming ‘*Cassia*-type’ [254]. *C. linata* is present in desert areas of Cuba [47], *C. nigricans* is present in Cuban semi-xerophytic vegetation [13,35].

Castilla (Urticaceae). Large trees [117] (used for the rubber latex [208]) of Atlantic [208], Central American and Brazilian rainforest [117], e.g. *C.*

reticulata is present in inundated savanna [208], *C. panamensis* is present in mature lowland rainforest on the Barro Colorado Islands, Panama [46]. *C. elastica* is present in Darién, Colombia, naturalised and extensively planted [222].

Casuarina (Casuarinaceae). Introduced tree common among populated areas [3,129].

Catostemma (Malvaceae). Trees, common on poor soils [117], e.g. the Guiana Shield area [117], rainforest and marsh forest, occasionally in savanna [290], e.g. *C. fragrans* is present in Guyanese lowland forest [81,104], *C. albuquerquei* is present on poor soils in Amazonian *terra firme* forest [209].

Cayaponia (Cucurbitaceae). Creeping succulents [117] common in well-drained uplands [168] and dry forest [231], e.g. *C. tayuya* [205] and *C. espedina* occur in cerrado [254].

Cecropia (Urticaceae/Moraceae). Trees of fertile soils and a common pioneer of secondary forest [117], a mainly lowland distribution, occasional in sub-Andean forest (1000–2500 m) [54,117] but not above 2500 m [54], e.g. *C. polyphlebia* is a large tree in Costa Rica, at Monte Verde [122], e.g. *C. insignis* and *C. obtusifolia* are present in primary swamp forest [105] and young successional forest [168]. Occurs in the dry evergreen forest and secondary forests of the Venezuelan Andes [255], present in lower montane rainforest in the Lake Valencia catchment, Venezuela [30]. *C. ficifolia*, *C. membranacea* and *C. pacis* are all common in secondary forest in Colombia (2000–2500 m), where they can form an association with *Apeiba*, *Ochroma* and *Trichospermum* [54]. A typical pioneer of Atlantic rainforest [80], e.g. *C. glaziovii* [273]. Present in Amazonian rainforest, e.g. *C. membranacea* is present on the well-drained floodplains of the Caquetá River [88], *C. polyphlebia* is prominent (<1200 m), rare at higher elevations, to 2300 m in Costa Rica [163]. Two species occur in Brazilian dry forests [205] and grasslands of *Canarana* parkland [208]. *C. obtusifolia* is used as live fencing in México [118]. Individuals are very fragile as seedlings [35].

Cedrela (Meliaceae). Trees common in late secondary growth forest [117], particularly in southern Brazilian Atlantic rainforest [80,117,129], e.g. *C. fissilis* [273], also present in Colombia [3] ex-

tending to sub-Andean forests [54] and the well-drained floodplains of Amazonia [168], particularly along the upper Amazon where it is a very large emergent [153]. *Cedrela* forms riparian associations with *Aspidosperma Attalea*, *Celtis*, *Coccoloba*, *Myroxylon*, *Protium*, *Tabebuia* in lowland Colombia [222]. *C. odorata* is an important timber (cedro), occurs in Brazilian dry forests [205].

Celasteraceae. Usually represented by *Maytenus*; a shrub and riparian tree [117] found in montane rainforest and Venezuelan coastal forest [117]. Found throughout the Antilles (including Cuba) [3], represented by a single species in Chocó [116]. *Crossopetalum* and *Maytenus* occasionally occur in Costa Rican montane rainforest, particularly under humid conditions [163]. *Maytenus disticha* [180] and *M. boaria* are present in open *Nothofagus*-dominated forest/woodland throughout southern South America [180]. Present in dry forest associations, e.g. *Plenckia (Austroplenckia) populnea* is very frequent in cerrado [205,254].

Celtis (Ulmaceae/Urticaceae). Medium to large trees [117], often an indicator of high canopy turnover [168], a component of early–mid successional forest following human disturbance [59,168]. An Andean and southern South American distribution; a few species are recorded from Amazonia and northern Colombia seasonal forest [117,129], also extending to México [3,183]. Common in Costa Rican lower montane rainforest [137], e.g. *C. schippii* is present in Costa Rican primary swamp forest [105]. Common in southern South America, e.g. *C. iguanaeus* forms xerophytic open forest in northern extreme of Chilean Pacific coastal desert [270], extending to cerrado [205], *C. tala* is present in northeastern Argentina about 1000 m, particularly along stream banks [195], forming gallery forest below the Monte high puna [165]. Characteristic xerophytic woodland ('talar') extends in an arc along eastern border of pampa grasslands on palaeo-dunes or Holocene beach ridges, *C. tala* is associated with *Cassia corymbosa*, *Cestrum parqui*, *Colletia paradoxa*, *Iodina rhombifolia*, *Phytolacca dioica*, *Sambucus australis* *Schinus longifolius*, *Scutia buxifolia* and *Zanthoxylum hiemalis*, south of 38°S the 'talar' is only represented by *Celtis tala* [61,248].

Cerastium (Caryophyllaceae). Herbs frequently found in humid steppe, modified soils, and hills of pampa grasslands, e.g. *C. junceum* is a native species from Paraguay, Uruguay, northeastern Argentina, also present in northern Patagonia on dunes and salty swamps [62]. A number of species are present in north Andean grasspáramo [3].

Cercidium (Leguminosae). Spiny trees of deserts and arid areas [117] of northern Colombia, eastern Venezuela, southern Bolivia and central Argentina [117,165], e.g. *C. praecox* forms an association with *Castela erecta*, *Lycium tweedianum* and *Opuntia wentiana* in dry areas of the Caribbean coast [253]. Forms a low stature gallery forest of the Atacama Desert [261], extending to the Monte Desert [270], e.g. *C. microphyllum* is present in Mexican Sonoran Desert scrub and coastal desert fringes [167].

Cestrum (Solanaceae). Shrubs sometimes in understorey of *Alnus jorullensis*-dominated forests (2500–3100 m) [54], present with *Solanum* in Costa Rican late secondary montane rainforest [163], e.g. *C. megalophyllum* is present at Monte Verde, Costa Rica [122]. *C. parqui* and *C. lorentzianum* are found at approximately 1000 m in northwestern Argentina, particularly along stream banks [195]. Can be common in cerrado, e.g. *C. obovatum* [205].

Chomelia (Rubiaceae/Aquifoliaceae). Spiny trees [117], e.g. *C. spinosa* is an invasive taxon of Costa Rican derived savanna, particularly when fire regime is controlled [230].

Chorisia (Malvaceae). Large tropical trees, occasionally emergent [117], characterised by swollen trunks, some with spines [265], can be one of the largest trees in Peruvian Amazonia [168]. Present in Brazilian seasonal forests [205], other species in Argentinean dry lowland forests [165,265] e.g. *C. speciosa* occurs in cerrado [254].

Chrysobalanus (Rosaceae). Shrubs, mainly with a coastal distribution in northwestern South America [117], e.g. *C. icaco* is common in littoral areas of Cuba [47].

Chrysophyllum (Sapotaceae). Trees and shrubs common on Guiana Shield [117]. The trunks are often fire resistant [208], e.g. *C. subspinosum* is common in savanna [208], *C. marginatum* is common in Brazilian dry forest [205], *C. oliviforme* is

present in Cuban semi-xerophytic vegetation [13,35]. Can be common in lowland moist forest, Amazonia [74] and Atlantic rainforest where it is specious [17], e.g. *C. amazonicum*, *C. pomiferum* and *C. sanguinolentum* are present on poor soils in Amazonian *terra firme* forest [209]. Community of *C. argenteum*, *Nectandra megapotamica* and *Wetinia* spp. form mid-altitude montane forest (about 1200 m) in Colombia [222].

Chuquiragua (Asteraceae). Shrubs (forming big bushes) in deserts with or without succulents [117,299], can be common in mid-altitude scrub (around 1600 m) [265] and high Andean forest (2650–2750 m), often in association with *Cordia lanata* [54]. Forms rounded bush complex in Chile up to 2700 m [15], common in Patagonian steppe [180], extending to puna [165], e.g. *C. atacamensis* is present at high altitudes in the Atacama Desert [226], *C. erinacea* is common in the Monte to northern Patagonia, *C. hystrix* and *C. opposifolia* are present along the Andes to northern Patagonia [43].

Cissus (Ampelidaceae/Vitaceae). Forest lianas [117] present in northwestern South America lowlands [117], extending to lower montane rainforest [3], becoming frequent in Costa Rican montane rainforest [163], often in association with *Quercus humboldtii*-dominated forest [54]. Present in *Nothofagus*-dominated forests of southern South America [296], e.g. *C. striata* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103]. Present in cerrado [254], and Brazilian seasonal forests [205].

Citharexylum (Verbenaceae). Trees in upper montane rainforest, can be present in Atlantic rainforest, extending to Brazilian semi-deciduous forest [17], e.g. *C. scabrum* is found at low elevations extending to coastal restinga [17]. Present in dry forest, e.g. *C. spinosum* is common in Cuba and on Yucatán penninsular [47].

Clematis (Ranunculaceae). Semi-deciduous lianas [74] common at mid-elevations, extending to lower areas in disturbed wet forests [117], can be locally common in Atlantic rainforest [161]. Present in inundated savanna of lower Amazonia [208], *C. dioica* is a liana in the Brazilian seasonal forest [205].

Clethra (Ericaceae/Geraniaceae). Trees and

shrubs [117] recorded throughout Central America and the northern Andes, extending along northern and southern fringes of Amazonia [263]. Bimodal distribution, southern Andean and Brazilian, the former area being the more important [124]. Present in Costa Rican upper montane (*Quercus*-dominated) forests [141], particularly from 3250 to 3500 m [137], extending to páramo [54], e.g. *C. gelida* and *C. fimbriata* [230], *C. occidentalis* is present in Jamaican montane rainforest [9]. *Clethra fagifolia* forms a montane forest (about 20-m tall) in the Cordillera Oriental, Colombia (2800–3300 m), usually in association with *Clusia*, *Gaiadendron*, *Palicourea*, *Saurauia*, *Tournefortia* and *Weinmannia* [71,225]. *C. hondurensis* is a fire tolerant tree common in outer margins of savanna gallery forests [143], *C. scabra* is found at high altitudes in Brazil, particularly on well-drained soils [124].

Clusia (Guttiferae). Trees and shrubs [168], epiphytic and semi-parasitic [117], some behave as hemi-epiphytes and may strangle hosts [163]. Facultative CAM plant can adjust to a range of environmental conditions [168], e.g. typical of restinga [80] and dry forest associations [161] (campo rupestre, caatinga [208] and campina [48]), also extending from high Andes [311] to rainforest [140]; forming floating mats in Amazonia [74], *C. spathulifolia* is present in the well-drained uplands of Colombian Amazonia [83]. Common in Brazilian gallery forest surrounded by seasonally dry forest [142], sub-Andean and Andean forests (1500–3200 m) [54], Costa Rican and Venezuela montane rainforest [255], e.g. *C. alata* and *C. rolorta* are important in upper montane rainforest [138,230], being common in *Weinmannia*-dominated forests (2800–3200 m) [54], *C. havetioides* is present in Jamaican montane rainforest [9]. Very important taxa of northwestern South America with a wide ecology, e.g. *Clusia chiribiquitensis* is a large Amazonian tree [217,294], whereas *C. multiflora* is more montane [136]. *Clusia multiflora* readily forms an association with *Ternstroemia* and *Schefflera* [259]. *C. fockeana* can dominate both seasonal swamp forest and dry evergreen forests in Guiana [24]. *C. chiribiquitensis* is a particularly common shrub on top of the sandstone plateau and scrubby lowland forests of Co-

lombia [291]. *C. cruiva* and *C. nemorosa* are important trees in the Brazilian gallery forests, extending to higher, more humid, altitudes [124].

Cnemidaria (Pteridaceae). Tree fern [117] mostly found in Andean montane rainforest [168], from the Greater Antilles to Bolivia, disjunct in southeastern Brazil, where it can be common in Atlantic rainforest [285].

Coccoloba (Polygonaceae). Wide growth form and ecology [117], in gallery forests [129], a tree of sandy beaches and littoral areas [164], lianas and shrubs in Brazilian dry forests [205], present in mature lowland rainforest on the Barro Colorado Islands, Panama [46]. *C. candolleana* is present in matorral, Colombia, where it can be the emergent species [222].

Colignonia (Nyctaginaceae). Herbs common in Andean montane rainforest and dry inter-Andean valleys [117], especially in Ecuador [138] and Colombia [3].

Colletia (Rhamnaceae). Shrubs present in southern South America, e.g. *C. hystrix* is present between 30° and 46°S in Chile and between 38° and 48°S in Argentina [65].

Colliguaja (Euphorbiaceae). Shrubs present in southern South America, e.g. *C. integerrima* is common on sandy and stony soils in the Chilean Andes and Patagonian steppe from San Juan to Santa Cruz [65], south of Mendoza, it is present from 1000 to 1800 m, where it is particularly related with fire disturbance [193].

Colubrina (Polygonaceae/Rhamnaceae). Spiny shrubs common in dry areas [117], particularly in semi-deciduous forest [17], e.g. *C. texensis* can dominate subtropical savanna [147], *C. spinosa* is present in Costa Rican freshwater lowland swamps [230].

Combretaceae. Trees and lianas [117], palynologically mostly combined with Melastomataceae [202,254]. *Combretum* and *Terminalia* are important genera of cerrado and dry forests [208], also present in Chocó [116] and lowland Darien forest, Panama [28], e.g. *Terminalia argentea* is a tree of cerrado whereas several other species of this genus and *Combretum* are trees in Brazilian seasonal forests [142,205]. See also *Laguncularia*.

Commelina (Commelinaceae). Weedy, succulent herbs [117] locally common in dry high Andes

[74,167], and temperate areas [115], an indicator of disturbance [117]. Can be common in Mexican highlands [247]. *C. diffusa* is a herb in Galápagos pampa [264].

Connarus (Connaraceae). Small trees and woody canopy lianas [117], occasionally large trees [17] in Atlantic rainforest, extending to semi-deciduous forest [17]. Present in dry forest, e.g. *C. suberosus* is frequent in cerrado [205,254].

Convolvulaceae. Trees, herbs and lianas (morning glory) [117], mainly in tropical areas [19], common around lake margins [168] in campo rupestre [3], e.g. *Evolvulus* and *Ipomoea* occur in cerrado and campo [205] extending to very dry areas, e.g. *Convolvulus arvensis* is present at high altitudes of the Atacama Desert [226]. Some *Ipomoea* are cultivated [254]. See also *Bonamia*, *Evolvulus*, *Ipomoea*, *Mariipa* and *Operculina*.

Copaifera (Leguminosae). Large trees [17] with Amazonia-centric distribution [117,129], present in mature rainforest from Costa Rica to Brazil [168], can be important in cerrado, e.g. *C. langsdorfii* extends from high altitude Brazilian rainforest to coastal situations [124], upland rainforest, central Amazonia [4], in tropical seasonal forest and cerrado [17] where it often forms clusters of trees (capões de mata) [205].

Coprosma (Rubiaceae). Shrubs and trees of lowland tropical rainforest [164]. Present in montane forest, e.g. *C. granadensis* [222].

Cordia (Boraginaceae). Woody shrubs and herbs common in open thorn woodland of the northern Andes [261,305], particularly from 2700 to 2850 m [54], e.g. *C. lutea*, a beautiful tree with yellow flowers [117], extends to low montane rainforest in Brazil [80] also in grasslands of Canarana, forming parkland [208], and cactus forests on the Galápagos Islands. Widely distributed in western South America [264], common in montane areas, e.g. *C. lanata* is found in high Andean forest (2650–2750 m) [54], *C. alliodora* is present in Costa Rican [230] and Panamanian [168] tropical moist forests, *C. cymosa* and *C. lucidula* are present on Monte Verde [122], *C. caracasana* is present in Venezuelan montane rainforest, near Mérida [191]. *C. bogotensis* is present around Bogotá, whereas *C. cylindrostachya* is present in matorral in the Cordillera Central of Colombia

[73,219], forming secondary matorral in association with *Capparis*, *Cordia*, *Opuntia*, *Pithecellobium* and *Prosopis* [253]. *C. rotundifolia* forms open forest towards the northern extent of the Pacific coastal desert [270]. Two species of *Cordia* are herbs in cerrado [205]. Present in lowland moist forest, e.g. *C. lomitoloba* and *C. sagotii* are present on poor soils in Amazonian *terra firme* forest [209] and in Guyanese lowland rainforest [81].

Cornus (Cornaceae). Trees [117] present in Costa Rican upper montane *Quercus*-dominated forest, extending to the Ecuadorian humid montane rainforest [3,288], e.g. *C. disciflora* [163] is often found in late secondary montane rainforest [117], *C. peruviana* is present in Andean Colombia (2500–3200 m) [219].

Coutarea (Rubiaceae). Small trees common in dry forest [117], although also present in moist forests [17].

Croton (Euphorbiaceae). Shrubs to large trees in lower Andean forest [54,140], also important in sub-Andean forests [311], with a number of species in Costa Rica [163], a typical pioneer species of Atlantic rainforest [311]. Can be common on brejos [124], in floodplains and swamps [168], locally dominant on the hardstone plateau of Ararucara, Amazonas [3], possibly indicative of dry conditions [117], *C. lagumensis* is present on poor soils in Amazonian *terra firme* forest [209]. *C. gossypifolius* and *C. glabellae* are present about 900 m in Colombian lower montane forest, often in association with *Eugenia*, *Miconia spicellata*, *Ocotea* and *Oreopanax* [222]. Several species of *Croton* occur in cerrado; pollen of cerrado species of *Croton* have the same pattern as *Manihot* [254], in lowland dry forests (where precipitation is 1000–1500 mm yr⁻¹) [161] it can be important in dry valley formations [261]. Nine species occur in campo and/or cerrado [205], a number extending to more mesic forest, e.g. *C. urucurana* is found in gallery forests of Brazil [124], *C. agrophilus* and *C. jotropha* form a treelet-scrub savanna with *Byrsonima* in Carajás, Brazil [53], *C. scouleri* is found in cactus forests and pampa of the Galápagos Islands, also extending to higher elevations [264] and *C. repens* is present in Cuban semi-xerophytic vegetation [13,35].

Ctenitis (Dryopteridaceae). Arborescent tree

ferns of wet mature forest, usually present at lower elevations of montane rainforest [285], forming a dense understorey beneath lowland tropical forests [185,285].

Cucurbitaceae. Lianas and herbs with a wide ecology [117] distributed from México to Argentina [252], particularly common in lower to upper montane rainforest [3], a single species in Chocó [116]. Several genera of this family occur in cerrado [205,254], e.g. *Cayaponia espelina* and *Cucurbita maxima* are important agricultural plant in the Llanos Orientales [50]. See also *Cayaponia*.

Cuphea (Lythraceae). Trees, shrubs and small herbs [3,17,117]. Although most common in dry forests, this genus has species adapted to a range of environments; some are shrubs in tropical moist forests, others are weeds of moist sites such as along stream banks [58] and around lake margins [117,129]. Present in Amazonia as a shrub of closed forest [74], Amazonian *terra firme* rainforest and on the damp sandy soils of drained marshland, e.g. *C. carthagenensis* and *C. mesostemon* are common in waterlogged soils adjacent to rivers [59]. Important in campo rupestre [124], cerrado [205,254] and Colombian savanna [291] extending to the dry hills about the Sabana de Bogotá [3], e.g. *C. dipetala* is present in dry vegetation types about Bogotá, Colombia [68]. *C. dipetala* is found in *Quercus humboldtii*-dominated forests (2300–2800 m) [54], *C. annulata* is present along the margins of the Atlantic rainforest [53]. *C. carthagenensis* is present on the Galápagos Islands pampa [264].

Cupressaceae. Conifers present in southern Argentina and Chile [300] from temperate rainforest to steppe ecotone [145,296]. Pollen morphological separation of the family into genera depends on location: *Cupressus*, *Juniperus* and *Taxodium* pollen cannot be distinguished within this pollen type [95,339]. *Fitzroya* is found in temperate rainforest and *Pilgerodendrum* in standing water and bogs [296], *Cupressus* is present in Guatemala [37] and México [3], *Cupressus lindleyi* is found on humid slopes (2350–3000 m) within *Pinus* and *Quercus*-dominated forests [20,91], e.g. *J. californica* is present in the northern mountains of Baja California [248]. See also *Austrocedrus*, *Fitzroya*, *Juniperus* and *Pilgerodendron*.

Curatella (Dilleniaceae). Trees and shrubs characteristic of savanna [117,129] from México to Paraguay [48], often found in association with *Byrsonima* [82,305], common in campos cerrado [36,168,265], particularly important in the transition towards more closed forest, forming monospecific stands [305]. An ancient family of fire adapted taxa indicating that fire has been an important influence on savanna for a long time, certainly before the arrival of man [30], also able to tolerate poor drainage, indicative of wet savanna [17]. *C. americana* is common in derived savanna of Costa Rica [230], present in moister areas, such as seasonally inundated forest of the Llanos Orientales [30]. Palynologically, *Curatella* cannot be separated from *Dillenia*, which is a tree of igapó [168].

Cyathea (Cyatheaceae). Tree ferns [117], mostly Andean [168] (1500–2500 m) extending up to 4200 m [199,285,310] found from the Greater Antilles to Chile and Argentina with the centre of diversity located between Venezuela and Perú [285]. A typically montane rainforest genus, including a number of tree ferns which inhabit half-shaded environments such as small gaps and roadsides in closed forest [163], can be locally common in upper montane *Quercus*-dominated forests of Costa Rica [141,230,275], may attain coverage of approximately 20% or more about 2000 m [54]. A good indicator of permanently humid conditions; can be common in Atlantic rainforest [129], present in lower montane rainforest of the Lake Valencia catchment, Venezuela [30]. *C. mettenii* can be common in *Quercus humboldtii*-dominated forests (2300–2800 m) [54], *C. caracasana* is one of the most common taxa of Ecuadorian upper montane rainforest [138], *C. furfuracea* is present in Jamaican montane rainforest [9], *C. demissa* is widespread in the Guiana highlands [48]. Found in dry forests, e.g. *C. weatherbyana* [264], particularly away from grazing pressure and at low altitudes on the Galápagos Islands.

Cydista (Bigoniaceae). Shrubs common in lowland tropical forests of northwestern South America [117].

Cyperaceae. Mostly aquatic, but also recorded in cerrado, páramo, puna and savanna [79,307] a

wide ecology [117,129]. *Bulbostylis*, *Lagenocarpus*, *Rhynchospora* and *Triplepis* are important in campo rupestre [124]. Common in páramo with *Carex*, *Oreobolus*, *Rhynchospora* and *Uncinia* being the main genera [3,54,163]. *Carex gayana* and *Cyperus* are present at high altitudes of the Atacama Desert [226]. Can dominate in caatinga formations [208], *Rhynchospora* and *Eleocharis* are important in wetter areas of cerrado [124]. *Rhynchospora* can be common along river margins in Amazonia [86,168]. *Fimbristylis*, *Rhynchospora* and *Scleria* occur in brejos, campo and cerrado [205]. Present in the understory of *Alnus acuminata*-dominated forest (2500–3100 m) [54]. *Cyperus andersonii* is found in the littoral zone of the Galápagos Islands [264] and campo rupestre [80]. *Carex*, *Scirpus* and *Uncinia* are present in *Nothofagus*-dominated forests of Chile and Argentina [103]. Numerous genera are common in depressions in the pampa grasslands [62,248]. Important for household, ornamental and traditional medicines in México [199,310].

Cystopteris (Woodsiaceae). Ferns found in páramo, particularly in wet areas [117].

Dalbergia (Leguminosae). Lianas and trees with a wide ecology [117] from dry to moist lowland forest, *D. foliolosa* and *D. nigra* (*Jacarandá*) trees are precious woods [205], a particular focus of timber extraction in the Atlantic rainforest [17,80]. Several species occur in cerrado, e.g. *D. restusa* is an invasive taxon of Costa Rican derived savannas, particularly when fire regime is controlled [230]. Present in moist forest, e.g. *D. inundata* is present in the eastern Amazonian floodplain forest [302].

Dalechampia (Euphorbiaceae). Herbs [117] and lianas [129] common in dry lowland areas [168], e.g. *D. linearis* is frequent in cerrado [205].

Daphnopsis (Thymelaeaceae). Small trees and shrubs [117], can be common in *Araucaria*-dominated forests [59], locally common in Colombian and Costa Rican upper montane rainforest [3] (2650–2750 m) often with *Cordia lanata* [299] as an element of mature forest [133], e.g. *D. americana* is present at Monte Verde [122].

Dasyphyllum (Asteraceae). Shrubs and trees [117] present in semi-deciduous forest [17] and Valdivian rainforest [297], e.g. *D. diacanthoides*

is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Datura (Solanaceae). Herbs, shrubs and small trees, 20 species in the lowland areas. Contains alkaloid ‘La dautrina’, a powerful narcotic [97]. *D. ceratocaula* is found from 2250–2300 m, becomes very abundant following rains [97].

Deberya (Pteridophyta). Ferns found in southern South America, e.g. *D. diacanthoides* is a Valdivian rainforest taxon not recorded south of 46°S [23,296], *D. excelsum* is found in tall sclerophyllous forests to the north of the Matoral [11].

Desmodium (Fabaceae). Mostly herbs, also lianas and trees [117] found in open vegetation from sea-level to approximately 2800 m [299]. Two species occur in cerrado [205,254].

Dicksonia (Dicksoniaceae). Tree fern forming closed forests [80] in wet montane forests especially in the tropics. It usually occurs from 1500 to 2500 m, sometimes to 3500 m [285], distribution can relate to *Araucaria* forest [117,129], specifically *A. augustifolia*. Particularly common in wet montane rainforest, especially in the tropics although also present in *Quercus*-dominated woods of México and Colombia and in páramo thickets [3,285], e.g. *D. gigantea* is common in Costa Rican montane rainforest [163,167].

Didymopanax (Araliaceae). Trees commonly found in seasonal forest [117], mid-elevation montane rainforest, inter-Andean valleys [117], open areas [17,129] of Amazonia [168] and cerrado [17], e.g. present in Colombian dry, mid-altitude forest in association with *Cassia*, *Opuntia*, *Phitecellobium* and *Swartzia* [216]. Some taxa are adversely affected by fire, e.g. *D. macrocarpon*. Some pioneer taxa are particularly common in secondary forest [168], e.g. *D. pittieri* is present in Costa Rican montane rainforest [230]. *D. pittieri* is important in Costa Rican upper montane *Quercus costaricensis*-dominated montane rainforest, particularly on the wetter Atlantic-facing mountain slopes [163]. *D. vinosum* and *D. macrocarpum* occur in cerrado [205,254], *D. morotoni* is present in savanna/seasonal dry forest around Lake Valencia, Venezuela [30].

Dioclea (Asteraceae). Lianas recorded around Manaus [196], important in Amazonia mature

forest [74]. Present in Brazilian dry forests, e.g. *D. glabra* and *D. latifolia* [205].

Diospyros (Ebenaceae). Small to mid-canopy stature trees [117] present in cerrado [254] and tropical seasonal forest, occasionally in gallery forests [74], numerous species in Amazonia [254], extending to montane rainforest, e.g. at Monte Verde in Costa Rica [122]. *D. hispida* var. *camporum* is common in cerrado whereas *D. hispida* var. *hispida* and *D. serricea* are trees of Brazilian seasonal forests [205], *D. texana* can dominate subtropical savanna [147].

Dodonaea (Anacardiaceae/Sapindaceae). Shrubs and trees, particularly common in dry mid-elevations areas [3,117] and on eroded slopes [140] of Atlantic rainforest and semi-deciduous forest [17], e.g. *D. viscosa* is important in secondary Brazilian gallery forest [124], Andean xerophytic bush (2250–26850 m) [3,54] and can form a pioneer association with *Mysine* [214] in eroded páramo and Venezuelan montane rainforest [255]. Present in México from 2300 to 2600 m, particularly in disturbed areas [243].

Doliosarpus (Dilleniaceae). Canopy lianas in moist tropical rainforest of northwestern South America [117] and Brazilian seasonal forests [205], a common secondary forest tree species in Brazilian Amazonia [274]. Present as liana in bushes on open hardrock vegetation of Colombia [3].

Donatia (Saxifragaceae). Hard cushion-forming shrub common in temperate moorland [180], e.g. *D. fascicularis* is common in cushion bog on Magallanic moorland [181].

Dorstenia (Moraceae). Herbs [117] favouring moist conditions, common in waterlogged soils [168]. Two species are present in cerrado [254], *D. heringerii* is frequent in the campos [205].

Draba (Brassicaceae). Dwarf shrubs and herbs [117,140], mainly present in superpáramo [3] can be common in bryophyte-dominated marshes or wind-swept ridges [3], in open páramo vegetation (2500–3500 m), an established Andean element [133] being common in superpáramo of northern Andes [3]. *D. magellanica* is only rarely found north of 50°S [13], commonly recorded in Patagonian steppe [181]. *D. gilliesii* is found from 3200 to 3600 m [307], forming wall rosettes in humid

spots such as protected by rocks [13], *D. alchemilloides* is recorded at 4500 m, close to the upper limit of vegetation of northern Chilean altiplano [12], *D. jorullensis* grows from 3000 to 4100 m, beneath the limit of arboreal vegetation around the basin of México [269], *D. higalguensis* is found in *Abies*-dominated forest (2900 m) [235]. *D. sericea* is present in particularly wet páramo sites (3700–4200 m) [66,279,216]. *Drabo cheiranthoides* is found in association with *Calamagrosti effusae* [56], *Draba pachytyrsa* and *D. pennell-hazenii*, being present with *Calandrinia* (4250–4350 m), Cordillera Central, Colombia [56].

Drypetes (Thymeleaceae). Cushion-forming shrubs and herbs common in southernmost South America [180,181,263]; a moorland taxon. *D. muscosus* can grow in frost hollows on Tierra del Fuego and above the forest line, an important component of cushion bogs [181]. Present in lowland moist forest, e.g. *D. variabilis* is present on poor soils in Amazonian rainforest [209].

Drimys (Magnoliaceae/Winteraceae). Large trees (> 10 m) very frost tolerant [117,202], common in montane [208], subtropical habitat, often present in *Araucaria*-dominated forest, and around the southern limit of Atlantic rainforest [80,129]. Can be common in *Weinmannia*-dominated forests (2800–3200 m) [54], locally common in Costa Rican upper montane *Quercus*-dominated forests [141], e.g. *D. grandensis* [37], extending to the equatorial Andes, as local patches up to 3000 m [3], at lower elevations towards the south [140,168], forms forest limit in Colombia, sometimes associated with *Clusia*, *Ocotea* and *Weinmannia* [156,308]. Found in lowland dry forests [265], e.g. *D. braziliensis* has a bimodal distribution; southern Andean and Brazilian [124], found at higher altitudes in Brazil, also present in campo rupestre [124]. *D. winteri* is common in Valdivian rainforest, *Araucaria*-dominated forests [59] and Patagonian and Magallanic rainforest [297], present in *Nothofagus alessandrii*-dominated forests of central Chile [103], also forming a mixed northern Patagonian forest type on Chiló [6], can form a mixed forest association with *Nothofagus betuloides* in central Tierra del Fuego [181], co-dominant with *Nothofagus nitida* in mid-elevation forests of northern Chile [116]. One of the fastest

growing, and shortest lived, of the large trees in the Magallanic rainforest [188], a coloniser after fires and forest clearance [297], formerly much more extensive, at present reduced due to exploitation by Europeans for firewood and charcoal [181].

Drosera (Droseraceae). Herbs of wet bogs (sundew) [117,129] able to tolerate submersion [202], can be indicative of poor soil fertility, particularly low nitrogen levels [291]. Contains about 100 species recorded throughout eastern South America, particularly in the southwestern area [263] growing on acid soils; many species occur in bogs at the top of the tepuys [135], common in Magallanic moorland [180], also in campo rupestre of southeastern Brazil [80], particularly boggy areas [124,208], *D. montana* occurs in brejos [205]. *D. capillaris* is found on open hardrock vegetation of Colombia, on the Guiana Shield [3,291].

Dryopteris (Pteridaceae). Ferns locally common in Costa Rican upper montane *Quercus*-dominated forests [141], often a coloniser after fire [299].

Duroia (Rubiaceae). Small to mid-canopy trees, characterised by ant-filled nodules, common in Amazonia [117].

Echinopsis (Cactaceae). Succulents present in dry vegetation formations, e.g. *E. atacamensis* and *E. uebelmanniana* are present at high altitudes of the Atacama Desert [226].

Eichornia (Pontederiaceae). Aquatic water lilies of lowland Neotropics [3,117,265] containing floating and rooting growth forms [3], extensively introduced, extending to the subtropics, and high altitude lakes, e.g. on the high plain of Bogotá, a major invasive taxon [168,202]. *E. crassipes* is present in warm waters within areas of dry forest e.g. Valle del Cauca, Colombia (100–1000 m), where it forms associations with *Heliconia* and *Pistia stratioides* [73,313].

Elaeagia (Rubiaceae). Small to mid-canopy trees [117] in mid-altitude montane rainforest [117], e.g. *E. auriculate* is present at Monte Verde, Costa Rica [122]. *Elaeagia utilis* forms forest associations with *Brunellia*, *Inga* and *Pourouma* in the Cordillera Occidental de Colombia (550–2300 m) [219].

Elaeocarpaceae. Trees in montane Brazil [117,129], México, southern South America

[3,181] and Chocó [116]. See also *Aristotelia* and *Sloanea*.

Elaphoglossum (Elaphoglossaceae). Species-rich ‘tongue’ ferns found from the Greater Antilles and México to Argentina, a centre of diversity in Colombia and Venezuela [285]. Primarily an epiphytic genus, although some species are terrestrial or rupestral, in crevices or on ledges of cliffs [285]. Numerous endemic species in Costa Rican montane rainforest [163], both epiphytic and terrestrial elements [163]. Found from the high Andean shrub belt to upper montane valleys [275], most common in montane rainforest [3] (1500–3500 m) [54] as near-ground epiphytes [285]. *E. mathewsii* is present in Colombian páramo (4200–4700 m) in association with *Muhlenbeckia vulcanica* [260].

Elytropus (Apocynaceae). Liana found in Valdivian rainforest [6].

Embothrium (Proteaceae). Small trees and shrubs found in drier rainforest, common in steppe [117], particularly in successional areas (possibly fire/disturbance indicator [117]). Andean and southern South America distribution, from southern coasts [263] extending to central Chile [11], e.g. *E. coccineum* is present in Valdivian, Patagonian and Magallanic rainforest [297]; particularly beneath *Nothofagus antarctica*-dominated forest, occasionally forming pure stands [181,227].

Empetrum rubrum (Empetraceae). Single species common in high Andes and Patagonian steppe as a mat-forming shrub [265], forming tightly packed mats above the forest line in southwestern Argentina [303] particularly on acidic soils. Can form associations with *Hebe* [181] in understorey beneath *Nothofagus anartartica*-dominated forest, occasionally forming pure stands [181], *Empetrum*-dominated heath is extensive on cold and dry Patagonian high plateaus [299].

Ephedra (Ephedraceae). Shrubs in semi-desert southern Andes, in dry inter-Andean valleys, puna [117] microphyllous desert in northern México [248] and superpáramo [3], e.g. *E. breana* is found in Chilean Andes [15], *E. multiflora* is present at high altitudes in the Atacama Desert [226], *E. frustillata* extends farther north on the eastern flanks [181], is present on high Patagonian plateau [65]. *E. andina* is present on both slopes of

the Andes, from north of Mendoza to Santa Cruz, reaching 3000 m, *E. ochreatea* is present from Catamarca to Santa Cruz, in the western Monte and Patagonian steppe [99].

Epilobium (Onagraceae). Herbs with high Andean distribution [117], present in understorey of *Alnus*-dominated marsh forests (2500–3100 m) [54], several species occur on Tierra del Fuego [179]. Present in areas where there is mineral-rich seepage and around montane/alpine lakes [3], e.g. *E. denticulata* is present in Colombian lakes to 3100 m [223].

Equisetum (Equisetaceae). Horsetail ferns, terrestrial and emergent aquatics [168] often forming dense colonies [285]. Widespread in the Neotropics, absent from the Amazon basin and northeastern Brazil [285] and particularly common in wetter areas from 0–4200 m but most frequently from 500–4000 m [3,5,225,285], e.g. *E. bogotense* is common on wet poorly-drained sites in Costa Rican montane rainforest, also along roadsides and near peat bogs [163], present in the understorey of *Nothofagus alessandrii*-dominated forests of central Chile [103].

Ericaceae. Lianas, dwarf shrubs and small trees with a wide ecology [74,168] characteristic of montane areas, although with some lowland distribution [117,140], important in high Andean shrub belt and moist puna [275], locally dominant in shrubpáramo as a dwarf shrub [3,54], e.g. *Pernettya* is a dominant puna genus, clearly originating from the eastern side of the Andes [267], *P. pumila* can dominate (45% cover) above the forest line in northwestern Argentina [303]. Common in Costa Rican upper montane *Quercus*-dominated forests [141] (2300–2800 m) [54], e.g. *Comarostaphylis* is dominant in Costa Rican alpine dwarf forest (3200–3400 m) [163]. One of most important montane rainforest plant families in Costa Rica represented by numerous shrubs (*Pernettya*, *Vaccinium*) and epiphytes (*Cavendishia*, *Macleania*) [141]. Common in Venezuelan montane rainforest gaps and in the transition to páramo, two genera occur at the top of the tepuys [135]. A liana in Amazonia [74], present in Chocó [116], also common in Chilean rainforest [77,152] and southeastern Brazilian highlands [129]. See also *Gaultheria* and *Vaccinium*.

Eriocaulaceae. Herbs, and small shrubs, aquatic in Amazonia, distributed from páramo to cerrado [17,74]. *Eriocaulon*, *Leiothorix*, *Paepalanthus* and *Syngonanthus* are present in dry areas, rocky outcrops and on sandy soils, a few taxa are present in cerrado [117,205] and peat bogs [129], *Eriocaulon* and *Paepalanthus* occur at top of tepuys [135], particularly where soils have good water retention [305]. *Paepalanthus* has an array of species in Colombian páramo of the Cordillera Oriental [20,110]. Three species of *Eriocaulon* occur in the Basin of México on seasonally flooded areas, also present in *Pinus/Quercus*-dominated forest [32].

Eriogonum (Polygonaceae). Herbs, common in steppe but a wide ecology [117], *E. trichopes* is present in Mexican desert scrub [293].

Eryngium (Apiaceae). Herbs, ground rosettes and spiny rosettes in tropical and temperate areas, principally in México [164] and the northern Andes [3].

Erythrina (Leguminosae). Trees and shrubs, often shade-tolerant trees on traditional coffee plantations [3], particularly common in *Croton/IngalVismia*-dominated forests of the sub-Andean forest belt [54]. Indigenous peoples use the seeds [74]. Found on wet soils of southeastern gallery forests of Brazil [80] and northern Argentina [165], in lowland dry forests [161], savanna/seasonal dry forest around Lake Valencia, Venezuela [30], e.g. *E. crista-galli* is an important shrub in drier regions of Brazil [120,205]. *E. velutina* forms matorral/spiny forest in Colombia in association with *Cordia*, *Eugenia*, *Prosopis* and *Trichilia* [253].

Erythroxylaceae. Trees and shrubs, containing alkaloids [117,129] (coca) [167,168]. Distribution is concentrated in Caribbean coastal forests, extending to lowland sub-Andean forests [168], found from 300 to 840 m on eastern Andean slopes, from 1000 to 1500 m on western slopes [311]. A wide distribution, from Amazonia to cerrado, common in secondary vegetation [74,202], e.g. *Erythroxylum albertianum* is present on poor soils in Amazonian *terra firme* forest [209], *Erythroxylum citrifolium* can be an important component of campo rupestre [53]. Many species of *Erythroxylum* occur in cerrado of central Brazil [254], e.g. *E. campestre* and *E. suberosum* are fre-

quent [205], *E. minutifolium* is common in Cuban dry areas [47]. *Erythroxylum citrifolium* forms associations with *Coccoloba*, *Erythroxylum* and *Myrcia* in Colombia (1000–2400 m) [279].

Escallonia (Escalloniaceae/Saxifragaceae). Trees and shrubs, important in equatorial high Andean forest, locally dominant below *Polylepis* zone [117] extending to sub-Andean forest (1500–2500 m) [54] forming mixed or pure stands in upper Andes [90]. *E. myrtilloides* is present in the páramo of Costa Rica [230], Colombia and Ecuador [3] where it is a dominant tree at 3000–3400 m, particularly in the wet upper forest line [3], characteristic microphyllous leaves [230], *E. prasoma* is important in Costa Rican upper montane rainforest [230] whereas *E. itayensis* is present in Colombian Amazonia poorly drained floodplains [83,86]. *Escallonia myrtilloides* forms high altitude (3800–4100 m) forest association in Colombia with *Baccharis*, *Espeletia*, *Geranium* and *Weinmannia microphylla* [52,216,259]. Common in late secondary montane rainforest [163], bordering grasslands and bogs in southern South America [6] where it can support many epiphytes [194,278]. *E. pendula* is present in dry forests at low altitudes [3] along coastal Brazil [17], where it forms a dense sclerophyllous scrub inter-grading to Chilean Matorral [11], also present in temperate forests, e.g. *E. revoluta* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103,227].

Eschweilera (Lecythydaceae). Large emergent to small trees [117] present from the lowlands to the high Andes, can be common in igapó and tropical seasonal forest [74,140,202], e.g. lowland forest near Mérida [191], 27 species are present in Guyana [176], e.g. *E. sagotiana* and *E. subglandulosa* are present in Guyanese lowland forest [104], *E. tenuifolia* is present in the eastern Amazonian floodplain forest [302], *E. coriacea* can dominate upland rainforest, central Amazonia [4]. *E. verruculosa* and *E. microcalyx* typify forest of Pacific Colombia [314], where it can form an association with *Clathrotropis* [25,216].

Espeletia (Asteraceae). Stem rosette growth form [140] found from Venezuela to Ecuador [3]. *Espeletia, sensu lato* has many rosette-plant species that are exclusive in páramo and subpá-

ramo (3000–4400 m) [54,265,311], emerged from the Pleistocene as a speciose (130 spp.) genus endemic to high altitudes of the northern Andes [267] (2°S–11°N) [178]. Subdivided into seven subgenera with the same general pollen type, except for *Coespeletia*, from the highest elevations [256]. *E. grandifolia* is characteristic of the dwarf shrub layer of the páramo [214], dominant in bunch-grasspáramo (3500 m) [54] and free-draining slopes between 3300 and 4500 m on the Venezuelan páramo [255,267]. Highly rich in species in Colombia, e.g. *E. arbelaezii*, *E. argentea*, *E. boyacensis*, *E. brachyaxiantha*, *E. chocóntana*, *E. congestiflora*, *E. conglomerata*, *E. grandifolia*, *E. hartwegiana*, *E. incana*, *E. lopezii*, *E. murilloi* and *E. pycnophylla* often found in association with *Baccharis*, *Calamagrostis*, *Coprosma*, *Hypericum*, *Lycopodium* and *Sysyrinchium* [49,216,304].

Eucryphia (Eucryphiaceae). Trees in Valdivian rainforest, particularly in primary, high species diversity forest [297], e.g. *Eucryphia cordifolia* and *Caldcluvia paniculata* are present in Valdivian rainforest [300] but cannot be distinguished palynologically [299].

Eugenia (Myrtaceae). Trees and shrubs from high Andean forests [3,140] to restinga [80], found across a range of forest types, particularly important in sub-Andean forests (1060–2500 m) [311], e.g. montane rainforest of Sierra Madre Oriental [269]. Found in a range of environmental settings of upper Andes, high Andean shrub belt [90], moist puna [275], usually >700 m although can be common in lowland dry forests [161], e.g. *E. procera* forms associations with *Astronium*, *Casearia*, *Daphnopsis* and *Pisonia* in the Colombian lowlands (to 350 m) [190]. A typically lower montane tree in Costa Rica [163], e.g. *E. guatemalensis* is a medium-sized tree in Costa Rican montane rainforest, at Monte Verde [122], *E. marchiana* is present in Jamaican montane rainforest [9]. Abundant in semi-deciduous forest, campo and gallery forest in cerrado but not cerrado *sensu stricto* [17], e.g. *E. salamanensis* is an invasive taxon of Costa Rican derived savanna, particularly when fire regime is controlled [230]. Present in campo rupestre [124], e.g. *E. gardneriana* [205], *E. puniceifolia* [124]. *E. flavescens* are present in *Callisthene*-dominated low savanna in campo rupestre,

extending to the margins of Atlantic rainforest [53]. *E. mato* is present in humid forests of north-western Argentina at approximately 1000 m [195]. *E. lundelli* can be found in the thorn forest of Yucatán [248], *E. fadyenii* is common in Cuba and Yucatán [47]. Palynologically *Eugenia* is difficult to separate from other Myrtaceae [129].

Euphorbia (Euphorbiaceae). Mostly herbs [117] indicative of dry, degraded areas from 2000–2800 m [3], can be present in xerophytic Andean bush (2250–2650 m) [54] extending to Amazonia [168], two species in cerrado [205,254]. Common in the basin of México in grasslands, xerophytic scrub and forest (2250–3000 m) [250], e.g. *E. polycarpa* is present in Sonora [293], whereas *E. misera* is present in Mexican coastal deserts [2], *E. podocarpifolia* is present in open dry vegetation on Cuba [35,13]. *E. portulacoides* is recorded about the forest line (2200 m) in southwestern Argentina [303].

Euphorbiaceae. Wide growth form [117], mainly lowland distribution, dominant in Chocó [116], locally common in Costa Rican lower montane rainforest [137]. Many genera occur in cerrado [254], brejos and campo [205]. Occur in the pampa grasslands, some genera are common on modified soils, e.g. *Euphorbia portulacoides* has a wide distribution on sandy arid soils, and brackish ponds of the pampa grasslands [62,200]. See also *Acalypha*, *Actinostemon concolor*, *Alchornea*, *Alibertia*, *Ammonia*, *Bernardia*, *Caperonia*, *Colliguaja*, *Croton*, *Dalechampsia*, *Hura*, *Hyeronima*, *Mabea*, *Manihot*, *Maprounea*, *Pera*, *Phyllanthus*, *Sapium*, *Sebastiania*, *Styloceras* and *Tetrorchidium*.

Euplassa (Proteaceae). Herbs and small shrubs common in montane areas, some taxa in lowlands [117], being abundant in Atlantic rainforest [17] and Brazilian seasonal forest, e.g. *E. inaequalis* [205].

Euterpe/Geonoma (Arecaceae). Palms, a catholic distribution throughout the Neotropics as far south as eastern Brazil, from lowland situations in Central America [126] and Amazonia [140] to the Atlantic rainforest [80,117,273] but can occur in montane rainforest to 3000 m, particularly common in the lower *Solanum* and *Euterpe*-dominated zone, e.g. *E. caatinga* common in association with *Myrsine elongata* [215]. *Euterpe* can

form open forest with other palms [140], common along river margins of Amazonia [208] under a range of environments including floodplains [175], várzea [208], e.g. *E. oleracea* has adapted to flooding of the inundated savanna by developing ‘breathing’ roots [127]. Present in dry vegetation types, e.g. *E. precatoria* is an important taxon of cerrado [36], present in well-drained floodplains of Colombian Amazonia, extending to the poorly drained floodplains [83,86], common along white water river margins [126]. Large areas of sandstone savannas, derived from the erosion of the Guiana Shield, are dominated by *E. caatinga* [127]. *E. macrospadix* are found in areas of steep topography and on poor soils [189]. *Geonoma brevispata* is common in Brazilian seasonal forests [205].

Evolvulus (Convolvulaceae). Herbs and shrubs of dry areas [117], indicative of disturbance from 2000–2800 m [3], can be present in Andean xerophytic bush (2250–2650 m) [54] and on open ground, common in degraded vegetation [3].

Fabaceae. Widely introduced herbs to Latin America. Represented in the pampa grasslands by *Adesmia*, *Lathyrus* and *Trifolium*, introduced and invasive of cultivated and abandoned fields. Present in nearly all seral communities of the pampa grasslands, e.g. species of *Lotus*, *Medicago*, *Melilotus* and *Trifolium* [213]. Present in páramo, particularly species of *Lathyrus* and *Lupinus* [3]. See also *Desmodium*.

Fagus (Fagaceae). Trees restricted to Central America, e.g. *F. mexicana* is present in northeastern México (2000–2500 m) [117], the southernmost beech forests of the Northern Hemisphere [3].

Ficus (Moraceae). Trees and lianas [117], mainly from lowland rainforest, e.g. lowland Darien forest, Panama [28], extending to upper montane rainforest [3,54], e.g. *F. crassiuscula*, *F. hartwegii* and *F. velutina* are present at Monte Verde, Costa Rica [122]. Present in Brazilian restinga dune forests [80]. Common in gallery forest [74], along Amazonian river margins [168] and within Amazonian terra firme forest [84], *F. insipida* is present in Atlantic rainforest [273]. *F. laevigata* is common in Cuba and Yucatán [47]. *F. hartwegii* and *F. insipida* is found in association with

Andira, *Hura*, *Piper*, *Trichilia* and *Zanthoxylum* in lowland (350 m) Colombian forests [190]. *F. glabrata* is present in mature lowland rainforest on the Barro Colorado Islands, Panama [46]. Pollination is cleistogamous involving a wasp vector [129].

Fitzroya (Cupressaceae). Tree restricted to temperate rainforest of the Andes [129], normally on poorly drained/waterlogged soils, shade intolerant taxon, may find it difficult to regenerate [297]. *F. cupressiodes* is the largest, and longest lived of southern South American conifers [297], a taxon of Valdivian rainforest, montane areas (700–1000 m) of very high precipitation [296]. *F. patagonia* can form pure stands [311], forming a distinct forest type with *Nothofagus betuloides* between 800 and 1200 m in the southern Andes, scarce at low elevations [297]. *F. cupressiodes* is common in high elevation conifer forests of southern Chile [77,299]. Present populations may originate from at least two, but possibly more, glacial refugia located in coastal Chile and on the southern flanks of Argentinean Andes [12].

Forsteronia (Apocynaceae). Tropical trees in lowland forest, Atlantic rainforest [129], Amazonia to the Barro Colorado Islands [168], also present in Costa Rican tropical dry forests [74].

Fraxinus (Oleaceae). Trees indigenous to México and Guatemala [3], e.g. *F. udehi* is found in humid areas of the Basin of México (2250–2800 m), *F. cuspidata* grows in *Quercus*-dominated forest in northern México [248] and within gallery forest [249,251].

Fuchsia (Onagraceae). Shrubs and lianas common in montane, humid conditions of southern South America, present along the Andes to México [3], the northern Andes is a possible centre of distribution [117]. Often in association with *Quercus humboldtii*-dominated forests (2500–2800 m) [54]. Common in southern South America [181], e.g. *F. magellanica* forms a scrub (1.5–2 m) on fringes of *Nothofagus/Drumys*-dominated rainforest [181], present in *Nothofagus alessandrii*-dominated forests of central Chile [103], *F. lycoides* is present at northern end of Chilean Pacific coastal desert [11].

Gaiadendron (Loranthaceae). Parasitic (on roots) trees of montane areas [117], common in

forest-páramo ecotone [3], e.g. *G. punctatum* can be common in wet shrubpáramo in association with *Espeletia* (3000–3400 m) [3,54], extending to Costa Rican páramo, particularly around the upper forest line [230], in Costa Rica this is present in both subalpine dwarf forest and shrub páramo [163].

Gaimardia (Centrolepidaceae). Herb in Magallanic moorland, e.g. *G. australis* is an important component in cushion bog of Magallanic moorland [181].

Galium (Rubiaceae). Montane herbs and shrubs of holarctic origin with Andean and southern South America distribution [117,129], common in Costa Rican secondary montane rainforest [163] in understorey of *Alnus*-dominated marsh forests (2500–3100 m) [54], and azonally above 2000 m [3,163], e.g. *G. cuatrecasasii* is present in Colombian páramo (3300–3800 m) [66]. Locally common in upper montane *Quercus*-dominated forests (2700–2850 m) [54], can be associated with *Polylepis*-dominated forests [54], extending to páramo [140]. Common in Basin of México (2250–3400 m), e.g. *G. aschenbornii* and *G. uncinellatum* are present in *Pinus/Quercus*-dominated forests [248], *G. stellatum* is present in Sonoran Desert [293]. Present in southern temperate forest, e.g. *G. aparine* is present in understorey of *Nothofagus antarctica*-dominated forests [181], *G. cotinoides* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Gallesia (Phytolaccaceae). Large trees [117,175], excellent timber (Garlic wood) [168], mostly found on fertile soils with a distinct dry season [117], present in Brazilian gallery forests [17].

Gaultheria (Ericaceae). Shrubs [117], a pioneer in montane areas [265], the south Brazilian highlands [117, high altitude forest savanna [265], *Weinmannia*-dominated forests (2800–3200 m) [3,54], extending to the páramo [163], e.g. *G. anastomosans* and *G. ramosissima* can be common in shrubpáramo in association with *Espeletia* (3000–3400 m) [54], *G. erecta* is present in Costa Rican shrubpáramo [163]. *G. hapalotrichia* and *G. ramosissima* are found in association with *Arcytophyllum* and *Hypericum* in the Cordillera Oriental (3150 m), Colombia [294,304]. Common in southern South America, e.g. *G. antarctica* is recorded

throughout Tierra del Fuego [125], *G. myrtilloides* is present in *Nothofagus betuloides*-dominated forests [296].

Genipa (Rubiaceae). Shrubs, found from México to Brazil [164], in Costa Rican tropical moist forest [230], common on moist soils, such as along river margins and floodplains [17], e.g. *G. americana* can be common on outer edges of groves in the Llanos Orientales [30,50], *G. spruceana* is present in the eastern Amazonian floodplain forest [302]. *G. americana* is common in dry areas of Cuba, such as the limestone hills (mogote) [47]. Often used as live fences, the plants are unpalatable to livestock [164].

Gentianaceae. Herbs from Guatemala and México [3] and along the Andes [168], e.g. *Gentiana prostrata* is found above 3500 m [307]. *Gentianella* and *Halenia* are present in Venezuelan páramo at 3600 m [30], and above 3000 m in northern Chile [13], e.g. *Gentiana sedifolia*. *Gentiana dasyantha* and *Gentiana sedifolia* are found in association with *Draba* in the Cordillera Central, Colombia (3800–4250 m) [56]. Five genera occur in brejos and campos [205]. See also *Halenia*, *Macrocarpea* and *Nymphoides*.

Geonoma (Arecaceae). Palms present in tropical lowlands [164], a dwarf palm common in understorey of Costa Rican montane rainforest, up to 2600 m, particularly under deep humus accumulation [163], e.g. *G. seleri* is present at Monte Verde [122], *G. weberbaen* is present over 3000 m in upper montane rainforest [3]. *G. brevispatha* is present in cerrado, reaching the southern fringes of the Andes, common in Amazonian *terra firme* forest [126]. *G. undata* is negatively affected by human disturbance in Ecuadorian Andean forest [148].

Geraniaceae. Herbs and shrubs from Andes and southern South America [117], common in high Andean shrub belt (3400–2800 m) [275]. Holarctic herb family common in Costa Rican páramo, e.g. *Geranium guatemalense* [163] is present in understorey of *Alnus*-dominated forests (2500–3100 m) [54], *Geranium* can be diagnostic of upper páramo [133]. *Geranium sessilifolium* forms sizeable patches between bunchgrass communities above southwestern Argentinean forest line [303], *Geranium patagonicum* is recorded on Tierra del Fuego [181], *Geranium robertianum* is present in *Notho-*

fagus alessandrii-dominated forests of central Chile [103]. See also *Oxalis* and *Wendtia*.

Gesneriaceae. Herbs, shrubs and woody lianas [117] found in wet/montane rainforest habitats [117], present in lowland and lower montane rainforest [3], common in Chocó [116], co-dominant in understorey of Costa Rican montane *Quercus*-dominated forest [163]. See also *Mitraria*.

Gilia (Polemoniaceae). Herbs with northern Andean distribution [117].

Gleasonia (Rubiaceae). Trees and small shrubs present in dry forest, e.g. *G. prancei* is present on sandstone tepuys in Brazil [48].

Gleichenia (Pteridaceae). Ferns found throughout the Neotropics [285] (500–3800 m), most common as thicket species, often a pioneer on rock slides [285], along roadsides, e.g. *G. simplex* is a common taxon found from 3000 to 3800 m [285]. A wide distribution on Tierra del Fuego, extending to Magallanic moorland [179], e.g. *G. quadripartita* can be common in the understorey of *Pilodendron*-dominated forests [181].

Gomphrena (Amaranthaceae). Herbs common in Amazonia [168] on moist soils, e.g. along river margins, floodplains [17]. Present in dry vegetation, a pioneer ephemeral plant on bare soils of Chaco [165], common in cerrado and campo, e.g. *G. macrocephala*, *G. pohlii* and *G. virgata* [124,205], *G. fouticosa* is a desert forb, can be common on salt pans [299], *G. elegans* is frequent in northeastern Argentina, *G. perennis* is frequent on hills of pampa grasslands [62]. *Froelichia interrupta* has the same pollen type [254].

Gordonia (Theaceae). Herbs and shrubs in upper montane rainforest, e.g. *G. fruticosa* [117], also common along river margins and floodplains [3,168] from 1000 to 1500 m in Brazilian montane rainforest [17]. Present about 3400 m in upper montane rainforest of northern Andes [3].

Gouania (Rhamnaceae). Lianas present in canopy of mid to late Amazonian successional forest [168].

Goupia (Celastraceae). Trees, some emergent in late secondary growth forest, a light-gap taxon, mostly found on clay-rich poor soils [299], e.g. *G. glabra* is prominent in well-drained uplands of Colombian Amazonia, particularly on soils of medium nutrient status [4,209,293].

Grammitis (Grammitidaceae). Epiphytic fern genus, wide distribution throughout the Neotropics, a centre of diversity in Colombia/Venezuela [285], common in montane rainforest, extending to páramo [3,163]. Present in Amazonia, especially in wet areas although extending to dry campina forests [285]. Present in southern South America, e.g. *G. magellacium* is recorded on Tierra del Fuego [179,180].

Greigia (Bromeliaceae). Herbs recorded in drier Valdivian rainforest [117], e.g. *G. spacelata* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103]. Present as ground rosettes in the lower páramo, particularly common in the understorey of montane dwarf forest on the wet side of the Andes [3], e.g. *Greigia mulfordii* is present in the Cordillera Oriental, Colombia [49].

Griselinia (Cornaceae/Griselinaceae). Semi-parasitic herbs present in *Araucaria*-dominated forest, drier Valdivian rainforest [129,297], *Nothofagus alpina* and *N. dombeyi*-dominated forests of southern South America [152,296], e.g. *G. jodiniifolia* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Guapira (Nyctaginaceae). Small to mid-canopy trees common in northwestern South America [117], rarely in Brazilian seasonal forests [205]. Present in dry forests, e.g. *G. gracifolia* and *G. noxia* are present in cerrado where they are adversely affected by fire [203].

Guarea (Meliaceae). Trees of lowland rainforest in understorey and canopy [117], extending to sub-Andean forest [128], a typical lower montane tree with several species in Costa Rica [163] and Venezuela [191], e.g. *G. glabra*, *G. kunthiana* and *G. rhopalocarpa* are present at Monte Verde, Costa Rica [122]. Found in Brazilian seasonal forest [205], *G. macrophylla* is present in well-drained Colombian Amazonian uplands [83,86], *G. bullata* in Costa Rican primary swamp forest [105]. *G. gomma* and *G. guidonia* form an association with *Acalypha*, *Cecropia*, *Cedrela*, *Inga*, *Maytenus* and *Sapium* in Colombian mid-altitude forest (1000–2400 m) [219].

Guazuma (Sterculiaceae). Trees recorded in seasonal forests of western Amazonia [74], southeastern Brazilian seasonal forests [17], Costa Rican

tropical moist forests [230], and dry forest [205], e.g. *G. ulmifolia* is a common invasive taxon of Costa Rican derived savanna, particularly when fire regime is controlled [230] extending to Colombian lowland dry forests [161], e.g. *G. tomentosa* is common in Cuban dry scrub formation [47], *G. ulmifolia* forms a community with *Hura crepitans* about 680 m [216].

Guettarda (Rubiaceae). Understorey shrubs and canopy trees present in montane rainforest, e.g. *G. poasana* is present at Monte Verde, Costa Rica [122], becoming rare in lowland rainforest [117], *G. pohliana* and *G. viburnoides* are frequent trees in seasonal Brazilian forests [205], *G. foliosa* and *G. olivacea* are present on poor soils in Amazonian *terra firme* forest [209]. *G. chiriquiensis* forms association in Colombia with *Miconia*, *Siparuna* and *Sloanea* from 1350 to 2300 m [221].

Gunnera (Gunneraceae/Haloragidaceae). Herbs with a bimodal distribution; found in Central America (extending towards the northern Andes) and northern Central America [263], particularly from 2000 to 3000 m [3], a possible temperate restriction to distribution [202] in the lowlands [175]. Most common in montane rainforest, found below *Quercus* in Costa Rica and Panama [168] and in disturbed Andean montane rainforest [117,299], Brazilian humid montane rainforest [117,129] and Valdivian rainforest [152]. Wide distribution in southern South America, e.g. *G. magellanica* is present in bogs and in marshes of Patagonian steppe, *G. chilensis* is found along rivers and in wet forests as a disturbance indicator [297]. *G. tinctoria* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Gustavia (Lecythidaceae). Canopy trees [117] present in wet forests on the Barro Colorado Islands and Panamanian semi-deciduous forest [168], e.g. *G. superba* [46]. *G. speciosa* forms an association with *Anacardium*, *Bursera*, *Brosimum*, *Brownea*, *Pseudobombax*, *Pterocarpus* and *Spondias* from 720 to 750 m in Colombia [190].

Halenia (Gentianaceae). Herbs with many endemic species common in Páramo [3,140], *H. rhyacophila* is present in Costa Rican secondary montane rainforest [163].

Hasseltia (Flacourtiaceae). Canopy trees found throughout Central America [117], particularly in

montane rainforest, e.g. *H. floribunda* is present at Monte Verde, Costa Rica [122].

Hedyosmum (Chloranthaceae). Trees and shrubs in montane habitats from 500 to 2500 m from 18°N to 25°S [251], more humid environments at low altitudes, particularly in disturbed areas [117], as a relict (in a swamp setting) [74], and Chocó, at or near sea-level [116]. Can be common in montane rainforest, e.g. Costa Rican upper montane *Quercus*-dominated forests [137,138,141,163], Colombian *Quercus* [54 and *Weinmannia*-dominated forest (2800–3200 m) [54]. One species present in México on dry forest [251]. Recorded in the highest part of Venezuelan montane rainforest [202], e.g. *H. glabratum* (pollen reaching the páramo) [255], and Ecuadorian humid montane rainforest [288]. Present at low altitudes in Perú (230 m) [168], e.g. *H. scaberrimum* is common in Costa Rican primary swamp forest [105]. Specious genus in Colombia, e.g. *H. bonplandi*, *H. huilense* and *H. racemosum* forming a lower montane rainforest association in Colombia with *Brunellia*, *Clethra*, *Gordonia*, *Miconia*, *Oreopanax*, *Stylocerax*, *Tournefortia*, *Vallea* and *Weinmannia* (2200–3100 m) [57], where *H. popayanensis* is a herb [3]. Restriction below 3000 m suggests temperature may be controlling factor on distribution [58], although dryness may be a factor as well [3]. *H. brasiliensis* has a disjunct distribution; being found in the southern Andes and the Brazilian highlands [205], the former area being the most important [124]. *H. arborescens* is present in Jamaican montane rainforest [9].

Heliocarpus (Tiliaceae). Large trees and shrubs of late secondary montane rainforest [117], common in lower montane rainforest [3], Mexican [102,249] and Costa Rican primary swamp forest [105], e.g. *H. appendiculatus* is a large tree in Costa Rican montane rainforest at Monte Verde [122].

Heliocereus (Cactaceae). Epiphytes, 16 species in México and Central America, two species in the Antilles and one in northern South America [249].

Hemitelia (Pteridaceae). Fern common in Colombian *Quercus humboldtii*-dominated forests [54], a subgenus of *Cyathea* [285] (*Cyathea horri-*

da), *H. petiolata* is present in mature lowland rainforest on the Barro Colorado Islands, Panama [46].

Hesperomeles (Rosaceae). Trees and shrubs prominent about Colombian upper forest line [214], e.g. *H. heterophylla* is in Costa Rican shrub-páramo [163]. Forms monospecific stands in sub-Andean rainforest, e.g. *H. lanuginosa* is present in Colombia and Ecuador [3], *H. ferruginea* is present in the Cordillera Central (2950 to 3100 m) [71], often in association with *Berberis*, *Gaultheria*, *Hesperomeles*, *Myrsine* and *Oreopanax* [287].

Hibiscus (Malvaceae). Trees and shrubs restricted to Central America, common in the lowlands [230], e.g. *H. tiliaceous* is a pantropical tree recorded in Costa Rica [230]. Two species occur in cerrado [89,205].

Hippeastrum (Amaryllidaceae). Monocots with bulbs in Central and South America [129], particularly common along the northern Andes about 2500 m [3].

Hippocratea volubilis (Hippocrateaceae). Lianas with wide ecology, prevalent in dry forest [117].

Hippocrateaceae. Lianas with wide ecology [117], from dry forest to Chocó [116]. See also *Anthodiscus* and *Hippocratea*.

Hippuris vulgaris (Haloragaceae). Herbs, some semi-aquatic, present from tropical lowlands [3] to Tierra del Fuego [179], particularly in shallow pools of water [180].

Hirtella (Chrysobalanaceae). Shrubs in savanna from Venezuela to southern Brazil [48]. *H. glandulosa* shows no morphological difference throughout its range [48], present in eastern Amazonian floodplain forest [302], upland rainforest, central Amazonia [4], *H. bicornis* and *H. piresii* are present on poor soils in Amazonian *terra firme* forest [209], *H. lemsii* in Costa Rican primary swamp forest [105].

Humiria (Humiriaceae). Shrubs to large trees [117], montane distribution, extending to lowlands, particularly in Guiana-influenced Amazonia, mostly on white sands [117,161], e.g. *H. balsamifera* is common on brejos [124], eastern Amazonian floodplain forest [302], extending to campinas and caatinga [48].

Humulus (Cannabaceae/Moraceae/Urticaceae).

Lianas with wide ecology, prevalent in dry forest [117].

Huperzia (Lycopodiaceae). Lycopods present in montane, subalpine and alpine Costa Rica, common on landslides and along road cuts [163], wide distribution in upper grasspáramo, particularly in superpáramo [3]. Present in southern South America in Magallanic tundra [300], *Nothofagus betuloides*-dominated forest on Tierra del Fuego [179].

Hura (Euphorbiaceae). Spiny trees [164] found in Amazonian lowlands, north-east Brazil, Costa Rica, Panama, and Venezuela [74], a range of environments from dry forest to river margins [168], e.g. *H. crepitans* is present in mature lowland rainforest on the Barro Colorado Islands, Panama [46] and northern South America. In Colombia *H. crepitans* forms associations with *Coccoloba*, *Gliricidia*, *Guazuma*, *Machaerium*, *Prosopis* and *Tabebuia* from Bolívar to Santander in lowland settings [25,222].

Hydrangea (Hydrangeaceae/Saxifragaceae). Shrubs and epiphytic lianas [117] in lowland and mid-elevation montane rainforest [117], lower montane rainforest [3], e.g. *H. asterolasia* is a woody liana in Costa Rican *Quercus*-dominated forest [163]. *H. serratifolia* is present in Valdivian and northern Patagonian rainforest [300] and *Nothofagus alessandrii*-dominated forests of central Chile [103].

Hydrocotyle (Apiaceae/Hydrocotylaceae). Forest understorey herbs, mostly Andean distribution [117], abundant in Costa Rican upper montane pasture lands [163], Colombian and Venezuelan sub-Andean and Andean forests (1500–3200 m) [54], locally common in montane rainforest [117], extending to México [112]. *H. ranunculoides* is a semi-aquatic herb with a wide ecology, from lowland swamps to high altitude lakes (3500 m) [3] common in superficial waters in basin of México [248], also present in the Cordillera Oriental, Colombia where it forms aquatic pantano (2300–3100 m), often in association with *Myriophyllum* [66,314]. Present on eastern fringes of Tierra del Fuego [179], e.g. *H. cryptocarpa* and *H. ranunculoides* are common in shallow waters, ponds and creeks of pampa grasslands, *H. bonariensis* is common in hydromorphic soils and coastal dunes,

other species are common in coastal rivers [62,132], *H. galapagensis* in Galápagos pampa [60,264]. Present in tropical lowlands, e.g. *H. quinqueloba* is present in brejos [205].

Hyeronima (Euphorbiaceae). Large trees present in lower montane rainforest [117], common in Colombian (1000–2500 m) [54,70] and Costa Rican [163] sub-Andean forests, e.g. *H. poasan* [230]. Rare in lowlands [175], but common under high levels of precipitation ($> 3000 \text{ mm yr}^{-1}$) in Ecuadorian lowlands [168], present in Brazilian gallery and moist forests [17], e.g. *H. alchorneoides* is present in the Atlantic rainforest [273], *H. oblonga* is present in Costa Rican primary swamp forest [105], this taxon is negatively associated with fire action in Belize savanna gallery forests [143].

Hygrophila (Acanthaceae). Herbs and small shrubs [117] common along streams in north-western South America [117], e.g. *H. guianensis* forms aquatic associations with *Eleocharis* in the Cordillera Oriental, Colombia [276].

Hymenaea (Caesalpiniaceae). Large trees [117], smaller in cerrado [202]. A widespread distribution from dry to mid-altitude forest of Costa Rica [17,168] to Atlantic rainforest, spreading into gallery forests [80] and lowland liana forest [208], e.g. *H. parvifolia* is present on poor soils in Amazonian *terra firme* forest [209], *H. stigonocarpa* is frequent in cerrado [205], *H. coubaril* is present in Costa Rican tropical dry forests [230]. Pollen of *H. stigonocarpa* cannot be distinguished from *Cassia*, also present in cerrado [254].

Hymenophyllum (Hymenophyllaceae). Filmy ferns present in wet perhumid understorey environments, often as epiphytes [181], locally common in Costa Rican upper montane *Quercus*-dominated forests [141,163], extending to lowland rainforest [3]. Common in Colombian sub-Andean and Andean forests (1500–3200 m) [54], e.g. *H. lindenii* is important in epiphytic communities in the Cordillera Central, Colombia (2700–3500 m) [70,173]. *H. peltatum* is common in understorey beneath *Nothofagus/Drimys*-dominated forests [103,181]. *H. stigonocarpus* is present in cerrado [89,124] and in Amazonian *terra firme* forest [3].

Hypericum (Guttiferae/Hypericaceae). Shrubs

and dwarf shrubs in high Andes [140,214], trees in lowlands [124]. Common in grasspáramo [311], *Weinmannia*-dominated forests (2800–3200 m) [54], Venezuelan páramo and *Polylepis* dwarf forest [255], e.g. *H. lycopodioides* and *H. laricifolium* (3200–3450 m) [54], the latter extending from Venezuelan and Costa Rican to Colombian and Ecuadorian páramo [163,230], at approximately 3500 m [268]. A very diverse genus in Colombia (*H. brathys*, *H. goyanesii*, *H. humboldtianum*, *H. juniperinum*, *H. lancioides*, *H. laricifolium*, *H. lindenii*, *H. lycopodioides*, *H. magniflorum*, *H. pimeoides*, *H. ruscooides*, *H. strictum*, *H. struthiolaefolium*, *H. thuyoides*, and *H. trianae*) distributed from 2800 to 4150 m, for specific ranges and ecologies see [49,56,66,216,279,304]. Although a zoophilous taxon it can be common in pollen spectra [119].

Hypolepis (Pteridaceae). Ferns in upper montane rainforest, low páramo [3] and wet forest, particularly in clearings from 0–2500 m, occasionally extending to 4000 m [285]. Found throughout the Neotropics, a centre of diversity focusing on Venezuela [285]. *H. poeppigii* is present in the understorey of *Nothofagus alessandrii*-dominated forests of central Chile [103].

Hyptis (Labiatae/Lamiaceae). Herbs and shrubs [117] important in campo rupestre and savannas of northern South America [305], also present on the Barro Colorado Islands [168], e.g. *H. velutina* and *H. linaroides*, both of which extend throughout cerrado [89] to Mato Grosso and into Bolivia [124]. *H. braluata* is found on inundated savannas in the Llanos Orientales, particularly in better-drained areas [30] and brejos [205]. *H. emoryi* (desert lavender) is important in the Sonoran Desert [293]. Pollen cannot be distinguished from *Eriope*, *Ocimum* and *Rhabdocaulon* [254], indeed, a taxonomic ‘dump group’, probably including a wide range of taxa with a similar range of habitats [168].

Ilex (Aquifoliaceae). Trees, a liana in French Guiana [167], infrequent in seasonally inundated tahuampa, lowland várzea forest [117], igapó, semi-deciduous forest [84], and Amazonian marsh forest [290,291], can form a closed canopy [291], recorded down to sea-level in the Chocó [116], e.g. *I. divaricata* [291], can be common in open forest

[291] and on poor soils in Amazonian *terra firme* forest [209]. Important in montane areas, in *Araucaria*-dominated forest, present at relatively low elevations along the Pacific coast [134], common in Ecuadorian humid montane rainforest [288] and part of humid *Quercus*-dominated forest in central and south México [248], e.g. *I. toluicana* is present in central México (2500–2800 m) [240], *I. vulcanicola* [230] and *I. lamprophylla* are present in Costa Rican montane rainforest, at Monte Verde [122]. *I. Colombiana* is present up to 3600 m in Colombia [70] particularly at humid sites [224]. Four species in Brazilian dry forests [205], e.g. *I. asperula*, *I. conocarpa*, and *I. velutina* are common in cerrado [124,254], *I. kunthiana* can be common in drier types of Andean forest (2700–2850 m) [54], extending to subpáramo as a shrub [3]. *I. obcordata* and *I. vaccinoides* are present in Jamaican montane rainforest [9]. *I. paraguariensis* forms a close association with *Araucaria*-dominated forest [80], indicative of closed forest [59]. *I. paraguariensis* has been cultivated in Paraguay and southern Brazil to prepare a type of tea (yerba-mate) [306].

Indigofera (Leguminosae). Herbs [117], occasionally a tree of lowland dry areas [128], e.g. *I. lespedezioides* is present in cerrado [207]. *I. tinctoria* is common in desert areas of Cuba [47].

Inga (Leguminosae). Trees planted as crop shade [164], a tropical lowland distribution [164] extending to sub-Andean forest [163], particularly in disturbed areas [74,168], frequent in Brazilian seasonal forests [205], often associated with riparian habitats [17], e.g. *I. cocleensis* is present in Belize savanna gallery forest, negatively correlated with fire [143], *I. trachystachys* is present in Colombia Amazonian well-drained floodplains [83], *I. sessilis* is present in the Atlantic rainforest [273], *I. alba* in Guyanese lowland rainforest [81]. A common secondary forest species in Brazilian Amazonia [274], present in lowland Venezuelan forest [191], *I. longispica* is a small tree in Costa Rican montane rainforest, at Monte Verde [122], *I. hintoni*, *I. mortoniana* and *I. quaternata* are also present [122], a number of these extending to Costa Rican primary swamp forest [105]. *I. acrocephala* and *Inga nobilis* form associations with *Cecropia* [219].

Ipomoea (Convolvulaceae). Thin-stemmed lianas (sweet potato) [129], common in inundated savanna [208] and cerrado [3], a pioneer of restinga [208,265], an important shoreline liana [17]. Three species occur in cerrado [89] and campos, extending to Brazilian seasonal forest [205], *I. batatas* (sweet potato), a possible human indicator [117], can be common in the Llanos Orientales [50]. *I. habeliana* and *I. triloba* (morning glories) are present throughout littoral and dry zones on the Galápagos Islands [264], the latter species has a wide distribution throughout South America [264]. Can be common in xerophytic Andean forests (2350–2750 m) [54], e.g. *I. fritulosa* is an invasive taxon of grazing land, toxic to cattle [208]. Present in moist forests, e.g. *I. batatas* is present in the Atlantic rainforest [273].

Iresine (Amaranthaceae). Herbs of open vegetation [117] mainly in montane rainforest gaps [3], occasionally extending to páramo [140], e.g. *I. diffusa* is present in Costa Rican lower montane rainforest [163].

Iriartea (Arecaceae/Iriarteaceae). Large palm [117] characteristic of the tropical lowlands, not present in Atlantic rainforest [117,129], important in igapó and semi-deciduous dry forests [84], e.g. *I. deltoidea* is frequent in low altitude, wetland forests [140], such as Costa Rican freshwater lowland swamps [230], well-drained uplands of the Caquetá River in Colombian Amazonia [83], extending to dry tropical forests [54]. Often associated with riparian habitats, particularly in Costa Rica and Panama [168], e.g. *I. exorrhiza* is present in mature lowland rainforest on the Barro Colorado Islands, Panama [46]. Present spatial distribution in Costa Rica may result from past human activity by local harvesting for heart-of-palm, this may favour expansion of *Socratea* [189].

Iridaceae. Herbs indicative of wet conditions although with a wide ecology [117], common in high Andean páramo, puna, coastal lomas and open grass steppe [117]. Common in dry vegetation types [3], e.g. *Cipura*, *Gelasine*, *Sisyrinchium*, and *Trimezia* occur in cerrado and campo, *S. luzula* occurs on brejos [205], *Sisyrinchium* is only common in páramo [3]. See *Orthrosanthus*.

Isoetes (Isoëtaceae). Submerged aquatics [129] of páramo and puna swamps and lakes [140].

Grows in a variety of habitats from sea-level to 4200 m, most frequently above 2000 m elevation in soils saturated with water for at least a portion of the year [285]. Occasionally found in Amazonian and high mountain lakes of Central America [3,112], e.g. *I. mexicana* grows in lake margins and swamp areas in central México [33]. A single species is present in the Llanos Orientales [17], *I. karstenii* and *I. palmeri* being present at higher altitudes [66]. *Isoëtes* microspores are abundant but the macrospores are rarely found [255].

Ixora (Rubiaceae). Shrubs present in Brazilian gallery forests, extending to semi-deciduous forest [17], e.g. *I. warmingii* is a tree of Brazilian dry forests [205].

Jacaranda (Bignoniaceae). Trees and shrubs common in wet forest, particularly secondary growth forest [117], present in Atlantic rainforest [80], e.g. *J. copava* is an emergent tree of Brazilian lowland forest [88] and Guyanese lowland rainforest [81], *J. copaia* is present in mature lowland rainforest on the Barro Colorado Islands, Panama [46]. Common in dry forest, e.g. *J. decurrens* and *J. morri* are common shrubs in cerrado [17,124], the former being affected by fire [203], e.g. *J. lasiogyne* is common on alluvial terraces of the Llanos Orientales in Colombia [30], *J. macrocarpa* in well-drained Colombian Amazonian uplands, where it is tolerant of poor soils [83], *J. coerulea* is common in Cuban thickets [47]. *J. hesperia* forms associations with *Clidemia Ficus*, *Inga*, *Pavonia*, *Psychotria*, *Sorocea*, and *Tovomitopsis* from 550 to 730 m in Colombia [279].

Jamesonia (Gymnogrammaceae). Fern recorded from México to Bolivia, disjunct in southeastern Brazil [285]. Common at high altitudes, in areas characterised by low temperatures [168], can be important in páramo [117], common in high Andean shrub belt and in moist locations of puna [275,285] extending to Costa Rican [163] and Venezuelan páramo [255], usually present from 3000 to 4000 m [285]. *J. bogotensis* is restricted to the high paramo in Colombia [308].

Juglans (Juglandaceae). Trees, rarely shrubs, recorded from México [37,155] to the northern Andean montane rainforest [117], common in association with *Alnus* and *Podocarpus* [290], can be indicative of mature Andean forests [54], e.g. *J.*

mollis grows in *Quercus*-dominated forest in some parts of the Sierra Madre Oriental (1600–2500 m), *J. neotropica* is present in the Cordillera Central, Colombia (2000–2300 m), often in association with *Aegiphila*, *Ficus*, *Miconia*, *Ocotea*, and *Saurauia* [225]. *J. australis* is recorded in northern Argentinean montane dry forest [120].

Juncaceae. Semi-aquatic [117] herbs [3] common on moist soils in upper montane rainforest, puna and páramo [3]. *Distichia* is an important component of cushion bog vegetation [149]. *Juncus densiflora* is a herb in Brazilian seasonal forests [205], *J. chilensis* is distributed throughout the Andean spine [181], *J. balticus* is present at high altitudes of the Atacama Desert [226]. *Juncus ecuadoriensis* and *J. microcephalis* are present in the Cordillera Oriental [223] and Cordillera Central [49,52], Colombia (3400–4100 m). Common in semi-aquatic and brackish ponds as well as ‘esteros’ (Chaco-Paraguayan water bodies) in Uruguay and Argentina [61,62]. *Luzula* is present in temperate and alpine environments from Tierra del Fuego, puna and páramo to northern México, forms a local wetland in zacatonal alpino [112].

Jungia (Asteraceae). Shrubs, lianas and herbs recorded from México to the Andes [164], also in southern Brazil [129], e.g. *J. ferruginea* occurs in Costa Rican *Quercus*-dominated montane rainforest, particularly at drier sites, such as along the Pacific-facing slope [163], mostly found as lianas [3]. *J. floribunda* is present in Brazilian dry forests [205].

Juniperus (Cupressaceae). Trees present in Mexican and Guatemalan mixed forests [3,37], in xerophytic *Pinus*- and *Quercus*-dominated forests of the Mexican highlands, e.g. *J. deppeana* occurs from 2500 to 2850 m, where it can form pure stands, *J. californica* is present in the northern mountains of Baja California [248].

Justicia (Acanthaceae). Herbs in Costa Rican montane rainforest [163] to cerrado [167,205], e.g. *J. lithospermifolia* can be important in the seasonally inundated savannas of the Llanos Orientales [30], also recorded from Amazonia [168]. Can dominate in southern South American temperate zone and montane rainforest [117].

Koenigia (Polygonaceae). Antarctic/alpine herb present on Tierra del Fuego and the Malvinas [3],

present in cushion heath above the forest line of Tierra del Fuego [181], a pioneer plant of open wet grounds at high altitudes [299].

Labiata (Sapotaceae). Shrubs [164] and herbs with a wide ecology found in many areas of Latin America [202].

Lachemilla (Rosaceae). Widely distributed Neotropical genus [164] present in páramo, common in Costa Rican upper montane pastures [179], montane Andean forest [3], secondary shrublands [163], high altitude páramo and in Guatemalan mid-altitude forest [37]. Found in the understory of *Alnus acuminata*-dominated forests (2500–3100 m) [54]. *L. sandiensis* is common on the northern Chilean Altiplano, often restricted to high Andean bogs [12], *L. verticillata* is present in Venezuelan páramo (3600 m) [268] whereas *L. lactescens* is present in well-drained Amazonian uplands of the Caquetá River [83].

Laguncularia (Combretaceae). Mangrove tree [117] (white mangrove [230]), occasionally a shrub [264], e.g. *L. racemosa* is often associated with *Acrostichum* [80,208,265], forms matorral along the Caribbean and Pacific coast of Colombia [73,76]. A wide distribution throughout South American coastal areas [264], common in littoral areas of Cuba [47] and the Galápagos Islands [146,264].

Lamanonia (Cunoniaceae/Saxifragaceae). Herbs in southern Brazil [129], locally common, particularly at higher altitudes (> 800 m) [17].

Lantana (Verbanaceae). Trees and shrubs in tropical and subtropical Latin America [113]. Frequent at mid-altitudes within disturbed areas [3].

Laportea (Urticaceae). Herbs [164] with a wide ecology, particularly common in lowland moist areas [202].

Larrea (Zygophyllaceae/Leguminosae). Shrubs (creosote bush) present in Andean dry areas, Peruvian coastal desert, dry areas of Chile, in Argentinean puna at approximately 900 m, where it can form pure stands [165], central Argentina [117], and northern Mexican semi-desert [3]. Current spread is possibly a remnant of a previously much wider distribution [117]. Extends from the puna to open shrubby vegetation of north-central Chile [261], dominates the Sonoran Desert [293], extending towards coastal areas [2], e.g. *L. divari-*

cata forms characteristic associations with *Opuntia* spp. [98,265]. Characteristic of the 'jarillal' of Monte. *L. divaricata* is present in arid regions from México to northern Patagonia [65]. In the Precordillera of Mendoza, *L. cuneifolia* is present in arid and warm climatic conditions where it is associated with *Trichocereus candicans* and *Opuntia sulphurea*, between 750 m (with *Atriplex flavescens* and *A. argentina*) and 1100 m (with *L. divaricata*), often with *L. nitida* in riparian communities [298].

Lathyrus (Leguminosae). Herbs [117] present in montane habitats from 2000 to 3200 m [3], e.g. *L. magellanicus* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103] to Tierra del Fuego [180], extending to the Andes in humid subpáramo thickets [3].

Laurelia (Monimiaceae). Shrubs present in temperate southern South America [117,129], e.g. *L. sempervirens* is found in Valdivian rainforest [297] and *Nothofagus dombeyi*-dominated forests [296], extending to Chilean coastal ranges [11].

Lecythidaceae. Canopy trees [117], majority present in Amazonia, also present on the Barro Colorado Islands [168], Atlantic rainforest [53], rare in Chocó [116], where they extend to coastal areas [11]. Sixty-four species recorded in Amazonian forest around Manaus, Brazil [283]. *Lecythis* is present in Tierra firme forest, Colombian Amazonia [55]. *Lecythis currugata* is present in *Peltogyne*-dominated Amazonian *terra firme* forest of Brazil [51]. Present in dry vegetation types, e.g. *Lecythis nana* is recorded in campos cerrado [265]. See also *Eschweilera* and *Gustavia*.

Leguminosae. Trees, shrubs and herbs with a wide ecology [117], common in mature lowland rainforest [74], e.g. 127 species recorded in Amazonian forest around Manaus, Brazil [283], less abundant in montane rainforest, although *Inga* is the most common legume tree in Costa Rican lower montane rainforest [163]. Found in páramo and cerrado [205,254], e.g. *Lupinus* [163], common in a range of dry vegetation formations, campo, caatinga and cerrado, e.g. *Eperúa leucantha*, *E. purpurea* [48], all three subfamilies are represented in the cerrado by 153 spp. [172]. See also *Acacia*, *Adesmia*, *Aeschynomene*, *Anarthrophyllum*, *Andira*, *Bowdichia*, *Brownea*, *Cercidium*, *Copaifera*,

Dalbergia, *Erythrina*, *Indigofera*, *Inga*, *Larrea*, *Lathyrus*, *Lotus*, *Lupinus*, *Machaerium*, *Macrolobium*, *Mimosa*, *Myrocarpus*, *Myroxylon*, *Parapiptadenia*, *Pentaclethra*, *Phaseolus*, *Phyllanthus*, *Piptadenia*, *Piscidia*, *Pithecellobium*, *Poiretia*, *Prosopis*, *Schizolobium*, *Sophora*, *Stryphnodendron*, *Swartzia*, *Trifolium*, *Vicia* and *Zornia*.

Lemna (Lemnaceae). Herbs, mostly floating, distributed from lowlands to 4000 m [20], *L. affinis* is restricted to Brazilian and Panamanian rainforest [210].

Lemnaceae. Floating small herbs [3], widespread distribution, rare in lowland Amazonia [168] and Ecuadorian montane rainforest [288]. See also *Lemna*.

Lepidoceras (Loranthaceae). Semi-parasitic herbs of Valdivian rainforest [300].

Licania (Chrysobalanaceae). Canopy trees [117] in lowland rainforest [3], e.g. Chocó [111,116], particularly abundant in Guyanese forests [119] (61 species), seven being endemic [176], often associated with lakes, e.g. *L. apetala* is common in the poorly drained floodplain of Colombian Amazonian [83,209], lowland Venezuelan forest near Mérida [191] and in Ecuadorian forest [168], *L. apetala* is present in eastern Amazonian floodplain forest [302], *L. alba* and *L. heteromorpha* are present in Guyanese lowland forest [81,104], the former is often found in Colombia associated with *Alchornea Astronium Bactris Brownea Byrsenima Ficus Xylopia* from 200 to 1000 m [216]. Found in Brazilian semi-deciduous forest [205] and cerrado [17], e.g. *L. humilis* [254]. Present on sandstone tepuys in Brazil, e.g. *L. aracaensis* [48].

Liliaceae. Climbing herbs with a wide ecology, can be semi-aquatic, but also found in Chile, Bolivian Chaco and surrounding dry forest associations [117]. See also *Astelia* and *Philesia*.

Lindsaea (Lindsaeaceae). Ferns present from 0 to 2300 m [285], lowland rainforest to lower montane rainforest [3] throughout Central America extending to Perú, a centre of diversity is focused on the Roraima sandstone [285]. Found in wet grasslands also in savanna [285].

Lippia (Verbenaceae). Trees and shrubs distributed in tropical and subtropical Latin America [113], shrub on the campos of the Brazilian Shield [3].

Liquidambar (Hamamelidaceae). Trees in Central American highlands [117], present in Guatemalan mid-altitude forest [37], e.g. *L. macrophylla* is characteristic of montane rainforest (600 to 1500 m) [204]. Forms monospecific stands in México associated with *Pinus*-dominated and mesophyllous montane rainforest [249,251].

Lithospermum (Boraginaceae). Shrubs and herbs present in temperate México [249].

Lithraea (Anacardiaceae). Shrubs and small trees mainly restricted to dry vegetation associations, present, but rare, in the Chocó [116], e.g. *L. caustica* is a small tree of Chilean dry sclerophyllous forests [117,297], relatively common in Chilean matorral deciduous xerophytic vegetation [206], *L. caustica* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Lobelia (Campanulaceae). Herbs common throughout southern South America [129] present at high Andean altitudes (2500–3500 m) [3], also above the forest line [117], e.g. *L. tenera* can be common in Colombian lower páramo [140]. *L. salicifolia* is present, but rare, in Chocó [116,111]. Present in Pacific coastal desert of Chile, e.g. *L. decurrens* is particularly found towards the south [270].

Lomatia/Gevuina (Proteaceae). Small trees found in *Nothofagus*-dominated forests to the east and west of the Andes [165]. *Lomatia hirsuta* and *Gevuina avellana* are found in cool temperate *Nothofagus*-dominated forests [297], *L. ferruginea* in Valdivian rainforest, extending to Magallanic forests [188], *L. dentata* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Lophosoria (Cyatheaceae). Ferns, some arborescent, from México to South America [151], characteristic of closed forest, extending to páramo (3800 m) [285], locally important in upper montane rainforest [117], e.g. *L. quadripinnata* is common in Costa Rican and northern Andean montane rainforest [163] and *Quercus humboldtii*-dominated forests (2300–2800 m) [54]. Disjunct in southeast Brazil [285]; present in the southeast Brazilian highlands [129] and Atlantic rainforest [3].

Loranthaceae. Parasitic shrubs and trees common in Argentinean and Chilean forests, south-

eastern Brazil [129], lowland Amazonian rainforest [168], lowland Darien forest, Panama [28] and sub-Andean forests [140], extending to the páramo. Present in the upper montane Mexican and Guatemalan *Pinus*-dominated forests [3]. Several genera occur in cerrado [205]. See also *Aetanthus*, *Antidaphne*, *Arceuthobium*, *Gaiadendron*, *Lepidoceras*, *Orycanthus* and *Phrygilanthus*.

Lotus (Leguminosae). Herbs [17] locally common on poor soils, e.g. *L. strigens* is present in Sonoran Desert, México [293].

Lozanella (Ulmaceae/Urticaceae). Trees restricted to Central America [117].

Ludwigia (Onagraceae). Herbs [3] and shrubs with a wide distribution in tropical South America [112,16] from lowland to 3900 m in equatorial Andes [3], particularly common around lake margins [168] and on brejos, e.g. *L. erecta* [205]. *L. decurrens* is a typical Amazonian herb [87].

Luehea (Tiliaceae). Trees present in a wide range of environments in Central and South America [129], most abundant in semi-deciduous forest, particularly late successional forest [17,168], present in Belize savanna gallery forest [143], Costa Rican tropical dry forests [230] and Brazilian seasonal forests [205] to Argentina [299], e.g. *L. seemannii* is common in Costa Rican primary swamp forest [105].

Lupinus (Leguminosae). Creeping herbs up to 3 m, sometimes woody, common in Guatemalan mid-altitude forest [37] and in Costa Rican páramo, particularly at recently burnt sites [163]. Present in dry vegetation types, e.g. *L. arizonicus* is present in Sonoran Desert [293], *L. crotalarioides* and *L. velutina* occur in cerrado [254,205] and campo [205]. *L. alopecuroidis* is present up to 4000 m in Colombian páramo [70,72], often in association with *Cerastium*, *Geranium* and *Senecio* [157].

Lycium (Solanaceae). Shrubs common in arid and semi-arid regions, particularly southern South America, e.g. in Argentina out of 22 species, six are present in Patagonia, *L. ameghinoi*, *L. chilense* and *L. repens* are common in Monte and Patagonian steppe [114,165].

Lycopodiaceae. Cosmopolitan taxon [128], present from sea-level to 4400 m [117], common in montane rainforest [3], e.g. *Lycopodium com-*

planatum can be common in shrubpáramo [54], present around the montane bogs in Costa Rica [74], Venezuelan Andes [255] and on tepuys [135]. Often found following landslides, land fills, road cuts and with other disturbed regenerating vegetation; a good disturbance indicator [168,285]. Common in southern South America, e.g. *Lycopodium magellanicum* grows in frost hollows, where deciduous forests normally grow [181], *L. confertum* is present on the eastern fringes of Tierra del Fuego [179], growing from sea-level to 2600 m [135]. See also *Huperzia* and *Selaginella* [109].

Lygodium volubile (Pteridaceae). Ferns found in humid conditions [117], recorded from 0 to 3500 m, it is most common in the lower part of the range [285], e.g. in Atlantic rainforest [129].

Lysipomia (Campanulaceae). Herbs present in high Andean cushion bogs [117] and on humid ground in grasspáramo and bamboo-páramo (3270–3500 m) [54], e.g. *L. sphagnophilla* is present in the Cordillera Oriental of Colombia [66] to 3900 m [262,279].

Mabea (Euphorbiaceae). Large rainforest trees [117] present in a wide range of environments; igapó, várzea [84], semi-deciduous forest, cerrado [89] and Amazonian *terra firme* forest, although particularly common in relatively moist forests [17,168], e.g. *M. nitida* is present in eastern Amazonian floodplain forest [302], *M. caudata* is present on poor soils in Amazonian *terra firme* forest [209].

Machaerium (Leguminosae). Large rainforest trees of Amazonia [117] and Atlantic rainforest [80]. Three species occur in cerrado [205,254], e.g. *M. bisvulatum* is present in Costa Rican tropical dry forest [230]. *Machaerium* and *Dalbergia* cannot be separated palynologically [166].

Maclura (Moraceae). Trees and shrubs with a wide ecology, *M. tinctoria* extends from southern México to northern Argentina in a range of different forest types [17].

Macoubea (Apocynaceae). Large trees of lowland and Andean forest, often associated with *Tabernaemontana* spp. [117].

Macrocarpea (Gentianaceae). Shrubs and trees [164], mainly showing a tropical lowland distribution [164].

Macrobium (Leguminosae). Trees and herbs found in tropical gallery forest [117,129], shrub-páramo, extending to páramo [128], a semi-aquatic rainforest tree in Chocó [116], particularly common in igapó, along black water rivers [74] and in Colombian Amazonia in poorly drained uplands [83], e.g. *M. multijugum* is present in eastern Amazonian floodplain forest [302] and in Guyanese lowland rainforest [81], *M. arenarium* is present in campina [48].

Malpighiaceae. Trees, herbs and lianas with a wide ecology [117], prevalent in swamps and mangrove scrub [290], also in Costa Rican tropical moist forests [230], sub-Andean forests (1000–2500 m) [3] and Chocó [116]. One of the dominant families in cerrado [205,254,281], represented by 46 spp. [172]. See also *Banisteriopsis* and *Byrsonima*. *Malpighia glabra* is present in Chocó [216].

Malvaceae. Shrubs, trees and herbs with wide ecology [117] and cosmopolitan distribution [249]; present in marsh forests, along rivers, mangroves [290], Andean xerophytic forests (2250–2650 m) [54] and Costa Rican tropical moist forests [230]. Three genera occur in cerrado [254], *Pavonia* being the most frequent one [205]. *Nototriche* is present in puna, a common food of the Vicuña [309], several genera occur in pampa grasslands [62]. See also *Abutilon*, *Catostemma*, *Chorisia*, *Hibiscus*, *Pachira* and *Pavonia*.

Manihot (Euphorbiaceae). Lianas present in lowland areas [74] and common in cerrado [89] and caatinga [261], e.g. *M. caerulescens* [124] and *M. anomala* (maniçoba) [205]. Palynologically it is possible to separate domesticated and native taxa [117], of which the latter are distinguishable by size from the larger cultivated *M. esculenta* [254].

Maprounea (Euphorbiaceae). Shrubs (in dry areas) to large forest trees [117] present in cerrado and tropical seasonal forest, particularly common in drier forest [17], e.g. *M. brasiliensis* and *M. guianensis* are common in cerrado [205,254]. Present in moist forest, e.g. *M. guianensis* is present in the eastern Amazonian floodplain forest [302].

Marcgraviaceae. Lianas characterised by clinging roots [164] (hemi-epiphytic) [117], common in moist and wet forests [117], lower montane rainforest in Colombia, important in Chocó [111,116],

Norantea brasiliensis occur in seasonal Brazilian forests [205].

Marila (Guttiferae). Trees and shrubs in lowland rainforest found in Amazonia and the Barro Colorado Islands [74,168].

Maripa (Convolvulaceae). Thin-stemmed lianas of lowland rainforest [117].

Matayba (Sapindaceae). Trees present in montane rainforest [117], e.g. Monte Verde, Costa Rica [122]. Present in dry vegetation types, e.g. *M. guianensis* and *M. heterophylla* are frequent in cerrado [124,205], *M. oppositifolia* is found in gallery forest and savanna of Belize [143].

Mattia (Boraginaceae). Slender lianas present from the lowlands to Andean forest [117], usually humming bird pollinated [117].

Mauritia (Areaceae). Palms widely distributed in northern South America, east of the Andes [126] in humid/moist conditions [117], and in areas characterised by bad soil drainage [140]. Characteristic taxa of gallery forests in central Brazil [80,129], e.g. *M. minor* is common where the water table is high. Distributed throughout Amazonia [140], common in Amazonian marsh forests [24], lowland swamps [168], back swamp habitats [202] forming extensive swamp forests, e.g. *M. flexuosa* is a common species on buritizal [21,208], *M. vinifera* forms almost continuous stands in seasonal swamp forest [117] when the level of inundation reaches more than 40 cm [30], e.g. along the poorly drained floodplains of the Caquetá River [83], particularly on podsolised soils [219,289,295]. *M. flexuosa* is locally dominant in the savannas of Roraima, particularly when the water table is high [208], along white water river margins and in gallery forests [126] in the wet campo [172], a southern limit in Brazil is approximately 20°S [58,167], this could be related to winter temperatures, strong seasonal climate, soil humidity and/or topography [167]. *M. carana* occurs as isolated trees in Colombian 'savanna' on sandstone plateaus, particularly on acidic soils [291] (podzols [83]) and dune savannas of the Llanos Orientales [30] where densities of 8–20 specimens hectare⁻¹ are recorded [30]. *M. flexuosa* fruits are used for oil [161] and may be locally abundant.

Mauritiella (Areaceae). Palms, widely distrib-

uted throughout northern South America [126], e.g. *M. aculeata* is present in well-drained Colombian Amazonia uplands [83], *M. armata* is a typical palm of Amazonian savanna, extending along black water river margins [126,140], common in the Llanos Orientales [161]. Present in Brazilian Amazonia, particularly on hydromorphic soils [129], common around lake margins [168].

Maytenus (Celastraceae). Trees (<29m) [188] present in caatinga [17] and temperate forests along the coastal ranges of central Chile [11] and southern Argentina [299], e.g. *M. alaternoides* is frequent in Brazilian seasonal forests [205], *M. opaca* is important in cerrado [124], *M. octogona* in dry cactus forests on the Galápagos Islands [264], extending to western South America [264]. Occasionally found in Costa Rican montane rainforest [163], e.g. *M. schippii* is present at Monte Verde [122], *M. jamaicensis* is present in Jamaican montane rainforest [9]. Present in lowland forest, e.g. *M. guianensis* is present on poor soils in Amazonian *terra firme* forest [209]. Important in southern South America, e.g. *M. magellanica* is found in Valdivian, Patagonian and Magallanic rainforest [297], also forming a distinctive scrub around *Nothofagus*-dominated forests [181], almost extinct from Tierra del Fuego due to the excellent charcoal the wood produces [181]. *M. disticha* can form an understory beneath *Nothofagus pumilo*-dominated forests [181], *M. boaria* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103], a riparian and woodland tree of Chile and Argentina [152].

Melastomataceae. Lianas, dwarf shrubs and trees ubiquitous throughout moister parts of the Neotropics [58], well represented in the savanna of northern South America [3,290] and Ecuadorian secondary forest [117]. Found in Amazonian marsh forest [291], Chocó [38,116], Andean forest [128], common about the upper forest line [214], extending to shrubpáramo (3000–3400 m) [3], where it can dominate [54]. Present in lower montane rainforest in the Lake Valencia catchment, Venezuela [30]. Eighty-one species are recorded in Amazonian forest around Manaus, Brazil [196,283], characteristic of mature Andean forest [133] and Atlantic rainforest [53,154], abundant in Ecuadorian [101], Colombian [3] and Costa Rican

[138] upper montane rainforest, *Miconia* being the most species-rich genus of this family [163]. Common in secondary vegetation in the montane rainforest clearances in the Venezuelan Andes [255], *Comolia* occurs on top of the tepuys [135]. Twelve genera occur in campos, cerrado and brejos [205], represented in the cerrado by 32 spp. [172]. Pollen grains of this family are similar to those of *Terminalia* (Combretaceae) [254]. See also *Miconia* and *Tococa*.

Meliaceae. Large trees common in tropical montane and subtropical regions [117], sub-Andean forest (1000–2500 m) [54], particularly in lowland settings [168], e.g. Chocó [111,116] and Brazilian seasonal forest [205]; 120 species are recorded around Manaus, Brazil [283]. Important timber tree of Costa Rican lower montane rainforest [163]. See also *Cedrela*, *Guarea* and *Trichilia*.

Meliosma (Meliosmaceae/Sabiaceae). Trees distributed in montane areas [117], rare in Amazonia [168], present in Chocó, extending to sea-level [116], lower montane rainforest [3], e.g. *M. glabrata* is indicative of undisturbed Costa Rican lower montane rainforest [163], *M. idiopoda* and *M. vernicosa* are present at Monte Verde, Costa Rica [122].

Menispermaceae. Lianas and weeds [117] of lowland and lower montane rainforest [3], also caatinga [17]. *Cissampelos* represented by shrubs and herbs in cerrado [205] and lower montane rainforest [3].

Metopium (Anacardiaceae). Shrubs restricted to México [164], e.g. *M. brownei* is abundant in northeast Yucatán [204], also common in Cuba [47].

Metrodorea (Rutaceae). Trees locally common in the strongly seasonal forest of northwestern South America [117].

Miconia (Melastomataceae). Dwarf shrubs and small trees [117] well represented in moist and wet early successional forest from sea-level to 4800 m, e.g. *M. chionophila* is a trailing dwarf shrub close to erratic boulders [3]. Highly diverse, palynologically indistinguishable from other Combretaceae and Melastomaceae [168,202]. A common secondary forest tree species in Amazonia [274], frequent in transition from páramo to high altitude forest

[311], sub-Andean forests (1500–3200 m), often in association with *Cordia lanata* (2650–2750 m) and *Polylepis* (2800–4200 m) [54]. *M. brenesii* and *M. biperuifolia* are important in Costa Rican montane rainforest [122,230]. A species-rich genus of Ecuadorian upper montane rainforest, e.g. *M. pustulata*, *M. salicifolia* and *M. theaezans* are common here [138,288], the latter two species also in Colombia [3]. *M. cleefii*, *M. elaioides*, *M. latifolia*, *M. minutiflora*, and *M. salicifolia* are present along the Cordillera Occidental, Colombia (3400–3600 m), often in association with *Baccharis* [225], *Aragoa abietina* [49] and *Hyeronima* [25]. Present in tropical dry forest [161], e.g. *M. albicans* and *M. pohliana* are present in cerrado [124], where they are adversely affected by fire [203]. Present on the dune savanna of the Llanos Orientales, indicative of a tendency towards closed forest development [288], secondary forest taxon common on abandoned Brazilian lowland pasture [88]. Occurs in Venezuelan dry evergreen forests [255]. Present in gallery forest, e.g. *M. caudigera*, *M. cyathanthera* and *M. sclerophylla* are all important in Brazilian gallery forests [124]. *M. robinsoniana* is endemic to dry forests of the Galápagos Islands [264]. Palynologically difficult to separate from Combretaceae.

Mimosa (Leguminosae). Trees, shrubs and herbs [117,159] with a wide ecology, well represented in caatinga [124,261], common in the savanna, cerrado and campos associations of northern South America [205,305], also present in tropical lowland forest [161]. Xerophytic shrubs also present in thorn forest [248], e.g. *M. acutistipula* can be an important in dense treelet-scrub savanna in the campo rupestre of Brazil [53]. *M. tenuiflora* and *M. hexandra* are present in seasonal dry forests, particularly in northeastern Brazil [142]. *M. cabre-ra* forms an association with *Capparis* and *Cordia* in semi-desert areas, the Caribbean coast of Colombia [71] and in dry inter-Andean valleys [253]. Palynologically subdivided into *Mimosa* cf. *M. scabrella* and *Mimosa* cf. *M. taimbensis*, the former is an important taxon in *Aracauria*-dominated forest [117,129,167], the latter in montane rainforest [117].

Mimulus (Scrophulariaceae). Wetland herbs [3,117] present from 2500 to 3500 m, common

in páramo [232], particularly along small streams [3].

Misodendrum (Misodendraceae). Parasitic herbs, e.g. *M. punctulatum* and *M. quadriflorum* are parasitic on *Nothofagus* [152]; this pollen type is indicative of open *Nothofagus*-dominated forests [299].

Mitraria (Gesneriaceae). Liana found in temperate Patagonian and Valdivian rainforest [297], present in *Nothofagus obliqua*-dominated forests [296].

Monstera (Arecaceae). Lianas (swiss cheese plant [168]) and small trees favouring organic-rich soils [117], common in wet forest [117] and lower montane rainforest [3], e.g. *M. deliciosa* is common in Costa Rican lower montane mature montane rainforest, particularly along Atlantic-facing slopes [163].

Montia (Portulacaceae). Semi-aquatic herbs common in páramo [117] extending to upper montane rainforest and superpáramo [3], e.g. *M. paramense* is present in Venezuelan páramo at 3500 m [268], *M. fontana* on Tierra del Fuego [268]. Forms an association with *Pentacalia* in perhumid areas to 4750 m [56,222,255].

Monttea (Scrophulariaceae). Shrubs [299] found in driest areas of Chaco thorn forests, extensive in Monte Desert [165,270].

Moraceae. Trees common on fertile soils in tropical rainforest [117], e.g. Chocó [116], also important in mid-altitude forests [54], 68 species recorded in Amazonian forest around Manaus, Brazil [196,283]. In Panama most common in lowland settings, decreasing in abundance with altitude [74,168]. This family is sometimes associated with disturbed areas [168] and occasionally in cerrado and Brazilian dry forests [205,254]. See also *Cecropia*, *Dorstenia*, *Humulus*, *Maclura*, and *Trophis*.

Moritzia (Boraginaceae). Herbs of subtropical areas, common in eastern Brazil, one Andean species is present in páramo [3,117,129].

Mortonioidendron (Tiliaceae). Shrubs and trees common in Central American lowland tropical forest [117].

Muehlenbeckia (Polygonaceae). Lianas, or prostrate shrubs, locally common in montane rainforest [117], also present in páramo (to 4300 m) [3], e.g. *M. tamnifolia* is important in secondary

growth Costa Rican montane environments [163]. Present in temperate forest, e.g. *M. hastulata* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Mulinum (Apiaceae). Spiny shrub, cushion-forming at high altitudes in lowland steppe ecotone, e.g. *Mulinum spinosum* is a main component of grass-shrub steppe, common on lower slopes from San Juan and Mendoza to Santa Cruz (40 to 1500 m) [65].

Mutisieae (Asteraceae). Lianas, herbs and shrubs [117] of Patagonian steppe and Chilean Andes, recorded to 2700 m [15], e.g. *Mutisia latifolia* is recorded in subtropical dry vegetation along the South American Pacific coast [265]. Common in the transition from dry forest to upper montane rainforest [3], often in association with *Cordia lanata* (2650–2750 m) [54]. Common in cerrado, campos and forests of central Brazil [205,254]. See also *Nassauvia*, *Perezia* and *Trixis*.

Myrica (Myricaceae). Trees [117] and shrubs forming thickets on sloping humid ground along streams or in topographically incised valleys [54], important in upper Andean valleys [275], extending to shrubpáramo [3], on eroded Andean slopes [140], locally common in Costa Rican upper montane *Quercus* forests [54,141], often in association with *Cordia lanata* (2650–2750 m) [54], present at low altitudes in Costa Rica and Panama (1200 m) [168], e.g. *M. splendens* is present at Monte Verde, Costa Rica [122]. In Colombia, *M. pubescens* forms an association with *Weinmannia* [225]; *M. parvifolia* is restricted to the range of 3600–3800 m in the Cordillera Oriental, Colombia [66]. Present in restinga dune forests [80] and treelet-scrub outcrops of zonal rainforest [53] to México [249], e.g. *M. pubescens* [230] is present in upper montane rainforest, *M. parvifolia* forms thickets on wet soils whereas *M. pubescens* occurs in *Weinmannia*-dominated forests [161]. *M. vanulosa* can be a common tree in cerrado [124].

Myriophyllum (Haloragaceae). Submerged aquatic herbs found in the high Andes [117] (1500–4000 m) [3], a good indicator of Late Glacial cooling [168]. Widely distributed in the lakes of the Cordillera Oriental, Colombia [216,223]. Present in the south Brazilian highlands [129], common in ponds, creeks and flooded plains with-

in the pampa grasslands and throughout Patagonia [62,248].

Myrocarpus (Bixaceae/Leguminosae). Trees prized for their wood [208] present in Atlantic rainforest [80,208], one species being recorded in Amazonia [117], present on brejos, in southern Brazilian forests [210] and moist forest [202].

Myroxylon (Leguminosae). Trees in Atlantic rainforest [17,80], used for the ‘balsam of Perú’ [117], e.g. *M. peruiferum* occurs in the Amazonian forest of Brazil [205].

Myrsine (Myrsinaceae). Small trees characteristic of mid-elevation forests [117], a typical gap species [163] common in relatively wet areas on the savannas of Roraima, particularly on very acid soils [208]. Often found in association with *Araucaria*, *Ilex* and *Podocarpus* [59], rare in lowlands, becoming frequent at the rainforest limit. Typical of mid-elevation Andean forest (1500–3200 m) [54], locally common in Costa Rican upper montane *Quercus*-dominated forests [141] particularly in exposed areas [117,129], can extend to páramo as a shrub [140], e.g. *M. pittieri* [230], often in association with *Dodonaea* [214]. *M. guianensis* can be common in drier types of Andean forest (2700–2850 m) [54], frequent in Venezuelan dry evergreen forest [255]. *M. dependens* is present in upper Andean humid dwarf forests (3200–3500 m) [54], becoming most common genus in upper montane rainforest. *M. dependens*, *M. ferruginea* and *M. guianensis* are found in association with *Alchornea*, *Buddleia*, *Clusia*, *Miconia* and *Weinmannia* in the Cordillera Oriental, Colombia [225,284]. *M. coriacea* occurs at boundaries in secondary growth forest. *M. umbellata* and *M. guianensis* occur in cerrado [205,254], *M. monticola* and *M. venosia* are important in Brazilian gallery forests [124], becoming common in coastal vegetation [129], Atlantic rainforest [154] and lowland Darien forest, Panama [28]. *M. ferruginea* is present in lower montane rainforest in the Lake Valencia catchment, Venezuela [30]. Present in savanna gallery forests of Belize where the seedling success is improved following fire incidence [143]. This genus, formerly named *Rapanea*, is entomophilous [137].

Myrtaceae. Trees and shrubs [117] found from semi-deciduous forests to várzea [84], important

in upper Andean valleys, rainforest and on humid ridges near coastal areas [290] particularly in moist forests [275], e.g. *Eugenia* [290]. Common in *Araucaria*-dominated forests in Brazil [59,167], can be common in high altitude *Ilex/Podocarpus*-dominated forests [134], extending to wet shrub páramo [3], particularly in well-drained uplands [168]. Important in Chocó [116] and Atlantic rainforest [53], 50 species recorded in Amazonian forest around Manaus, Brazil [283]. Present in northern Valdivian and Patagonian forests [300], dry evergreen forests of Venezuela [255]. Represented by 46 spp. [172] in the cerrado [254], e.g. *Campomanesia*, *Eugenia* and *Myrcia* [205], can be a dominant family in cerrado [281]. The fruits are a source of nutrition and trees can be common around settlements [168]. See also *Campomanesia*, *Cariniana*, *Eugenia*, *Myrteola*, *Pisidium* and *Teupualia stipularis*.

Myrteola (Myrtaceae). Dwarf shrubs common in upper montane rainforest and páramo [3], e.g. *M. oxycoccoides* is present in *Sphagnum*-dominated cushion bogs of Colombian high Andes [117,149]. *M. nummularia* can grow in frost hollows of *Nothofagus*-dominated forests, forming a heath association above the forest line [181].

Nanodea (Santalaceae). Parasitic herb on *Empetrum* [180], can be important in gramanoid bogs on Magallanic moorland [181].

Nassauvia (Asteraceae/Mutisieae). Shrubs recorded in steppe [117] extending along the Andes to Argentina and Chile [307], e.g. *N. cumingii* and *N. lascaea* are found in the Andes at 3200–3400 m and 3500–3900 m, respectively. Forty Andean-Patagonian species present from the south of Bolivia to Tierra del Fuego, *N. darwinii* is associated with *Empetrum*-dominated heath [181], *N. maeviae* in southern Patagonia [14], being pollinated by *Diptera* [13]. Common in high mountains (*N. argyrophylla*, *N. darwinii*, *N. lascaea*, *N. pygmaea*, and *N. revoluta*) and in the Patagonian steppe (*N. ameghinoi*, *N. axillaris*, *N. fuegiana*, *N. glomerulosa*, and *N. ulicina*) [43].

Nephelea (Pteridaceae). Tree ferns distributed from the Greater Antilles to Argentina with a centre of diversity focused on the Greater Antilles [285], common in riverine montane rainforest [17] primarily from 500 to 2500 m [285].

Nertera (Rubiaceae). Herbs of temperate rainforest [300], occasionally in wet ditches where it can be mat-forming [117]. Present in the understorey of *Alnus*-dominated forests (2500–3100 m) [54], e.g. *N. granadensis* is a typically north Andean and Costa Rican páramo herb of wet places, common between bamboo clumps [20,163].

Nothofagus (Cupuliferae/Fagaceae). Trees and shrubs restricted to southwestern South America [169,263], restricted to sites in Chile and Argentina that are climatically or edaphically suboptimal, although the mature specimens are robust, seedlings are poor competitors [129,264]. The growth of *Nothofagus* is related significantly to topography, slope and quantity of precipitation in the warmest quarter of the year [212,227]. Can form parkland associations in conjunction with conifers [145,300], e.g. *N. betuloides* is found in the Magallanic rainforest [297] extending from sea-level to approximately 300 m where it forms a ‘Krumholz’ growth [181], increasingly important where precipitation exceeds 800 mm yr⁻¹, in the ‘transition zone’ it is intermixed with *N. pumilio* [181], this taxon extending to the treeline [299]. *N. alpina*, *N. antarctica*, *N. betuloides*, *N. dombeyi*, *N. nitida*, and *N. pumilio* are present in Valdivian rainforest [297], *N. nitida* in Patagonian rainforest [297], *N. antarctica*, *N. dombeyi*, and *N. obliqua* in Magallanic rainforest and cool temperate forests [297]. *N. pumilio* can form a subcanopy below *Araucaria araucana*-dominated forest [297]. The best stands of *N. pumilio*, with trees up to 25 m, occur at lower elevations on well-developed soils [181], not extending farther than 48°S [300]; *N. antarctica* has a wider ecological amplitude than *N. pumilio* [299] and is confined to poorer soil types [181]. *N. nitida* is co-dominant with *Drimys* in the mid-elevation forests of northern Chile [77]. Forest line in southwestern Argentina is comprised of *N. pumilio*, forming aggregates of several stems up to 2 m high [303]. *N. antarctica* is a tree that rarely exceeds 6 m, it can be a pioneer; after fire it is characterised by rapid regrowth; it has a fast life cycle and can attain local dominance [299]. *N. alessandrii* forms a specific forest type (ruil) that is suffering intense deforestation and fragmentation [103]. Palynologically, this genus can be subdivided into the *N. obliqua* and *N. dom-*

beyi groups [169], the former including *N. alessandrii*, *N. betuloides*, *N. dombeyi*, *N. nitida*, and *N. pumilio*, the latter including *N. alpina*, *N. antarctica*, *N. obliqua*, and *N. procera* [297]. Genetic variation of the present populations is consistent with the result of spreading from at least two, but possibly more, glacial refugia located in coastal Chile and on the southern flanks of the Argentinian Andes [311].

Nyctaginaceae. Trees and shrubs present in rainforest, e.g. Chocó [116], and Atlantic rainforest [53], often in extralimital dry areas [117]. Two genera, *Pisonea* and *Neea*, occur in cerrado [254], *Neea theifera* is very frequent [205]. See also *Bougainvillaea*, *Colignonia*, *Guapira*, and *Pisonia*

Nymphaea (Nymphaeaceae). Aquatic herbs found to 2500 m in the tropics [3], e.g. *N. mexicana* and *N. flavo-virens* are found in lakes and swamps of the Mexican basin at 2250 m [31,237], down to the lowlands [131,186,244]. *N. goudotiana* forms an aquatic association with *Cabomba aquatica* and *Trapa natans* [73].

Nymphoides (Gentianaceae). Aquatic herbs found in the tropics, common to 2000 m [3,117]. Two species are recorded in México from 1500 to 2600 m [20].

Ochnaceae. Shrubs and trees widely distributed throughout northern South America [117], mostly north of the Amazon with extraordinary concentration in Colombia [126], present from Chocó [111,116] to Guiana highlands [126], rocky savannas [3], secondary cerrado [167] and along white water river margins [126] – a relatively wide Amazonian distribution [168]. Found in savanna from Trinidad to Paraguay [48], e.g. *Poystachya* and *Ouratea* occur in cerrado [254], *Sauvagesia* occurs on brejos [205]. See also *Ouratea*.

Ocotea (Lauraceae). Trees and shrubs in well-drained Colombian Amazonian uplands [83], extending to lower and upper montane rainforest [3,191], Atlantic rainforest and occasionally within *Araucaria*-dominated forests [80]. *Ocotea*, together with *Miconia*, is one of the largest genera of trees in Costa Rican montane rainforest [168]. Numerous endemics are abundant in mature forests and as shade trees in pasture lands [163], e.g. *O. floribunda*, *O. meziana*, *O. tonduzii*, and *O. valeriana* are present in Costa Rican montane rain-

forest, at Monte Verde [122], *O. patens* is present in Jamaican montane rainforest [9], *O. babosa*, *O. cernua*, *O. dendrophane*, and *O. ira* are present in Costa Rican primary swamp forest [105]. Present in Paraguay and Argentina [299], can be an important fruit tree for bird populations [163]. *O. callophylla*, *O. discoloris*, *O. ira*, *O. neblina*, and *O. sericea* are present in Colombia, *Ocotea callophylla* can be locally dominant, forming associations with *Clusia multiflora* (2700–2900 m) [222]. Common in lowland forest, present in lowland Venezuelan forest near Mérida [191], *O. esmeraldana* is a diagnostic tree of lowland rainforest of Araraucara, Colombia [291]. Palynologically very rare, not recorded by modern pollen traps in Costa Rica [168].

Oenocarpus (Arecaceae). Palm found in the tropical lowlands [164], e.g. *O. bataua* is present in Amazonian floodplains, extending to well-drained uplands and areas characterised by polzolised soils [83], *O. bacaba* is present on poor soils in Amazonian *terra firme* forest [209], fruits are used for oil [161]. *O. bataua* is distributed in Colombian Amazonia, particularly along the Caquetá River, forming an association with *Clathrotropis* and *Eschweilera* [87].

Onagraceae. Wide growth form, semi-aquatic herbs to shrubs [117], important in Costa Rican and Andean montane rainforest [3,163], several species of *Ludwigia* are frequent on brejos, *L. erecta* is a shrub in Brazilian seasonal forests [205]. Several species of *Ludwigia* and *Oenothera* are common in floodplains of the Río de la Plata. *Oenothera indecora* and *O. mollissima* are common on sandy soils and dunes of the pampa grasslands [62,200]. See also *Epilobium*, *Fuchsia* and *Ludwigia*.

Operculina (Convolvulaceae). Thin-stemmed lianas found in lowland forest [117], e.g. *O. hamiltonis* is present in Brazilian seasonal forests [205].

Ophioglossum (Ophioglossaceae). Ferns found in lower páramo and upper montane rainforest [3], found throughout Latin America in a wide range of habitats, mostly on rocky substrates from 500 to 4000 m [285].

Opuntia (Cactaceae). Cacti, one of the most important genera of dry plant formations in South

America, common in Monte Desert [10] and in caatinga [261], e.g. *O. conoidea* and *O. ignescens* are present at high altitudes of the Atacama Desert [226]. A characteristic xerophytic shrub of northern México [248], e.g. *O. bigelovii* is locally common in the Sonoran Desert [293], *O. tormentosa* is present in the Mier y Noriega region of México [123]. *O. lindheimeri* and *O. leptocaulis* can dominate subtropical savanna [292]; common within degraded areas about the Sabana de Bogotá, Colombia [147]. *O. schumanni*, in association with *Lantana*, is recorded to 1760 m in the Sierra Nevada de Santa Marta, Colombia [219].

Orchidaceae. Epiphytic herbs [117], common from tropical rainforest to savanna [129], present in campo, cerrado and Brazilian seasonal forests, e.g. *Cyrtopodium*, *Epistephium* and *Habenaria* [205]. True terrestrial orchids only occur in the lower páramo [3]. A common family around the Chocó Pacific coast [38]. Present in southern South America, e.g. *Codonorchis lessonii* is a perennial herb with tuberous rhizome frequently found at shaded sites under *Nothofagus pumilio*, while *Gavilea lutea* occasionally occurs in disturbed *N. pumilio* forest clearings [41]. As pollen grains are grouped in pollinium, they are rarely present, if ever, in sediments, air or honey [166].

Oreopanax (Araliaceae). Hairy trees and shrubs [164] common in upper Andean forests [179], forming an important component of secondary upper montane rainforest [137,163], e.g. *O. palamophyllus* is present in humid montane rainforest, *O. xalapensis* in Ecuadorian secondary montane rainforest [288], *O. capitatus* is a hemi-epiphytic canopy tree in Costa Rican *Quercus*-dominated montane rainforest [163,230], *O. xalapensis* is present in montane rainforest at Monte Verde [122], is common in secondary forest and has a growth form which is similar to *Cecropia* [163]. *Oreopanax* forms an association in Colombia with *Greigia*, *Hesperomeles*, *Miconia*, *Monnina*, *Oxalis*, *Ribes*, and *Weinmannia*; it is particularly common from 3500 to 3700 m [215].

Orthrosanthus (Iridaceae). Bulbous herbs restricted to lowermost páramo and puna [117] (up to 4000 m) from Bolivia to Costa Rica [3], e.g. *O. chimboracensis* is present in open areas and

near streams of the Costa Rican páramo-montane rainforest boundary [163].

Orycanthus (Loranthaceae). Shrubs, relatively rare [117] in the Andes.

Osmunda (Osmundaceae). Ferns characteristic of wet conditions although found in a wide habitat range, particularly around bogs and in wet savannas from 1500 to 2500 m [285], present in Guatemalan mid-altitude forest [37].

Ostrya (Betulaceae). Trees, one species in México recorded in mesophyllous, *Quercus/Pinus*-dominated forest and gallery forest [29].

Ouratea (Ochnaceae). Shrubs and trees [117] of rocky savannas [3], moist forest, campo rupestre and cerrado [17,202,205,254], e.g. *O. castaneaefolia* is present in campo rupestre [53], *O. roraimal* is confined to the Guiana highlands but widespread [48] whereas *O. hexasperma* is present in eastern Amazonian floodplain forest [302]. *O. polyantha* forms communities with *Aspidosperma*, *Coccoloba*, *Eugenia*, *Ficus*, *Psychotria*, and *Terminalia* in Colombian mid-altitude forests [136].

Ourisia (Scrophulariaceae). Herbs of puna and páramo [117], distributed from Costa Rica to Bolivia [3], present in uppermost grasspáramo and lower superpáramo, preferring a moist habitat [3]. Present in Valdivian rainforest [152].

Oxalis (Geraniaceae/Oxalideace). Herbs mostly in upland Andes, a few taxa in the lowlands [117], a common genus in Costa Rican secondary montane rainforest [163], in understorey of *Alnus*-dominated forests (2500–3100 m) [54] and associated with *Quercus humboldtii*-dominated forests [54], becoming rare in páramo [3]. Common in the wet Campos Panto Grossa [202], campo and cerrado [205]. *O. enneaphylla* can form an understorey in coastal scrub on Tierra del Fuego [181], associated with *Empetrum*-dominated heath and cushion heath above the forest line [181], *O. gussfeldtii* is recorded at 3600 m [307], *O. tuberosa* is characteristic of the high Andes, *O. adenophylla* of Patagonian steppe, *O. gigantea* in the Pacific coastal deserts of Chile [270] and *O. rosea* in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Pachira (Bombacaceae/Malvaceae). Trees, Andean-centred distribution [311], also present in Amazonia, Panama and Costa Rica [168], com-

mon in gallery and swamp forest [117], e.g. *P. aquatica* is common in Costa Rican primary swamp forest [105].

Palicourea (Rubiaceae). Shrubs and small trees [117] locally common in savanna associations with *Byrsonima* and *Curatella* in northern South America [21], common from Colombia to São Paulo [48], e.g. *P. rigida* [48]. Found in lower montane rainforest (1500–3200 m) [54], often associated with *Cordia lanata* (2650–2750 m) [54], locally common in Amazonia [168], one of the most species-rich genus of Costa Rican montane rainforest [230], particularly at lower elevations [163]. Present in campo and cerrado [205], e.g. *P. mar-gravii* and *P. rigida* are important shrubs of cerrado [124,254]. Where it is affected by fire [203], the latter is present in the moister areas of the Llanos Orientales [30,50]. *P. angustifolia* is present in the highland forests of Colombia (1200–2400 m), dominated by *Allophyllus*, *Cyathea* and *Hedyosmum* [136].

Pamphalea (Asteraceae). Herbs with a limited distribution, locally frequent in southern Brazilian highlands [129].

Panopsis (Proteaceae). Trees mainly montane [164] although *P. rubescens* is present in eastern Amazonian floodplain forest [302], also in Chocó to sea-level [111,116]. *P. suaveolens* occurs in Costa Rican lower montane rainforest, particularly in dense and undisturbed habitats [163], present at Monte Verde, Costa Rica [122].

Parahancornia (Apocynaceae). Large trees characteristic on poor soils [117], present in Amazonia and Costa Rica [168]. Exudes a white liquid that can be drunk [168].

Parapiptadenia (Leguminosae). Trees, relatively rare in the subtropics [117].

Passiflora (Passifloraceae). Lianas, occasionally small canopy trees, mostly present in mid-elevation forests [117], common across a range of vegetation types [311] from lowland to upper montane rainforest [3], important in Costa Rican [230] and montane rainforest, especially along lower montane streams and in forest gaps [163]. *P. clathrata* is a herb in cerrado [89] and campo [205], *P. foetida* is present on the Galápagos Islands from dry associations to *Scalesia*-dominated forests [264].

Paulinia (Sapindaceae). Lianas present from Amazonian rainforest to lower montane rainforest [3] and Brazilian seasonal forests [205], rich in alkaloids [117].

Pavonia (Malvaceae). Shrubs with a wide ecology, mostly found in disturbed areas [117]. Present from *Nothofagus obliqua*-dominated forests [296] to cerrado [205,254], e.g. *P. speciosa* is found in the piedmont region of the Llanos Orientales and in seasonally inundated savannas [30].

Pelliciera rhizophorae (Ternstroemiaceae). Small trees and shrubs restricted to Pacific coastal Colombia to Costa Rica [230], present in mangroves [3] (tea mangrove) [230].

Pentaclethra (Leguminosae). Trees present in Costa Rican freshwater lowland swamps [230], e.g. *P. macroloba* is present in Guyanese lowland forest [104] and is common in Costa Rican primary swamp forest [105].

Peperomia (Piperaceae). Epiphytic and succulent herbs [117] present in Andean forests (1500–3200 m) [3] and xerophytic bush (2350–3000 m) [3], very species-rich, dominating branches in Costa Rican montane rainforest [163] to *Polylepis*-dominated forests (2800–4200 m) [3], common in dry areas of Cuba, such as on mogote [47]. *P. lilloi* is present in Argentinean montane rainforest at 1000 m [195], *P. vaupensis* extends along the margins of Atlantic rainforest [53], *P. circinata* is present in Brazilian seasonal forests [205].

Pera (Euphorbiaceae). Medium to large trees prevalent on sandy soils and exposed ridges, frequent in southeast Brazil [117,129] from moist forest to cerrado [17,205]. *P. glabrata* occurs in Venezuelan dry shrubby coastal forests, to 800 m [257]. *P. schomburgkiana* is present on poor soils in Amazonian *terra firme* forest [209].

Perezia (Asteraceae/Mutisieae). Herbs, mainly montane [164], can be dominant above the forest line [303], e.g. *P. recurvata* forms associations with *Empetrum*-dominated heath [181], *P. lactucoides* with *Sphagnum*-dominated bogs of southern South America [181] whereas *P. atacamensis* is present at the highest altitudes of the Atacama Desert [226].

Persea (Lauraceae). Trees with a catholic distribution [138], e.g. *P. americana* is present on Monte Verde, Costa Rica [122], in Venezuelan

lower montane rainforest [191], Atlantic rainforest [273] and in well-drained Amazonian floodplains [83] (the native avocado in lower montane rainforest [163]). *P. caerulea* and *P. mutisii* form communities with *Alchornea*, *Guarea*, *Heliocarpus*, *Inga* and *Roupala montana* about 1800 m in the Cordillera Occidental, Colombia [220]. Present in sclerophyllous Chilean forest [300], e.g. *P. lingue* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Pfaffia (Amaranthaceae). Lianas of open vegetation [117], can be common in highland southern Brazil [129] and dry cerrado [17], e.g. *P. gnaphalioides* [254] and *P. sericea* in campo and *P. paniculata* in Brazilian seasonal forests [205].

Phacelia (Hydrophyllaceae). Herbs characteristic of lowland steppe and rocky places above the forest line of northern South America [117], e.g. *P. magellanica* is found above 3200 m [307], *P. speciosa* is present in savanna associations on less-leached soils of the Colombian piedmont region [30,292], *P. magellanica* and *P. secunda* form the understorey in coastal scrub on Tierra del Fuego [181,307].

Phaseolus (Leguminosae). Lianas (beans) which can be indicative of human activity [129]. *P. lineatus* is present in the inundated savannas of lower Amazonia [208], *P. vulgaris* is present in the Atlantic rainforest [273]. Most Mexican species are present in mountains, rarely in lowland moist forests [271].

Philesia (Liliaceae/Philesiaceae). Shrubs found in the understorey of Valdivian [152] and Magallanic rainforest [180,188].

Phrygilanthus (Loranthaceae). Parasitic epiphytic herbs [117] in upper montane rainforest, extending to shrubpáramo [3]. Present in temperate forests of southern South America [299].

Phyllanthus (Euphorbiaceae/Leguminosae). Trees to weedy herbs with a wide ecology [117], characteristic of caatinga [208], dry vegetation associations on sandstone plateaus [168], also present in lower montane rainforest (to 2500 m) [3] and lowland rainforest, e.g. *P. mimosoides* [120].

Phyllostylon (Ulmaceae/Urticaceae). Tropical trees mainly present in lowland dry forests [164], e.g. *P. brasiliensis* is a common micophyllous tree in dry areas of Cuba [47].

Pilea (Urticaceae). Small herbs of tropical lower montane rainforest (up to 2500 m) [3], can be common in lowlands, e.g. present on the Barro Colorado Islands [144,168], also extending to Costa Rican montane rainforest [3,117,163]. Common in dry areas of Cuba, such as on mogote [46].

Pilgerodendron (Cupressaceae). Slow-growing (to 1000 years [188]) coniferous trees found in southern South America [129], particularly on poorly drained soil, often associated with *Fitzroya* [297]. Can form monospecific stands in the Chilean coastal ranges, particularly on the islands south of Chiloé [297]. One of the most important arborescent conifers in the Magallanic region, most common along interface between dense forests and alpine moorland [188] in Magallanic and Patagonian rainforest [297]. *P. uvifera* is important where the soils become boggy, particularly in *Sphagnum*-dominated bogs [181].

Pinus (Pinaceae). Trees, the southernmost species recorded in northern Nicaragua [141], present in lower to upper montane rainforest (to 4000 m) [3], important in the Mexican highlands, 45.5% of known species are present in México, dominant over a wide altitude range [92,251] where it is favoured by acidic soils related to intense volcanic activity [44,248]. *P. caribaea* and *P. tropicalis* are common in Cuba and Yucatán [47]. *P. radiata* has been extensively introduced to southern South America [17], e.g. has invaded *Nothofagus*-dominated temperate forests in central Chile [103], but also throughout the northern Andes.

Piper (Piperaceae). Wide growth forms, lianas [129], shrubs to mid strata trees [171], locally common in Costa Rican upper montane *Quercus*-dominated forests [141], present in Mexican lowland rainforest [118], a pioneer in lower montane rainforest, particularly along streams and in secondary growth forest [163], e.g. *P. andreanum* is common in Ecuadorian humid montane rainforest [288], *P. austinii* and *P. euryphyllum* are present at Monte Verde, Costa Rica [122], many species in the Chocó Pacific area [3,38]. Can be important in cerrado [36,205] and drier forest types, common in dry areas of Cuba, such as the mogote [47], e.g. *P. bogotense* is present in dry Andean forests (2600–2750 m) [54], *P. amalga* in tropical dry for-

est, whereas *P. cenocladum* is present around Costa Rican lowland freshwater swamps [230]. *P. cordulatum* and *P. marginata* are present on the Barro Colorado Islands [46,187].

Piptadenia (Leguminosae). Trees and lianas [117] present in Atlantic rainforest [80], thorn forests of the central Andes (1000–3000 m) extending to the puna [261]. *P. adiantoides*, *P. communis* and *P. macrocarpa* are very frequent trees in Brazilian seasonal forests [205] whereas *P. moniliformis* is common on brejos [124], matorral and in upland rainforest, central Amazonia [4].

Piscidia (Leguminosae). Herbs restricted to Central America.

Pisidium (Myrtaceae). Trees common in disturbed areas, possibly indicative of human disturbance [140]. *P. galapageum* is found in transitional forest of dry areas on the Galápagos Islands [264], *P. eugenii* and *P. gulinenne* are found in the piedmont areas of the Llanos Orientales [30].

Pisonia (Nyctaginaceae). Trees and shrubs with a lowland distribution [164], e.g. *P. noxia* and *P. subferruginea* occur in cerrado [205,254].

Pithecolobium (Leguminosae). Very large trees saprophytic on other rainforest trees, often hydrophilic [117], common in lowland tropical seasonal forests [161], can be dominant in open thorn woodland of the northern Andes [165,261]. *Pithecolobium* is found with *Guazuma* and *Lemaireocereus* in Colombian spiny vegetation formations, e.g. in the Magdalena River valley [177,224]. Present in montane rainforest, e.g. *P. costaricense* is present in Costa Rica at Monte Verde [122].

Pityrogramma (Gymnogrammaceae). Ferns common in moist, open environments, a wide distribution in the Neotropics from sea-level to 3500 m [285], can be common in lowland rainforest [168].

Plantago (Plantaginaceae). Herbs, some low shrubs, particularly common at high altitudes, in bogs from the páramo [140] to 4600 m [225], also present in the high Andean shrub belt [275], e.g. *P. rigida* is found in bogs (3400–4200 m) [54], forming cushion mire that relates to the relatively low conductivity (nutrient status) of the water [34]. Moreover, at lower altitudes often a disturbance indicator [117], *P. australis* is a common herb in eutrophic moors and seepage areas, also

along roadsides in Costa Rican montane rainforest [163,230]. Can be locally common in Costa Rican upper montane *Quercus*-dominated forests [141], present in dry, open, vegetation (2000–3000 m) [3], e.g. *P. barbata* can be dominant in saline grasslands of Tierra del Fuego [181], *P. maritima* is associated with the littoral vegetation of southern South America [181], *P. insularis* and *P. toluensis* are present in Mexican desert scrub [293], extending to dry Andean forests (2250–2650 m). *P. sericea* forms open, low stands on dry stony slopes in association with *Dodonaea* and *Puya*; this represents the farthest northerly extent of this originally puna element [54], *P. lanceolata* is present at high altitudes of the Atacama Desert [226]. *P. tubulosa* is found at 3850 to 4100 m in the Sierra Nevada alpine grasslands. Differs modally from the Northern Hemisphere taxa although closest affinity is shown with North American specimens – it has been suggested that the Atlantic coast formed the most likely migration route [182]. The origins of *P. tubulosa*, *P. rigida* and *P. australis* are southern [3]. Some taxa are used in traditional medicines [249].

Platanus (Platanaceae). Trees restricted to Central America [299], riparian genus found in Mexican gallery forests from 0 to 2800 m [248], present in Guatemalan lower montane mesophyllous forest [37].

Plenckia (Celastraceae). Trees present from Amazonia [17] to cerrado, occasionally reaching the pampas [117], e.g. *P. populnea* occurs in cerrado [254].

Poaceae. Wide ecology and growth form, arboreal bamboo to cushion and bunchgrass (tussock) forms [128]. In extreme southern South America, it is likely that *Deschampsia antarctica* is the source of this pollen [282]. Tussock grasses (*Calamagrostis*, *Festuca* and *Stipa*) can prevail in savannas, being favoured by regular burning regimes particularly towards the end of the dry season [90]. *Chusquea* is important in Valdivian rainforest dynamics, becoming dominant following fire [296], in Costa Rica, recorded in Ecuadorian montane rainforest as a secondary taxon [288], also dominating the understorey of humid montane *Quercus*-dominated forest, flowers once every 10 to 20 years [163]. Dominant family in puna

and páramo [255] and in savanna and cerrado [254,292]. The most important family of the pampa grasslands; in terms of number of species and abundance, the best-represented genera are *Aristida*, *Melica*, *Piptochaetium*, *Poa*, and *Stipa*, also characteristic are *Bothriochloa*, *Briza*, *Eragrostis*, *Panicum*, *Paspalum*, and *Sporobolus* [62]. The dominant species of the humid pampa are *Aristida nurina*, *Bothriochloa laguroides*, *Piptochaetium montevidense*, *Stipa neesiana*, and *S. papposa*. Dominant in the dry pampa are *Elyonurus muticus*, *Sorghastrum pellitum* and various species of *Stipa* [200]. *Hyalis argentea* *Poa ligularis* and *Panicum urvilleanum* are dominant on dunes, *Distichlis* and *Spartina* are the most important grasses on saline soils [107]. The Mesopotamic pampa (subtropical grasslands) is characterised by *Axonopus*, *Bothriochloa*, *Digitaria*, *Paspalum*, and *Schizachyrium* next to a paucity of species of *Piptochaetium*, *Poa* and *Stipa* [62,200,213]. The Eragrostoideae and Panicoideae subfamilies are characteristic of northern Patagonia [107]. In the high Andes the grass steppe is dominated by predominantly *Poa holciformis* as well as *P. tristigmatica* and the ‘pajonales’ of *Cortaderia pilosa* [107]. There is a problem of palynological interpretation as the terrestrial sources cannot be separated from the aquatic sources of the pollen [202] (61 aquatic genera) [112]. Poaceae should not be used as an index of drying as there can be common local sources including aquatic grasses, a complicated signal that cannot separate local from non-local changes [58]. Pollen grains of cultivated grasses (mainly *Zea*) and forest wood bamboos have larger grains than the herbaceous grasses [254,258].

Podocarpus (Podocarpaceae). Large trees forming pure stands in montane rainforest [117,296], showing a disjunct distribution, i.e. southern Andes and Brazil, the former being the most important area [124] where it is characteristic of the upland Andean forests. A few specimens reaching sea-level [117], particularly along the Pacific coast [134], e.g. Chocó [116] and lowland Darien forest, Panama [28]. Although found at a wide range of elevations only numerically significant above 1000 m [58], e.g. at 2950 m in *Podocarpus* National Park, southern Ecuador [108] and in Guatemalan mid-altitude forest [37], very rare in

Amazonia [3]. Twenty-nine species in the Neotropics, most of which restricted to high altitudes but *P. sellowii* and *P. lambertii* extend to 750 m in humid gallery forests of Brazil [58]. Decline in number of species moving south through South America, e.g. there are seven species in Perú, five in Bolivia and only one in Argentina [297] where *P. parlatorei* may form pure stands [297]. In Costa Rica, Panama and Venezuela *Podocarpus* is not found below about 800 m, above this altitude it can form almost pure stands [59], e.g. *P. oleifolius* and *P. rospighiosii* occur in Venezuelan montane rainforest and dry evergreen forest [255] and forms associations with *Drimys* and *Clusia* from 2800 to 3000 m. Can be locally common in Costa Rican [141,163] and Mexican [3] upper montane *Quercus*-dominated forests [225]. *P. lambertii* and *P. sellowii* are found in southeastern Brazil in combination with *Araucaria*-dominated forest, usually common on humid soils, e.g. valley bottoms [6,80,167]. *P. urban* is present in Jamaican montane rainforest [9]. *P. saligna* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103], also common in Valdivian rainforest whereas *P. nubigena* is also recorded in Patagonian rainforest [297,300], where it is often associated with the mistletoe *Misodendrum* and *Maytenus disticha* [162]. Prone to damage by herbivores and pathogens [75]. In México, *P. reichei* is reported from montane rainforest [248]. Extensively cleared for wood [117].

Poiretia (Leguminosae). Trees and lianas common in dry inter-Andean valleys [117] and cerrado [254], e.g. *P. latifolia* is a tree in cerrado, and *P. punctata* is a liana in Brazilian dry forests [205].

Polemoniaceae. Predominantly herbs poorly represented in southern America, mainly present in the Andes [117,129]; *Polemonium micranthum* is found on eastern Tierra del Fuego [179]. See also *Gilia*.

Polygala (Polygalaceae). Herbs or shrubs frequent in southern Brazilian grasslands and open savanna on poor soils [117], extending to the high Argentinean plateau [39], e.g. *P. salasima* is recorded on the eastern fringes of Tierra del Fuego [179], matorral present in dry forest, cerrado and campos [205], e.g. *P. remansoensis* is important in cerrado [124], *P. sancti-goorgii* dominates on

sandy soils of the littoral zone on the Galápagos Islands [264]. *P. sanariapoana* and *P. adenaspora* are present in the rock vegetation of western Guiana [3]. Nine genera occur in the pampa grasslands, *P. parissias* is present on dunes, *P. darwiniana* and *P. desiderata* are frequent on the Patagonian plateau from San Juan to Santa Cruz [65], *P. salesiana* is present from the Río Negro to Tierra del Fuego [65].

Polygonaceae. Wide growth form, from trees [117] to aquatic herbs [290]. Cosmopolitan genus with 200 species [102], present in inundated savanna [208], *Alnus*-dominated forests (2500–3100 m) [54], Chocó [116], brejos and Brazilian seasonal forests [205]. *Polygonum acuminatum* and *P. punctatum* are found in the Cordillera Oriental (3100 m) [222], *P. acuminatum* is frequent on humid soils, *P. acre* grows along margins of Venezuelan rivers and small lakes [257]. See also *Coccoloba*, *Colubrina*, *Eriogonum*, *Koenigia*, *Muehlenbeckia*, *Rumex* and *Symmeria*.

PolylepisAcaena (Rosaceae). *Polylepis* comprises small trees of the high Andes forming dwarf forests in páramo, high above forest in the northern Andes, above 4400 m, occasionally to 5000 m [128,255,265,275], e.g. *P. tomentella* is important in puna (3800 m) [101]. *P. incana*, *P. quadrijuga* and *P. sericea* are present in the Cordillera Oriental, Colombia (4000 to 4200 m) [225]. In the past, *Polylepis* greatly expanded its range from core areas in Ecuador [3] resulting in a high level of speciation [267]. *P. australis* is a characteristic low tree/shrub of the high Andes, extending south to northern Argentina [120]; *Acaena* spp. are montane herbs [117] or small shrubs in open vegetation, showing a wide distribution [263] mainly in the Southern Hemisphere [255,306], although *A. elongata* is present in Costa Rican páramo and montane pastures (2700–3400 m), particularly in heavily grazed areas [163] about the forest boundary [140]. In Bolivia, it withstands temperatures below 0°C [275], e.g. *A. magellanica* is found above 3500 m [307], *A. cylindristachya* is present in bunchgrasspáramo (3600–3800 m) [54], *A. lucida* is only rarely found north of 50°S. *A. pinnatifolia* can be an important component of Patagonian steppe [181], a ruderal disturbance indicator [180], *A. ovalifolia* can be impor-

tant in sheltered forest margins of Tierra del Fuego [181] and in *Nothofagus alessandrii*-dominated forests of central Chile [103]. *Polylepis-Acaena* has low pollen production, only being detected close to the parent plants [255].

Polypodium (Pteridaceae). Fern, usually epiphytic on lowland rainforest trees, extending to secondary dry forests, gallery forest and shrubby savanna [285]; recorded throughout Latin America from sea-level to 4400 m but common to 2500 m [285], e.g. understory of *Alnus*-dominated forests (2500–3100 m) [54]. *P. feuillei* is present in the understory of *Nothofagus alessandrii*-dominated forests of central Chile [103].

Populus (Salicaceae). Trees, introduced to South America [117] although endemic in México [3,249], e.g. *P. mexicana* is a lowland riparian species, also an important element of gallery forest [96,248].

Portulacaceae. Herbs mostly present in dry inter-montane habitats although a catholic distribution throughout South America [15], e.g. *Montia*, a tiny mat-forming herb, is characteristic of wet areas [117], or as a tiny cushion in the superpáramo, *Portulacca oleraceae* is found in dry zone of the Galápagos Islands [264]. See also *Montia*.

Posoqueria (Rubiaceae). Mid-sized canopy trees present in moist lowland forest [17].

Potamogeton (Potamogetonaceae). Aquatic, submerged and floating taxon common in lakes and streams throughout Latin America [117], present from 2500 to 3900 m in Colombia [3], extending along the Andes [3]. Nine species present in México from shallow water to 5 m depth [112].

Pourouma (Cecropiaceae). Large trees, present in mature tropical lowland forest [3,168], e.g. *P. bicolor* is present in well-drained floodplains of Colombian Amazonia [83], *P. cucura*, *P. ferruginea* and *P. minor* are present on poor soils in Amazonian *terra firme* forest [209], *P. guianensis* in Guyanese lowland rainforest [81], dominant in upland central Amazonian rainforest [4].

Pouteria (Sapotaceae). Wide growth form and ecology [117], common in lowland Amazonia, well-drained Colombian Amazonian floodplains [83], present on poor soils in Amazonian *terra firme* forest [209]. Forms associations with *Mico-*

nia, *Palicourea*, *Quercus*, *Rhamnus*, *Schefflera*, *Viburnum*, and *Weinmannia* from 2100 to 2500 m in the Cordillera Central of Colombia [216]. Present on the Barro Colorado Islands [144,168] and montane rainforest, e.g. *P. exfoliata*, *P. fossicola* and *P. reticulata* are present at Monte Verde, Costa Rica [122]. Present in cerrado [124], e.g. *P. ambrahiensis* and *P. ramiflora* are present in campo rupestre [53,205]. Present in moist forest, e.g. *P. cuspidata* is present in the wet forests of southern Guyana [197].

Prosopidastrum globosum (Leguminosae). Shrubs important in dry plant formations of South America [117], e.g. *P. globosum* is an endemic shrub present on sandy and stony soils of arid western Argentina [63].

Prosopis (Leguminosae). Trees and shrubs, important in dry plant formations of Latin America [117,261], distributed in dry areas from México to South America [264], e.g. *P. ruscifolia* is found in Chaco [208,299], *P. juliflora* in dry areas of the Galápagos Islands [264], *P. alba*, *P. caldenia* and *P. nigra* in gallery forests below the Monte Desert [11,165], *P. chilensis* and *P. nigra* form an open forest in the northern extreme of the Pacific coastal deserts [270], *P. velutina* in the Sonoran Desert [293], *P. julifera* in marginal coastal and lacustrine habitats in México [271] and *P. alba* and *P. tamarugo* at low altitudes of the Atacama Desert [226]. *P. glandulosa* is present on Chihuahuan Desert grasslands [266] and dominates in subtropical savanna [147] where it can outcompete forbs and grasses for moisture due to extensive root systems, which also provide fire resistance [266]. In southern South America, *P. alpataco* is an endemic shrub of Monte [64], *P. caldenia* is a characteristic tree of the Calden District, developing on sandy soils where the water table is near the surface [64]. *P. juliflora* can form monospecific stands in the valley of the Magdalena River, Colombia [253]. *P. castellanosii* is an endemic shrub of the arid region of southern Mendoza and northern Neuquén from 600 to 1500 m, *P. denudans* is an endemic shrub of Patagonian semi-desert, *P. flexuosa* is a shrub or tree frequently found in the Monte [64].

Proteaceae. Trees of exposed ridge-tops at edge of montane/premontane rainforest [117], impor-

tant in várzea [84], can be common in lowland Amazonia [168], extending to southern South America within drier *Nothofagus*-dominated forests [299] and cerrado [205,254]. See also *Banksia*, *Embothrium*, *Euplassa*, *LomatialGevuina*, *Panopsis* and *Roupala*.

Protium (Burseraceae). Tropical trees [117], many arboreal species in the warm humid forests of tropical South America [257] extending to the lower eastern sub-Andean slopes (1150–1670 m) [311], locally dominant at well-drained upland sites [175], tolerating a range of flooding and nutrient status regimes [83]. Forms mixed forest with *Acalypha*, *Genipa*, *Miconia Ocotea*, and *Vismia* [225]. Can be important in lowland Amazonia [168], present in lowland Venezuelan forest near Mérida [191], can dominate upland central Amazonian rainforest [4], in mature lowland rainforest at the Barro Colorado Islands, Panama [46] and Chocó [116], e.g. *P. nodulosum* is present in Colombian Amazonia [83] in well-drained floodplains and uplands, *P. grandifolium* is present in eastern Amazonian floodplain forest [302], *P. aracouchini* and *P. decandrum* are present on poor soils in Amazonian *terra firme* forest [209]. Can be important from cerrado [36] to gallery forest savanna [36], e.g. *P. brasiliensis* is common in gallery forests, *P. ovatum* in cerrado [205] and *P. heptaphyllum* in campina [48].

Prumnopitys (Podocarpaceae). Coniferous trees, austral-Antarctic, present in montane rainforest of Costa Rica [163] around the upper forest line, a good indicator of forest line depression [117]. Occurs mainly along the eastern side of the Andes, from Perú to northeastern Argentina and along the western Andes in Chile [296], e.g. *P. andina* is adapted to a range of climatic conditions including low winter temperatures and dry summers; although frequent in Andean forests, rare in coastal ranges [6], e.g. *P. montana* is one of the most common taxa in Costa Rican upper montane rainforest [138], matorral occurs in southwestern Brazil [297], a similar distribution to *Podocarpus*.

Prunus (Rosaceae). Andean trees and shrubs, occasionally in lowland rainforest [117], particularly common in upper montane rainforest (over 2500 m) [3], e.g. in understorey of *Alnus*-dominat-

ed forests (2500–3100 m) [54] and *Quercus humboldtii*-dominated forests [54], e.g. *P. annularis* is common in Costa Rican upper and lower montane rainforest [163,230]. *P. integrifolia* can dominate at mid-altitudes in Colombia (2200–2600 m) in association with *Casearia*, *Hyeronima*, *Morus*, *Palicourea*, *Prunus*, and *Saurauia* [229]. Can be found in Argentina [299], *P. brasiliensis* can be common in *Araucaria*-dominated forests [17], *P. sphaerocarpa* occurs in cerrado [254], *P. chamissoana* in seasonal forests [205]. Found in Mexican *Pinus*- and *Quercus*-dominated forests, e.g. *P. brachybotrya* grows in montane rainforest, *P. serotina* around the Basin of México (2300–2900 m) [248,269]. It has edible fruits [78].

Pseudobombax (Bombacaceae). Trees [117] recorded in rainforest [84] and campo cerrado [265], common in successional riparian forest [168], present in Brazilian tropical seasonal and semi-deciduous forests [17] and caatingas [254], e.g. *P. longiflorum* and *P. martianum* occur in cerrado [205]. Bat-pollinated, hence pollen type is rare [168].

Pseudopanax (Araliaceae). Lianas and trees present in central Chilean Andes [11], extending south of 48°S, along the coastal ranges [296] present in Valdivian and Patagonian rainforest [297,300].

Psychotria (Rubiaceae). Trees, shrubs and small herbs [117] of Andean forests (1500–3200 m) [54], e.g. *P. boqueronensis* can be common in drier Andean forest (2700–2850 m) [54] to upper montane rainforest of Ecuador [138] with high diversity in Amazonian forest [175] and Costa Rican lower montane rainforest [163], e.g. *P. panamensis* is a small tree in Costa Rican montane rainforest, at Monte Verde [122], *P. sloanei* is present in Jamaican montane rainforest [9]. Present in lowland forest, e.g. *P. furcata*, *P. horizontalis*, *P. limonensis*, and *P. marginata* are all present on the Barro Colorado Islands [144,187], *P. luxurians* is present in Costa Rican primary swamp forest [105]. *P. aschersoniana* forms associations with *Meliosma Myrcia Tovomita Siparuna* from 2100 to 3130 m in the Cordillera Occidental of Colombia [216]. Present in tropical dry forest [230] and cerrado [205], e.g. *P. angusta* is endemic to the dry vegetation on the Galápagos Islands [139].

Pteris (Pteridaceae). Diverse ecology and growth form, present in lower and upper montane rainforest [3], frequent in secondary forest, although rare in Amazonia [285]. Common at low altitudes, it extends to 3500 m [285], e.g. *P. chilensis* is present in the understory of *Nothofagus alessandrii*-dominated forests of central Chile [103].

Puya (Bromeliaceae). Ground rosettes, small to large forms, characteristic of tropical high Andes [265]. Although there is a single lowland species, it is most common in open páramo [133], often in mires, e.g. *P. goudotiana* has an affinity with *Sphagnum* spp. [149], *P. dasilyroides* is present in Costa Rican montane bogs [137], *P. dasylirioides* is a common terrestrial bromeliad in peat bogs, often associated with *Blechnum buchtieni* in paramillo [163]. Common in thorn forests and puna of central Chile [261], e.g. *P. venusta* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103], *P. nitida* can dominate Andean xerophytic vegetation [54], *P. ferox* is important in the puna [101].

Qualea (Vochysiaceae). Large trees [117] present in mature Amazonia forest [74], upland rainforest of central Amazonia [4], e.g. *Q. ingens* is present in Colombian Amazonian well-drained floodplains of the Caquetá River [83], *Q. brevipedicellata* and *Q. homosepala* are present on poor soils in Amazonian *terra firme* forest [209]. Common in cerrado, represented by 23 spp. [172], e.g. *Q. parviflora* [167], *Q. grandiflora* and *Q. multiflora* [205].

Quararibea (Bombacaceae). Large rainforest trees with a wide ecology present in tropical seasonal forest, riparian habitats [74,168], Costa Rican primary swamp forest [105]; very common along the Palenque River, Ecuador [116,138]. Chocó is a centre of diversity [116]; *Q. oblongifolia* is present in Colombian Amazonian well-drained floodplains [83], *Q. steyermarkii* in lowland Venezuelan forest near Mérida [191]; *Q. ochracalyx* occurs on poor soils in Amazonian *terra firme* forest [209].

Quercus (Fagaceae). Large trees (25–40 m), some shrubs, present in montane rainforest, becoming shorter in wetter and/or colder forests. Split distribution in Costa Rica, monospecific in lowlands where it is present to sea-level [3]; 13

species at higher altitudes [168], where it forms almost monospecific stands [141]. Indeed, a distinct forest unit between 2700 and 3130 m is dominated by *Q. humboldtii* [311], can extend to lower altitudes [54], comprises 35% of all the trees in the uppermost reaches [54,59]. *Quercus humboldtii* forms associations with *Clethra*, *Clusia*, *Gutteria*, *Hieronyma*, *Inga*, *Miconia*, *Oreopanax*, *Persea*, *Styrax*, and *Weinmannia* in the Cordillera Central, Colombia (2500–3100) [121,220]. *Q. costaricensis* is an important taxon of the uppermost montane rainforest of Costa Rica (particularly around the upper forest limit) [230]. *Q. oleoides* and *Q. penducularis* are present in the savanna gallery forests of Belize [143]. *Q. oleoides* is thought to have dominated the savannas of Costa Rica [168] prior to extensive clearance [230]. *Q. virginiana* is common in Cuba [47]. Most of the major mountain ranges in México are rich in *Quercus* species, an estimated 135 to 150 species make this an American centre of diversification [7,248].

Quinchamalium (Santalaceae). Herbs, many saprophytes [117], found on puna and Patagonian steppe [165].

Randia (Rubiaceae). Spiny lianas characteristic of sub-Andean and lowland forest, important in the lowland forests of Colombia [161], e.g. in the dry forest of inter-Andean valleys in the Cordillera Central, Colombia (300 to 1500 m) [311]. Important in Costa Rican dry forests [230].

Ranunculaceae. Herbs, mainly aquatic, with montane distribution [54,117,249], e.g. *Ranunculus cymbalaria* is found around 3500 m [307] and at high altitudes in the Atacama Desert [226]. *Ranunculus penduncularis* is present in understory of *Nothofagus antarctica*-dominated forest, *R. bitermatus* in *Fuchsia*-dominated scrub [181]. *Ranunculus* spp. are frequent in ponds, creeks and flooding soils of the pampa and páramo grasslands [62,248]. See also *Caltha*, *Clematis* and *Thalictrum*.

Rauwolfia (Apocynaceae). Trees present in Brazilian moist forests [17], e.g. *R. sprucei* is present on poor soils in Amazonian *terra firme* forest [209]. Often a source of medicinal alkaloids (tranquillising drugs), derived from roots [164].

Rhamnus (Rhamnaceae). Spiny trees, shrubs

and lianas with wide ecology [106,117] found from the Andes (1500–3200 m), e.g. *R. oreodendron* is present in the understory of Costa Rican montane rainforest [163], extending to lowland forests [54], important in central Chile [11] and the Costa Rican páramo [230].

Rhaphithamnus (Verbenaceae). Herbs and shrubs present in Valdivian rainforest [297], e.g. *R. spinosus* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Rhipsalis (Cactaceae). Epiphytes mostly present in moist lowland forest [117,265], present in northwestern Argentina, particularly around 1000 m [195], also about a similar altitude in Brazil [50].

Rhizophora (Rhizophoraceae). Mangrove trees, three species (*R. harrisonii*, *R. mangle* and *R. racemosa*), which can be separated palynologically, with different ecological roles [290]. *R. mangle* (red mangrove) is found in the Atlantic coast mangrove, particularly of northwestern Brazil [80], the littoral zone of the Galápagos Islands [264], and is common in Cuba and Yucatán [47]. As a high pollen producer [15] *Rhizophora* pollen is recorded 70 km from its source in northern Brazil [167]. A past fuel source [208], at present extensively cleared for shrimp aquaculture [168]. Interaction with *Avicennia* has been the focus of forest dynamic models [26].

Rhodognaphalopsis (Bombacaceae). Small trees and shrubs on poor sandy soils [168] centred on Colombian and Brazilian upper Amazon, extending to caatinga [168].

Ribes (Saxifrageaceae). Shrubs common in high Andean forest and páramo [117], recorded throughout Central America and western South America towards Tierra del Fuego [3,263]. Present in upper Andean humid dwarf forests (3200–3500 m), *Polylepis*-dominated forests (2800–3500 m) [54], Mexican central highlands within a range of habitats, e.g. *Quercus*-dominated forest, alpine grassland and xerophytic scrub [248]. *R. magellanicum* forms scrub on fringes of *Nothofagus/Drimys*-dominated forests [181].

Rosaceae. Trees, shrubs and herbs; except for *Prunus* this family is Andean [117]. *Prunus* and *Rubus* occur in Brazilian dry forests [205], e.g. *P. sphaerocarpa* occurs in cerrado of central Brazil [254]. Many genera are present in México, e.g.

Acaena, *Alchemilla*, *Crataegus*, *Rubus*, and *Rosa* [248]. *Acaena myriophylla* and *Margyricarpus pinnatus* are frequent on sandy soils and rock outcrops of the Pampa grasslands [62,200]. *Rubus* is present in the Subantarctic forest (*R. geoides*) and in southern Patagonia (*R. radicans*), *Fragaria chilenses* is present in Andean regions [64]. *Acaena* contains several indigenous species in Patagonia, e.g. *A. magellanica* is common in damp situations and especially towards the edges of bogs, both above and below the treeline; *A. pinnatifida* is locally common in *Festuca gracillima* sub-Andean steppe, *A. splendens*, is present from extra-Andean Patagonia to Tierra del Fuego, *Tetraglochin* spp. are present in the Andes and Patagonia, *T. alatum* is a shrub in the Precordillera, northern Patagonia [64]. See also *Eucryphia*, *Hesperomeles*, *Lachemilla*, *Polylepis/Acaena*, *Prunus* and *Rubus*.

Roupala (Proteaceae). Trees common in exposed montane rainforest, lowland forest, gallery forests, cerrado and open savanna – a wide distribution [168,202], mostly Andean but can be found at lower altitudes [117], in moist forests of Amazonia and Panama [168], e.g. *R. cearensis* and *R. montana* are characteristic in brejos [124]. Can be common in dry vegetation associations, e.g. *R. complicata* in the Llanos Orientales of Colombia and Venezuela [50], *R. brasiliensis* and *R. montana* occur in cerrado [205,254], where they are affected by fire [203], the latter is found in savanna from México to South America [48]. *R. magelanicum* grows to the forest limit in southwestern Argentina, but not above it [254,303].

Rubiaceae. Wide growth form [117] found from lowlands to superpáramo [3,239], dominant in Chocó, well-drained uplands of Colombian Amazonia [83], eastern Amazonian floodplain forest [302], the northern Andes and Costa Rican lower montane rainforest [101]. A common family at the Chocó Pacific coast [38]. Represented in the cerrado by 46 spp. [172]. There are few genera and species in the southern regions, *Galium* is frequent along the Andes on wet ground (*G. antarcticum*) and also on sandy soils (*G. gilliesii*, *G. magellanicum* and *G. fuegianum*), *Oreopolus glacialis* is frequent on stony soils along the Andes [114]. See also *Alibertia*, *Arcytophyllum*, *Borreria*, *Chomelia*, *Coprosma*, *Coutarea*, *Duroia*, *Elaeagia*,

Genipa, *Gleasonia*, *Ixora*, *Nertera*, *Palicourea*, *Posoqueria*, *Psychotria*, *Randia*, *Simira*, *Sperma-coce* and *Warszewiczia*.

Rubus (Rosaceae). Shrubs and lianas common in understorey of *Alnus acuminata*-dominated forests (2800–3500 m) [54], a highly specious genus in Costa Rican montane rainforest, planted in fruit plantations [163]. *R. geoides* found to forest line, but not above it in southwestern Argentina [303], extending to Tierra del Fuego [299], e.g. *R. ulmi-folius* is present in *Nothofagus alessandrii*-dominated forests [103]. *R. urticaefolius* is present in Brazilian seasonal forests [205].

RuellialDistictella (Acanthaceae). Herbs common in cerrado [254] and campo [205].

Rumex (Polygonaceae). Herbs [117] characteristic of disturbed areas [129], particularly moist locations of the puna in the high Andes [275]. Recorded from 2200 to 4000 m in Costa Rica, Colombia and Peru [3], *Rumex* is present in Costa Rica, e.g. *R. costaricensis* is a 2- to 3-m-tall herb of páramo and bog environments. *R. darwinianus* is a species of southern South America, extending to Patagonia, *R. magellanicus* is more extensive in southern Chile and Argentina [63], *R. magellanicus* is associated with southern South American littoral vegetation [181]. *R. acetosella* is a small herb of pasture lands in the upper montane zone [163], indicative of post-conquest age as it was introduced into South America [181] by the Spanish [3,161]. It is an important component of cattle pasture [125].

Ruppia (Ruppiaceae). Submerged herbs with a cosmopolitan distribution, characteristic of coastal and inland salt-water habitats, *R. cirrhosa*, *R. filifolia* and *R. maritima* are recorded in Argentina [150].

Rutaceae. Trees [117] present in the Chocó [116], also recorded in dry forests [3], cerrado [205] and hardrock vegetation [3]. Can be common in moist forests, e.g. 46 species recorded in Amazonian forest around Manaus, Brazil [283]. See also *Balfourodendron*, *Metrodorea* and *Zanthoxylum*.

Sagittaria (Alismataceae). Aquatic emergent plants, cosmopolitan distribution [131], important in várzea [84].

Salix (Salicaceae). Two species in South Amer-

ica, most common is *S. humboldtiana* with a mostly Andean distribution although it will descend along white water rivers, forming successional stands on sand bars [117], on moist soils within gallery forests [80], or in areas with superficial water table [288]. Found in association with *Alnus*, *Populus* and *Platanus* in México [96,236], also present in *Pinus*-dominated forest, particularly along streams [242,251].

Salvia (Lamiaceae). Trees, shrubs and herbs, a very important family in the Mexican mountains [245], particularly in the understorey and within forest gaps [3].

Sambucus (Caprifoliaceae). Small montane rainforest trees [117], common in the Andes, present from southwestern Brazil to northeastern Argentina [263], probably introduced to Colombia [3]. More widely distributed in Central America [117], e.g. *S. mexicana* is found within montane rainforest and in *Abies*-dominated forest around 2250–3100 m [7].

Sapindaceae. Lianas and trees with wide ecology and growth form, prevalent in the lowland tropical forests of Brazilian Amazonia [80,117]. See also *Allophylus*, *Cardiospermum*, *Dodonaea*, *Matayba*, *Paulinia*, *Serjania* and *Talisia*.

Sapium (Euphorbiaceae). Large trees and lianas common in successional forest [117], recorded from Central America to all but the southernmost areas of South America [263], locally common in Costa Rican upper montane *Quercus*-dominated forests [141], e.g. *S. oligoneurum* is present in montane rainforest at Monte Verde [122], also in lower montane rainforest [137] and early successional forest [168], e.g. *S. aucuparium* and *S. oligoneurum* are present in Costa Rican primary swamp forest [105]. A typical pioneer taxon of Atlantic rainforest [80], locally common in Amazonian liana forests [208], cerrado and campo [205,254], e.g. *S. marginatum* can form a treelet-scrub savanna, often in association with *Croton* and *Byrsonima* [53].

Sapotaceae. Forest trees [117] important in rainforest and gallery forests [54,117] throughout tropical America [3,175], common in Chocó, important in Atlantic rainforest [53]. Seventy-seven species recorded in Amazonian forest around Manaus, Brazil [283], matorral occurs in cerrado,

e.g. *Pouteria* [205]. See also *Bumelia*, *Chrysophyllum*, *Labiata* and *Pouteria*.

Satureja (Lamiaceae). Shrubs and trees, at higher elevations the growth form is more herbaceous [117], e.g. *S. boliviana* is a high Andean shrub [265] which can be common in herbaceous grassland [117], *S. darwinii* is recorded on eastern Tierra del Fuego, extending to the Patagonian cordilleras [180].

Saxegothea (Podocarpaceae). Trees, shade intolerant, only regenerating given a large forest gap [6]. Present in Valdivian rainforest and closely associated with *Podocarpus/Drumys*-dominated forests [300], e.g. *S. conspicua* is present in *Nothofagus alessandrii*-dominated forests [143] and with *Podocarpus nubigena* in Chile [211].

Saxifraga (Saxifragaceae). Cushion-forming herbs, frost tolerant [202], occurring on moist rocks and canyon walls of the high Andes [117], e.g. *S. magellanica* can be common in southern South American cold deserts [180], one species in Ecuadorian páramo [3].

Scheelea (Arecaceae). Palms, a sub-generic group of *Attalea* [126], present in moist equatorial lowlands [3], Amazonia [126], e.g. *S. pitteri* can be common around the Costa Rican lowland forest limit [230].

Schefflera (Araliaceae). Small trees and shrubs present in dry vegetation formations, e.g. *S. duidae* is confined to the Guiana highlands but widespread [48]. *S. sciadophyllum* is present in Jamaican montane rainforest [9].

Schinus (Anacardiaceae). Trees with a wide ecology present from México to southern South America, in Amazonia and *Araucaria*-dominated forest [3,167,168]. A highly invasive and common pioneer taxon [17] common in Andean xerophytic vegetation, particularly in central Chile [11] and dry inter-Andean valleys in Colombia and around the Sabana de Bogotá [3,161]. Extensive in dry areas of southern South America, e.g. *S. fasciculatus* is a common shrub from north and central Argentina to northern Patagonia, *S. marchandii* is present in Santa Cruz, *S. johnstonii* in the Monte [99], *S. patagonicas* in Patagonian steppe, particularly along creeks, *S. molle* at mid-altitudes of the Atacama Desert [226]. This genus can be used as a paper substitute [164].

Schizolobium (Leguminosae). Fast growing tree species [117], present in lowland Amazonian late successional forest and Atlantic rainforest [17,74], e.g. *S. parahyba* is present in the Atlantic rainforest [273].

Scleronema (Bombacaceae). Large trees [117] present in Colombian Amazonia [299], e.g. *S. micranthum* is present on Colombian Amazonian well-drained floodplains [83], *S. micranthum* is present on poor soils in Amazonian *terra firme* forest [209], and dominant in upland rainforest, central Amazonia [4].

Scrophulariaceae. Shrubs and herbs, some aquatic [117], cosmopolitan [8], mostly recorded in upper montane rainforest and páramo [3], e.g. *Aragoa* is a common genus from 3200 to 4800 m in Colombian and Venezuelan páramo [3,117,140]. See also *Aragoa*, *Bartsia*, *Calceolaria*, *Mimulus*, *Monttea*, *Ourisia* and *Stachys*.

Scutellaria (Lamiaceae). Herbs common on wet grounds in the Andes, particularly on disturbed sites [3], e.g. *S. nummulariifolia* is present in the eastern fringe of Tierra del Fuego [84], *S. valdiviana* in *Nothofagus alessandrii*-dominated forests of central Chile [103]. One species recorded in the Sabana de Bogotá [3].

Sebastiania (Euphorbiaceae). Shrubs [117] found in the Brazilian Shield area [117,129] and in cerrado, particularly gallery forests [17,254], e.g. *S. bidentata* and *S. serrulata* [205]. *S. braziliensis* is present in *Araucaria*-dominated forest [129].

Selaginella (Lycopodiaceae). Terrestrial and epiphytic, with distribution centred in southern Peru, southern Bolivia, central Argentina and central México [109,117]; common in moist understorey [168] under Mexican mesophyllous forest [160]. Can be common in Costa Rican tropical dry forests [230], a disturbance indicator [129]. Present in mature lowland rainforest on the Barro Colorado Islands, Panama [46].

Senecio (Asteraceae). Herbs, ground rosettes species [3], usually characteristic of the high Andes, particularly above 3700 m [307], present in páramo and *Polylepis*-dominated forests [54]. *Senecio*, *sensu lato*, is extremely species-rich in the Costa Rican and Colombian lower montane rainforest, especially on steep slopes [3], represented by numerous endemic species in forest gaps and

secondary growth forest [163], present in *Abies-Quercus*-dominated forest (2300–4000 m), *S. praecox*, a xerophytic shrub, is characteristic of a rocky substratum [248]. *S. latiflora* and *S. canescens* form associations with *Calamagrostietum* from 4400 to 4500 m [224]. *S. haenkeanus* is present on Chilean Altiplano (4500–5000 m), close to the upper limit of vegetation, usually in association with *Draba alchemilloides* [12]. *S. rosarinus* is present at high altitudes of the Atacama Desert [226]. *S. magellanicum* is present on Patagonian steppe [181], *S. acanthifolius* grows in cold areas in *Nothofagus*-dominated forests [181], *S. vulgaris* and *S. yegua* are present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Serjania (Sapindaceae). Lianas [117] distributed throughout lowland areas, e.g. lowland Darien forest, Panama [28], lower montane rainforest [3]. Particularly common in dry forest, e.g. *S. schiedeana* is present in Costa Rican dry forests [230], *S. erecta* and *S. caracasana* are present in cerrado [205,254].

Simira (Rubiaceae). Mid-canopy trees common in moist forests [117], e.g. *S. maxonii* is common in Costa Rican primary swamp forest [105].

Siparuna (Momiaceae). Trees and shrubs present in moist forests and cerrado [17].

Sisyrinchium (Iridiaceae). Herbs restricted to high Andean páramo and puna [117], in moist meadows of southern South America [180], particularly along water courses [3]. Present in México at high altitudes in open habitats, mostly in humid areas [3]. Present on the high plateaus of Central Argentina [39], e.g. *S. junceum* is found above 3400 m [307]. Ten species are recorded from northeastern to central Argentina, some are frequent in steppe and on hills of Pampa grasslands [62], e.g. *S. patagonium* on Patagonian steppe [181], *S. magellanicum* on eastern Tierra del Fuego, extending to the Patagonian cordillera [181], *S. graminifolium* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Sloanea (Elaeocarpaceae). Large canopy trees of lower montane rainforest from Panama to Amazonia [168], e.g. *S. brenesii* and *S. faginea* are present in Costa Rican montane rainforest at

Monte Verde [122], *S. latifolia* and *S. synandra* on poor soils in Amazonian *terra firme* forest [209].

Socratea (Arecaceae). Palms with tropical lowland distribution from lowland Nicaragua south to Bolivia [126] and throughout Amazonia [140,168], occasionally in Costa Rican lowland forest [189], e.g. *S. exorrhiza* is present in Colombian Amazonian well-drained floodplains [83], a common taxon of white water river margins, found in lowland forest to 1000 m, extending to higher altitudes where rainfall is high [126].

Solanaceae. Shrubs and small trees with wide habitat diversity [117], distributed over much of South America [264], throughout lowland forests extending to lower superpáramo [3], present in Chocó [116], *Alnus acuminata*-dominated forests (2500–3100 m) [54], Costa Rican montane rainforest, particularly secondary forests [201] and forest gaps [163], e.g. *Solanum lycopericoides* [12], *S. ramonense* and *S. rovirosanum* are present at Monte Verde, Costa Rica [122]. *S. oblongifolium* is found in Ecuadorian humid forests [288], *S. tucumanensis* is present along stream banks of northwestern Argentinean lower montane rainforest [195], extending to southern Brazil [195], matorral present in drier vegetation types [205] such as Colombian lowland dry forests [161], e.g. *Solanum grandiflorum*, *S. lycocarpum* and *S. stenandrum* are present in cerrado [124], often associated with species of *Cestrum* and *Schwenchia* [254]. *S. americanum* is found in a transition zone from the driest areas on the Galápagos Islands [264], *S. multinterruptum* is present in Pacific coastal deserts, particularly towards the south [270], *S. hindianum* is present in the Mexican coastal deserts [2]. *Fabiana* is an erect shrub present in dry and subhumid regions of northwestern, western and southern Argentina and Chile, southern Perú and Bolivia [114]. Some species are cultivated as traditional medicines [201]. See also *Cestrum*, *Datura* and *Lycium*.

Sophora (Leguminosae). Herbs and lianas present throughout coastal ranges, extending to the Chilean Andes [11], e.g. *S. macrocarpa* is present in *Nothofagus alessandrii*-dominated forests of central Chile [103]. Used as the principle hallucinogenic plant before *Peyote*, very toxic [164].

Sparganium (Sparganiaceae). Aquatic herbs, mainly lowland distribution [3,117].

Spermacoce (Rubiaceae). Herbs of open vegetation where there is regular disturbance, such as a seasonally exposed shoreline [168], also present in páramo [3], can be indicative of human influence [117].

Sphaeropteris (Cyatheaceae). Terrestrial ferns in montane forests and low elevation rainforest, some species are pioneers in open habitats due to landslides or stream cuts and on road banks [285].

Sphagnum (Sphagnaceae). Bryophytes of permanently humid conditions, occasionally in moist lowlands but normally restricted from 2000 to 3800 m [3]. Typical páramo moss [163], dominates páramo mires, growing in hummock and hollow growth forms [3,34].

Spirotheca (Bombacaceae). Trees present in mid-altitude forests of northwestern South America [117], particularly drier forests, e.g. *S. odouratissima* is present in cerrado where it is adversely affected by fire [203].

Spondias (Anacardiaceae). Trees, mainly lowland distribution [3], particularly in northwest Amazonia [168], *S. radlkofferi* is present in Costa Rican primary swamp forest [105], *S. purpurea* extending to lower montane rainforest in the catchment [30]. Present in lowland dry forests [161] and caatinga [124], e.g. *S. mombin* is an invasive taxon of Costa Rican dry savannas, particularly where fire regime has been controlled [230], *S. mombin* is present in savanna/seasonal dry forest around Lake Valencia, Venezuela, and forms associations with *Hirtella*, *Sapium* and *Terminalia* at low- to mid-altitudes in Colombia [216].

Stachys (Lamiaceae). Herbs common in *Alnus acuminata*-dominated forests (2500–3100 m) [54], e.g. *S. macraei* is a herb is present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Stellaria (Caryophyllaceae). Herbs in *Alnus acuminata*-dominated forests (2500–3100 m) [54]. *S. dicipiens* is recorded in mesic vegetation on Tierra del Fuego [179].

Sterculiaceae. Shrubs and small trees with a wide ecology [117], common in understorey of dry forests [3], several genera in cerrado [254],

e.g. *Guazuma*, *Helicteris* and *Sterculia* [205], matorral present in lowland moist forest, e.g. *Sterculia frondosa*, *S. parviflora* and *S. pruniensis* are present on poor soils in Amazonian *terra firme* forest [209]. See also *Ayenia*, *Byttneria*, *Guazuma*, *Theobroma* and *Waltheria*.

Stryphnodendron (Leguminosae). Large trees in cerrado [254], can be a dry forest indicator [58,117,129], e.g. *S. adstringens* [205], also present in moist forest, e.g. *S. excelsum* is common in Costa Rican primary swamp forest [105].

Styloceras (Buxaceae/Euphorbiaceae). Trees, present in mature Andean forests (1500–3200 m) [54], extending to low elevations [117].

Styrax (Styracaceae). Canopy and understorey trees in montane rainforest, occasionally lowland forest, especially present in tahuampa on poor soil areas [117], e.g. *S. argenteus* is common in Costa Rican montane rainforest [163]. Present in lowlands, e.g. *S. camporum* is an important tree of brejos [124], *S. camporum* and *S. ferrugineus* are frequent in cerrado [17,205]. Present on sandstone tepuys in Brazil, e.g. *S. tepuiensis* [48].

Swartzia (Leguminosae). Trees [164] present in lowland moist forests [17], 200 species in the Neotropics [176], e.g. *S. racemosa* is present in floodplains and well-drained uplands of Colombian Amazonia [83], *S. polyphylla* is present in eastern Amazonian floodplain forest [302], *S. dolichopoda* is present in campina [48]. Species are often narrowly distributed [176].

Symmeria paniculata (Polygonaceae). Herbs, halophytes, present in várzea and areas of brackish water [84].

Symphonia (Guttiferae). Large rainforest trees [117] in Amazonia [17], marsh and swamp forest [105,290], e.g. *S. globulifera* is present in Venezuelan seasonal swamp forest [24]. Present at higher altitudes in Costa Rica and Panama [3], e.g. *S. globulifera* is present in lower montane rainforest at Monte Verde [122], and on poor soils in Amazonian *terra firme* forest [209], matorral present in Brazilian restinga [3].

Symplocos (Symplocaceae). Trees and shrubs [117,129], present in mature Andean forests (1500–3200 m) [54], in northern Andes to Costa Rica [138,163] and Panama [122]. Common in mesophyllous lower montane rainforest, and

about the forest line [202], e.g. *S. theiformis* is characteristic of shrubpáramo [54]. Several species occur in cerrado [254], e.g. *S. lanceolata* [124], *S. nitens* and *S. variabilis* [205].

Tabebuia (Bignoniaceae). Trees [117], present in Atlantic rainforest and Pacific lowland forests of Panama [168], e.g. *T. pentaphylla* is present in mature lowland rainforest on the Barro Colorado Islands, Panama [46], *T. insignis* is present in well-drained uplands of Colombian Amazonia [83], *T. rosana* in Costa Rican lowland moist forests [230], *T. uleana* is present in *Peltogyne*-dominated Brazilian Amazonian *terra firme* forest [51], *T. barbata* in eastern Amazonian floodplain forest [302], *T. rosea* is common in Costa Rican primary swamp forest [105] and *T. cassinoides* is present in the Atlantic rainforest [273]. Common in seasonal and dry forest, restinga dune forests [80] and cerrado [17], e.g. *T. chrysanthia* is found in Venezuelan lowland dry forest [208], *T. alba* in northern Argentinean summergreen rainforest [120], *T. papyrifera* in campo rupestre [117], *T. nodosa* in Argentine Chaco [142,165], *T. caraiba*, *T. impetiginosa*, *T. ochracea*, and *T. serratifolia* are frequent in cerrado [205,254]. Some species, e.g. *T. impetiginosa*, show no morphological differentiation throughout the range, whereas *T. ochracea* is divided into taxonomic subspecies depending on setting [48]. *T. chrysantha* is present in savanna/seasonal dry forest around Lake Valencia, Venezuela [30].

Tabernaemontana (Apocynaceae). Shrubs and small trees, a few reaching the canopy [117], present in lowland moist forests, Amazonia and on the Barro Colorado Islands [168]. Present in montane rainforest, e.g. *T. longipes* is present in Costa Rica at Monte Verde [122]. Occurs in dry forest, e.g. *T. ascendens* occurs in cerrado [254].

Talisia (Sapindaceae). Trees with a wide ecology and growth form [117], can be common in lowland forest, 35 species present in Amazonia [272], e.g. *T. veraluciana* and *T. guianensis* are present on poor soils in Amazonian *terra firme* forest [209].

Tapiriva (Anarcardiaceae). Trees [164] present in lowland moist forests, Amazonia, the Atlantic [167,168] and Chocó rainforest [111,116], a pioneer of disturbed lowland forest [129], e.g. *T.*

guianensis is a common tree in Brazilian seasonal forests [205], *T. dumstervilleorum* occurs in Venezuelan lower montane rainforest [3,257], *T. guianensis* is present on poor soils in Amazonian *terra firme* forest [209].

Taxodium (Taxodiaceae). Shrubs and small trees commonly associated with riparian habitats [202], e.g. *T. mucronatum*, is found in gallery forests. *Taxodium* is found in mid-altitude forest [37], along streams from México to Guatemala [92], e.g. *T. oxylepis* grows from 2800 to 3200 in Mexican *Abies–Quercus*-dominated forests [91].

Tecoma (Bignoniaceae). Shrubs found along the Ecuadorian coast [117], also in Andean [140] and Atlantic rainforest [80]. *T. stans* is common in dry to coastal areas of Cuba [47], present in savanna/seasonal dry forest around Lake Valencia, Venezuela [30].

Tepualia stipularis (Myrtaceae). Shrubs forming dense thickets on poorly drained, waterlogged substrates [6], particularly in understorey under *Nothofagus*- and *Podocarpus*-dominated forests [6], found in northern Patagonian forests [300], can dominate understorey of Magallanic rainforest [188]. Can be locally dominant in coastal and central Chile [11] and in Magallanic moorland [179], e.g. within *Nothofagus alessandrii*-dominated forests of central Chile [103].

Ternstroemia (Theaceae). Trees and shrubs present in Andean upper montane rainforest [202] and lowland forest, especially on poor soils [117]. Present on sandstone tepuys in Brazil, e.g. *T. prancei* [48].

Tetrorchidium (Euphorbiaceae). Trees and shrubs with a relatively wide distribution; common in lowland rainforest, occasionally present in páramo [117,168]. An important element in forest succession in 'dry' rainforest of eastern South America [3]. Found in association with *Gutteria*, *Ocotea*, *Pourouma*, *Psychotria* and *Tetrorchidium* from 900 to 1100 m from the Chocó to the Cordillera Occidental, Colombia [110,216].

Thalictrum (Ranunculaceae). Herbs in upper montane rainforest (2000–3200 m) [3] to lower páramo habitat [117]. *T. strigillosum* is present at most elevations in México [248] (1900–3000 m) in *Pinus*-dominated secondary forest [1].

Thelypteris (Pteridaceae). Ferns locally found

throughout the Neotropics with the greatest diversity in the northern Andean area [127]. Common in upper montane *Quercus*-dominated forests [54], particularly under humid conditions [117] from 500–2500 m [285].

Theobroma (Sterculiaceae). Mid-sized trees on relatively fertile soils [117] in lowland forest, particularly várzea [3], e.g. *T. subincanum* and *T. sylvestre* are present on poor soils in Amazonian *terra firme* forest [209].

Thymelaeaceae. Small to mid-sized trees from montane to lowland situations [117], e.g. *Daphnopsis* is present in montane rainforest [17] and Chocó [116], also present in Valdivian rainforest [108].

Tiliaceae. Canopy trees with a cosmopolitan distribution [249], abundant in late secondary growth forest [117], moist lowland rainforest [3], present in Chocó [116]. Present in cerrado and campo, e.g. *Apeiba tibourbon*, *Corchorus hirtus* and several species of *Luehea* [205]. See also *Apeiba*, *Aristotelia*, *Luehea*, *Mortoniendron*, *Triumfetta* and *Vallea*.

Tococa (Melastomataceae). Understorey shrubs and herbs common on poor soils in moist lowland rainforest, lower montane rainforest [3] and in Atlantic rainforest [17]. Palynologically difficult to separate from other Combretaceae and Melastomataceae [168].

Tournefortia (Boraginaceae). High climbing lianas [117] and shrubs, widely distributed in South America [264], present in lowland forest [117], Ecuadorian humid montane rainforest [288], locally common in Costa Rican upper montane *Quercus*-dominated forests [141], e.g. *T. inhabits* is present in secondary Costa Rican montane rainforest [163], *T. glabra* at Monte Verde [122]. Present in dry vegetation types [205], e.g. *T. psilostachya* is present in *Scalasi*-dominated zone, *T. rufo-sericea* in the pampa on the Galápagos Islands [264], *T. gnaphalodes* is common in littoral areas of Cuba [47].

Tovomita (Guttiferae). Trees with large stilt roots [117], present in moist lowland rainforest and lower montane rainforest, can dominate the canopy [3], typical of dense Costa Rican lower montane rainforest [163], e.g. *T. spinosa* and *T. tenuifolia* are present on poor soils in Amazonian

terra firme forest [209]. *T. weddelliana* forms dry forest at mid-altitudes (1150–2500 m) [67], often in association with *Oreopanax*, *Miconia* and *Saurauia* [225].

Tovomitopsis (Clusiaceae). Trees of *terra firme*, distributed from Nicaragua to Amazonia [168], extending to montane rainforest, e.g. *T. allenii* and *T. psychotriifolia* are present in Costa Rican lower montane rainforest at Monte Verde [122].

Trattinnickia (Burseraceae). Trees and herbs [167,168], present from tropical seasonal forest to rainforest [168], e.g. *T. burseifolia* and *T. glaziovii* are present on poor soils in Amazonian *terra firme* forest [209].

Trema (Ulmaceae). Trees recorded from lowland rainforest to montane areas [117,129], particularly common in sub-Andean forests (1500–1800 m) [54] and Costa Rican lower montane rainforest [137], a possible disturbance indicator [117,129]. Common in Central America from Chiapas to Yucatán [3], widely distributed in the tierras calientes and templadas of the Venezuelan mountains, including the Lake Valencia region [257]. *T. micrantha* is frequent in Brazilian seasonal forests [205]. *T. micrantha* is present in savanna/seasonal dry forest around Lake Valencia, Venezuela [30].

Trichilia (Meliaceae). Understorey to canopy trees [117], common in tropical seasonal and lower montane rainforest, responsive to soil moisture deficiency [168], e.g. *T. havanensis* is a common lower montane rainforest tree often in dense forest canopy [163], present at Monte Verde, Costa Rica [122], extending to Costa Rican primary swamp forest [105], *T. dichotoma* is present in Guyanese lowland rainforest [81]. *T. acuminata* forms communities with *Astronium*, *Aspidosperma*, *Bursera*, *Hura*, *Peltogyne*, and *Sorocea* at low altitudes (300 m) in Colombia [218].

Trichocline (Asteraceae/Mutiseae). Herbs with wide ecology, present in tropical and temperate habitats [117].

Trichomanes (Pteridaceae). Ferns, many species epiphytic on tree trunks [127,285], widely distributed throughout the Neotropics in moist and wet areas from the high Andes to lowland Amazonia [168], greatest diversity in Amazonia [127].

Trifolium (Leguminosae). Herbs [117] of open

areas, some introduced [140], mainly present in open habitats in upper montane rainforest [3]. Can form a stable and weed-resistant pasture community [90], e.g. *T. dubium*, *T. glomeratum* and *T. repens* are present in *Nothofagus alessandrii*-dominated forests of central Chile [103].

Trigonia (Trigoniaceae). Large trees [117] common in lowland Amazonia [168].

Triumfetta (Tiliaceae). Wide growth form, trees to weedy shrubs [117] and wide ecology [128], common in Amazonia [168].

Trixis (Asteraceae). Herbs and shrubs frequent in southeastern Brazil [129], a low growing rosette herb of the Chilean high Andes (> 2700 m) [15]. Common in dry vegetation types, e.g. *T. californica* is present in Sonoran desert [293], *T. glutinosa* and *T. verbasciformis* occur in cerrado [254], whereas *T. antimerorrhea* is very frequent in seasonal forests [205].

Trophis (Moraceae). Trees and shrubs mainly restricted to Central America [17].

Typha (Typhaceae). Semi-aquatic [117] herbs, can be indicators of eutrophication, growth is highly responsive to nutrient status [168]. A mainly lowland distribution, present to 2650 m in Colombia [3], along water courses and in swamps, e.g. *T. dominguensis* occurs in brejos [205] and around Lake Valencia, Venezuela [30,257]. *T. dominguensis* and *T. latifolia* are common in ponds, swamps and depressions, which are inundated throughout the year in the pampa grasslands. The popular name of these communities is derived from the common name (totorales) [213,248]. *T. dominguensis* is often found behind the mangrove zone in lagoons along the Atlantic coast of Colombia [216].

Ulmaceae. Medium to large trees with a wide ecology, *Celtis*, *Ulmus* and *Trema* are important [117] in the lowland and lower montane rainforest [3] of Costa Rica [137] and Chocó [116], matorral present in dry vegetation formations, e.g. *Celtis iguanea* and *Trema micrantha* occur in cerrado [205]. See also *Celtis*, *Lozanella Phyllostylon*, *Trema* and *Ulmus*.

Ulmus (Ulmaceae). Trees restricted to Central America, extending south to Panama, in lower montane rainforest (1600–1900 m) [168], e.g. *U. mexicana* is found between upper limit of ever-

green forest and lower limit of montane rainforest [204].

Urticaceae. Herbs of ruderal environments in Costa Rican montane zones [137,163], mainly present in lowland and lower montane rainforest [3], e.g. *Myriocarpa* and *Phenax* are common in lower montane secondary growth forest [163]. *Urtica magellanica* is present throughout Tierra del Fuego [179], but rare in cerrado; shrubs of *Ureca caracasana* are occasionally found in Brazilian seasonal forests [205], matorral present in dry areas, e.g. *Urtica trichantha* is present at high altitudes in the Atacama Desert [226] and the puna where it forms a common food of the vicuña [309]. *Urtica* and *Parietaria* are frequent in modified soils of the pampa grasslands, *Boehmeria* is frequent in the gallery forests along the northern boundary of the Río de la Plata [62,200]. See also *Brosimum*, *Castilla*, *Cecropia*, *Celtis*, *Humulus*, *Laportea*, *Lozanella*, *Phyllostylon* and *Pilea*.

Utricularia (Lentibulariaceae). Herbs, epiphytic, present in temperate areas in México, particularly in shallow water [249].

Vaccinium (Ericaceae). Small to large shrubs present in dry vegetation formations, e.g. *V. pipo-lyi* is present on sandstone tepuys in Brazil [48].

Valeriana (Valerianaceae). Herbs, lianas, shrubs and trees commonly present in páramo [3], a typical páramo herb in Costa Rica [163], e.g. *V. plantagina* is virtually restricted to superpáramo (4100–4250 m) [54] and grasspáramo [311]. Present at high altitudes in northern Chile [13], extending to Tierra del Fuego [299], e.g. *V. urbanii* is present at high altitudes of the Atacama Desert [226], *V. carnosa* is present in drier lowland Patagonian steppe [181], occasionally extending to coastal areas. *V. fonkii* is frequent in subantarctic forest and wetter Patagonian sites [114].

Vallea (Elaeocarpaceae). Trees widespread in upper Andean montane rainforest [117], locally common in *Quercus*-dominated forests (2700–2800 m) [54], particularly about the forest line [214], where forest is secondary [125], important in high Andean dwarf forests (3200–3450 m) [54]. *V. stipularis* can dominate in dry forests (2600–2750 m), e.g. Venezuelan dry evergreen forest [255].

Verbenaceae. Wide growth form [117], mainly

present in lowland and lower montane rainforest [3], extending from *Alnus acuminata*-dominated forests (2500–3100 m) [54] to Chocó [116]. *Verbena sedula* is a pampa shrub on the Galápagos Islands [264], *Lantana* is frequent in seasonal forests, *Lippia* is common in cerrado [205]. *Verbena* (*Junellia*) is a common genus in Chilean and Argentinean Patagonia, it extends to northern Argentina, Bolivia and Perú, e.g. *J. tridens* is a dominant shrub in the Santa Cruz steppe forming thickets in mosaic with grassland on plateaus, in ravines or fluvial valleys [114,193], *J. conmatibracteata* is common in Monte [114], *Aegiphila cantholippia*, grows in arid northwestern, central and southern Argentina and southern Bolivia, *A. seriphoides* is present on stony soils of Patagonia and Monte [114]. See also *Aegiphila*, *Avicennia*, *Citharexylum*, *Lippia*, *Rhaphithamnus* and *Vitex*.

Vernonia (Asteraceae). Shrubs and small trees with a wide ecology [117], common in Costa Rican moist montane rainforest [168]. A typical pioneer in Atlantic rainforest [80]. About 30 species are frequent in cerrado [205], e.g. *V. muricata* can be important in open treelet-scrub savanna in Carajás [53].

Viburnum (Caprifoliaceae). Trees and shrubs, present in lower montane rainforest from the northern Andes to Central America, and tepuys [3]. Common in México, present from 2500 to 3000 m in mesophyllous forest [58,13].

Vicia (Leguminosae). Trailing lianas present in Andean locations [117], particularly in open habitats, occasionally extending to low páramo [3]. *V. bijuga* is present on Patagonian steppe [181], extending to the Patagonian cordilleras [180], e.g. *V. benghalensis*, *V. nigricans* and *V. vicina* are present in *Nothofagus alessandrii*-dominated forests of central Chile [103]. *Vicia* is the best-represented genus in native Patagonian grasslands, e.g. *Vicia setifolia* var. *bonariensis* is endemic on rock outcrops of the pampa grasslands although it is disappearing under cultivation [62].

Viola (Violaceae). Herbs, extremely rare on the Chilean Andes, restricted to volcanic soils about 4500 m [12,15], becoming common in marsh forests [290], present in Costa Rican upper montane and alpine environments, mainly as herbs [163], e.g. *V. cano-barbata* is found from 3000 to

3600 m [307], *V. cotyledon* can dominate above the forest line in southwestern Argentina [303]. *V. maculata* is present on the Patagonian steppe [181], *V. magellanica* is important in sheltered, mesic forest margins on Tierra del Fuego, and in cushion heath above the forest line [181].

Viola (Myristicaceae). Large to intermediate rainforest trees [168], particularly common in well-drained upland sites [74], e.g. *V. surinamensis* is an Amazonian taxon, also common in brejos [210], *V. calophylla* is present in the Colombian Amazonian floodplains, extending to well-drained uplands where it includes *V. theiodora* and *V. pavonus* [83], *V. sebifera* is present in lowland Venezuelan forest near Mérida, extending to lower montane rainforest [191]. Associated with palm swamp forest in French Guiana, e.g. *V. koschnyi* is common in Costa Rican primary swamp forest [105]. *V. panamensis* is present in mature lowland rainforest on the Barro Colorado Islands, Panama [46]. *V. urbania* is frequent in seasonal forest and *V. sebifera* in cerrado [205]. Red latex can be extracted in order to produce a hallucinogenic powder [117]. *V. sebifera* forms associations with *Xylopia* and *Pouteria* from 400 m to 1150 m in Colombia [54].

Vismia (Clusiaceae). Canopy to emergent trees [117], prevalent in lowland moist forest, common in secondary forest of Brazilian Amazonia [274], e.g. *V. cayennensis*, *V. japurensis* and *V. macrophylla* can be common on poor soils in Amazonian *terra firme* forest [209].

Vitex (Verbenaceae). Canopy to emergent trees, prevalent in seasonally dry forest [117], e.g. *V. thysoidera* is a common tree of cerrado [124], matorral present in moist forest, e.g. *V. polygama* occurs in Brazilian seasonal forests [205], *V. schomburgkiana* is present in *Peltogyne*-dominated Amazonian *terra firme* forest of Brazil [51], *V. trifolia* is present on poor soils in Amazonian *terra firme* forest [209], *V. divaricata* is common on Cuba and Yucatán [47]. *V. cymosa* forms associations with *Libidibia*, *Prosopis* and *Vitex* in Colombia about 170 m [253].

Vochysia (Vochysiaceae). Large trees present in the tropical lowlands [117] and Atlantic rainforest [80], becoming common in cerrado [17], campo [205] and dry forests [208]. Important taxon of

gallery forests, e.g. *V. acuminata* and *V. pyramidalis* are locally dominant [124], *V. hondurensis* is present in the gallery forest of Belize [143], *V. divergens* is dominant in the inundation forests of Panatela in Mato Grosso, Brazil [192]. *V. duquei* is present in Venezuelan lower montane rainforest [191], *V. odidensis* on poor soils in Amazonian *terra firme* forest [209].

Waltheria (Sterculiaceae). Shrubs present in dry areas; a savanna indicator [117], e.g. *W. glomerata* is present in piedmont region of the Llanos Orientales [30], *W. communis* occurs in cerrado of central Brazil [254]. Found in mesic locations, e.g. on the Barro Colorado Islands [144,168].

Warszewiczia (Rubiaceae). Trees with a tropical lowland distribution [164], common in the Atlantic rainforest, Amazonia and Central American low altitude moist forests [17,168].

Weinmannia (Cunoniaceae). Trees [117] with a disjunct distribution in three areas: southeastern Brazil, southwestern South America and from northern Amazonia along the Andes to Central America and México [117], the former area being the more important one [124]. Common in Andean forest (3100–3550 m) [311], most frequently above 3100 m [214] in Colombia [125], in Costa Rican upper montane *Quercus*-dominated forests, particularly mature forests [141], can dominate late secondary montane rainforest [163], *Alnus acuminata*-dominated forests (2500–3100 m) [54], e.g. *W. trianae* is present along the upper forest limit of Costa Rica [230], *W. pinnate* and *W. wercklei* are present at Monte Verde [122], *W. jahnii* occurs in upper part Venezuelan dry evergreen forest. Diverse genus: *W. agnifolia*, *W. balbisiana*, *W. engleriana*, *W. marequiae*, *W. microphylla*, *W. pinnata*, *W. pubescens*, *W. rollotii*, *W. subvelutina*, and *W. trianae* characterise the Andean forest, forming the Andean forest association with *Anthurium*, *Brunellia*, *Hesperomeles*, *Ocotea*, *Prunus*, *Miconia*, *Schefflera*, and *Symplocos* to 3700 m on the Cordillera Central, Colombia [225,216]. Common at higher, more humid, elevations of southeastern Brazil [117], also present in the Atlantic rainforest [129], e.g. *W. discolor* is present at high altitudes, often with *Podocarpus* [124], *W. paulliniifolia* forms isolated forest patches in campo rupestre, possibility due

to humid local microclimates [124]. Extends to Magallanic rainforest towards southernmost Chile [188], e.g. *W. trichosperma* is found in Valdivian and Patagonian rainforest [297], *W. trichosperma* in *Nothofagus dombeyi*-dominated forests [296, 103].

Wendtia (Geraniaceae). Herbs present in steppe and forests in Chile and Argentina [164].

Xylopia (Annonaceae). Shrubs found in Cuban savanna and from Panama extending to Paraguay [48], matorral present in moist forest, e.g. *X. benthami* and *X. crinata* are present on poor soils in Amazonian *terra firme* forest [209].

Xylosma (Flacourtiaceae). Trees in moist low forests of Central America and Amazonia to drier forest types [168], lower montane rainforest, e.g. *X. spiculiferum* can dominate drier types of Andean forests (2600–2750 m) [54], *X. intermedia* is often in subcanopy on Pacific-facing slopes of Costa Rica [163], *X. oligandra* is present at Monte Verde, Costa Rica [122].

Xyris (Xyridaceae). Herbs characteristic of moist conditions [117]; pantropical distribution [3,140], present in highlands of southern Brazil [129], in savannas of Roraima on acidic soils [208], scrubby vegetation of sandstone plateau of Colombia [291]. Can withstand above ground desiccation [291], present in a range of different savanna types [291], campo rupestre [124] and cerrado [124], e.g. *X. fallax* is an arid-adapted taxon [210], *X. picea* can be common in wetter areas of Colombian sandstone plateaus [168], matorral present at high altitudes, e.g. montane bogs of Costa Rica [230], *X. subulata* is also present in Venezuelan páramo (3500 and 3600 m) [268] and Venezuelan tepuys [161], *X. brachyfolia* is present on sandstone tepuys in Brazil [48].

Zanthoxylum (Rutaceae). Small to large trees prevalent in drier areas and late secondary growth forest [117], distributed from southern North America to Perú [264], important in Costa Rican upper and lower montane rainforest [141,163], e.g. *Z. panamensis* is present at Monte Verde, Costa Rica [122], on the Barro Colorado Islands [168,46] and in low altitude forests on the Galápagos Islands [214], *Z. fagara* is a tree of the *Scalesia*-dominated forest [264] and can dominate subtropical savanna [147]. A wide distribution in

Brazil, i.e. found in cerrado, lowland dry forests and the Atlantic rainforest [17,167]; *Z. coco* is an important in northwestern Argentinean montane rainforest at 1000 m [195].

Zea mays (Poaceae). *Zea* represents large (> 85 µm diameter) grains of Poaceae [254] and is one of the most important New World crops. All species and varieties are derived from *Z. mexicana* [100], the earliest presence of which is known from México and dated to 7000 yr BP, its first dietary use to approximately 6000 yr BP [100]. From México it spread throughout Central America into Amazonia [168,228] and subsequently into North America, i.e. by 3500 yr BP [100].

Zornia (Leguminosae). Herbs from northwestern South America [117], present in cerrado [254].

References

- Absy, M.L., 1979. A Palynological Study of Holocene Sediments in the Amazon Basin. Ph.D. Thesis, University of Amsterdam, Amsterdam.
- Behling, H., Hooghiemstra, H., 2001. Neotropical Savanna environments in space and time: Late Quaternary interhemispheric comparisons. In: Markgraf, V. (Ed.), Interhemispheric Climate Linkages. Academic Press, New York, pp. 307–323.
- Bush, M., Rivera, M., 1998. Pollen dispersal and representation in a neotropical rain forest. *Glob. Ecol. Biogeogr. Lett.* 7, 379–392.
- Farrera, I., Harrison, S.P., Prentice, I.C., Ramstein, G., Guiot, J., Bartlein, P.J., Bonnefille, R., Bush, M., Cramer, W., von Grafenstein, U., Holmgren, K., Hooghiemstra, H., Hope, G., Jolly, D., Lauritzen, S.E., Ono, Y., Pinot, S., Stute, M., Gu, Y., 1999. Tropical climates at the last glacial maximum: a new synthesis of terrestrial palaeoclimate data. I. Vegetation, lake-levels and geochemistry. *Clim. Dyn.* 11, 823–856.
- Gnècco, C., 1999. An archaeological perspective on the Pleistocene/Holocene boundary in northern South America. *Quat. Int.* 53, 3–9.
- Hooghiemstra, H., 1984. Vegetation and climate history of the high plain of Bogotá, Columbia: a continuous record of the last 3.5 million years. *Dissertationes Botanicae* 79, 1–365. Cramer, Berlin.
- Hooghiemstra, H., van Geel, B., 1998. World list of Quaternary pollen and spore atlases. *Rev. Paleobot. Palynol.* 104, 157–182.
- Huber, O., Riina, R., 1997. *Glosario Fitecológico de las Américas*, Vol. 1, América del Sur: Países Hispanoparlantes. UNESCO, Paris.

- International Plant Names Project (IPNI), 1999. International Plant Names Index. <http://www.ipni.org>.
- Kewensis, 1997. Index Kewensis version 2.0. Developed by Systems Simulations Ltd. Oxford University Press, Oxford.
- Latin American Pollen Database (LAPD). <http://www.ngdc.noaa.gov/paleo.html>.
- Marchant, R.A., Hooghiemstra, H., 2001. Letter to the Editor: 'Climate of East Africa 6000 ¹⁴C yr B.P. as inferred from pollen data' by Odile Peyron, Dominique Jolly, Raymond Bonnefille, Annie Vincens and Joël Guiot. *Quat. Res.* 55, 133–135.
- Marchant, R.A., Behling, H., Berrío, J.C., Cleef, A., Duivenvoorden, J., van Geel, B., van der Hammen, T., Hooghiemstra, H., Kuhry, P., Melief, B.M., van Reenen, G., Wille, M., 2001a. Mid- to Late-Holocene pollen-based biome reconstructions for Colombia. *Quat. Sci. Rev.* 20, 1289–1308.
- Marchant, R.A., Behling, H., Berrío, J.C., Cleef, A., Duivenvoorden, J., van Geel, B., van der Hammen, T., Hooghiemstra, H., Kuhry, P., Melief, B.M., van Reenen, G., Wille, M., 2001b. A reconstruction of Colombian biomes derived from modern pollen data along an altitude gradient. *Rev. Palaeobot. Palynol.* 117, 79–82.
- Marchant, R.A., Boom, A., Hooghiemstra, H., 2002. Pollen-based biome reconstructions for the past 450 000 years from the Funza-2 core, Colombia: comparisons with model-based vegetation reconstructions. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 177, 29–45.
- Marchant, R.A., Behling, H., Hooghiemstra, H., Markgraf, V., Harrison, S.P., Prentice, C., Björck, S., Bush, M., Cleef, A., Colinvaux, P.A., De Oliveira, P.E., Graf, K., Hansen, B.C.S., Heusser, C., Horn, S.P., Ledru, M.-P., Leyden, B.W., Lozano-García, M.S., Moar, N.T., Moreno, P.I., Salgado-Labouriau, M.L., Schäbitz, F., Watts, W.A., in press. Pollen-based biome reconstructions for Latin America at 0, 6000 and 18 000 radiocarbon years. *J. Biogeogr.*
- Markgraf, V., 2001. Interhemispheric Climate Linkages: Present and Past Interhemispheric Climate Linkages in the Americas and their Societal Effects. Academic Press, New York.
- Moreno, P.I., Jacobson, G., Lowell, T.V., Denton, G.H., 2001. Interhemispheric climate links revealed by a late glacial cooling episode in southern Chile. *Nature* 409, 804–808.
- Olsen, J.S., Watts, J.A., Allison, L.O.J., 1983. Carbon in live vegetation of major world ecosystems. ORNL-5862, Oak Ridge National Laboratory, Oak Ridge, TN.
- Piperno, D.O., Pearsall, D.M., 1998. The Origins of Agriculture in the Lowland Neotropics. Academic Press, San Diego, CA.
- Prentice, I.C., Webb, T., III, 1998. BIOME 6000: reconstructing global mid-Holocene vegetation patterns from palaeoecological records. *J. Biogeogr.* 25, 997–1005.
- Schmithüsen, J., 1976. Atlas zur Biogeographie. Bibliographisches Institut, Mannheim.
- UNESCO, 1981. Vegetation Map of South America. UNESCO, Paris.
- van der Hammen, T., González, E., 1960. Upper Pleistocene and Holocene climate and vegetation of the Sabana de Bogotá. *Leidse Geol. Meded.* 25, 261–315.
- von Hueck, K., 1972. Vegetationskarte von Südamerika. Gustav Fischer Verlag, Stuttgart.

References in dictionary

- [1] Aguilar, R., 1991. Solanaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [2] Anderson, R.S., Van Devender, T., 1995. Vegetation history and paleoclimatology of the coastal lowlands of Sonoran, Mexico – pollen records from packrat middens. *J. Arid Environ.* 30, 295–306.
- [3] Antoine Cleef, pers. commun.
- [4] Archer, S., Scifres, C., Bassham, C.R., Maggio, R., 1988. Autogenic succession in a subtropical savanna: conversion of grassland to thorn woodland. *Ecol. Monogr.* 58, 111–127.
- [5] Ariza, C., 1999. Estudio de la Diversidad Florística del Enclave Árido del Río Patía. Trabajo de Grado, Departamento de Biología, Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá.
- [6] Armesto, J.J., Villagrán, C., Aravena, J.C., Pérez, C., Smith-Ramírez, C., Cortés, M., Hedin, L., 1995. Conifer forests of the Chilean coastal ranges. In: Enright, N.J., Hill, R.S. (Eds.), *Ecology of Southern Conifers*. Melbourne University Press, Melbourne.
- [7] Arreguín-Sánchez, M.L., 1985. Caprifoliaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas, IPN, México, D.F.
- [8] Arreguín-Sánchez, M.L., 1991. *Viburnum*. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [9] Arroyo, K.M., Marticorena, C., Miranda, P., Matthei, O., Landero, A., Squeo, F., 1989. Contribution to the high elevation flora of the Chilean Patagonia: a checklist of species on mountains on an east–west transect in the Sierra de los Baguales, lat. 50°S. *Guyana Bot.* 46, 119–149.
- [10] Arroyo, M.T.K., Armesto, J.J., Primack, R.B., 1983. Tendencias altitudinales y latitudinales en mecanismos de polinizaciones en la zona *andina* de los Andes templados de Sudamérica. *Rev. Chil. Hist. Nat.* 56, 109–122.
- [11] Arroyo, M.T.K., Armesto, J.J., Primack, R.B., 1985. Community studies in pollination ecology in the high temperate Andes of central Chile. II. Effect of temperature on visitation rates and pollination possibilities. *Plant Syst. Evol.* 149, 187–203.
- [12] Arroyo, M.T.K., Caviars, L., Marticorena, C., Muñoz-Schick, M., 1995. Convergence in Mediterranean floras in Central Chile and California: insights from comparative biogeography. In: Arroyo, M.T.K., Fieder, P.H., Fox, M.D.

- (Eds.), Ecology and Biogeography of Mediterranean Ecosystems in Chile, California and Australia. Ecological Studies.
- [13] Arroyo, M.T.K., Marticorena, C., 1985. Addition to the flora of Chile - new records for the Altiplano. *Guyana Bot.* 42, 3–7.
- [14] Arroyo, M.T.K., Marticorena, C., Dollenz, O., 1985. New record for the flora of Chile based on an expedition to the Sierra de los Baguales, Ultima Esperanza, Patagonia. *Guyana Bot.* 42, 41–45.
- [15] Arroyo, M.T.K., Primack, R., Armesto, J.J., 1982. Community studies in pollination ecology in the high temperate Andes of Central Chile – pollination mechanisms and altitudinal variation. *Am. J. Bot.* 69, 82–97.
- [16] Arroyo-Frías, H., 1985. *Lantana y Lippia*. In: Rzedowski, J.C., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [17] Ary Teixeira de Oliveira-Filho, pers. commun.
- [18] Ayala-Nieto, M.L., Ludlow-Wiechers, B., 1984. Catálogo Palinológico para la Flora de Veracruz, No. 14: Familia Cupressaceae. *Biotica* 9.
- [19] Azcárraga del R., M., 1985. *Datura*. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [20] Balcazar, M.P., Rangel-Ch., J.O., Linares, E., 2000. Diversidad florística de la Serranía de las Quinchas, Magdalena Medio (Colombia). *Caldasia* 22, 191–224.
- [21] Barberi, M., Salgado-Labouriau, M.L., Suguio, K., in press. Paleovegetation and paleoclimate of 'Vereda de Aguas Emendadas', DF, Central Brazil. *J. S. Am. Earth Sci.*
- [22] Bastidas, M.N., Corredor, T.H., 1977. Contribución al Estudio Fitosociológico del Parque Nacional Natural Tayrona (Ensenadas de Chengue y Parte Este de Nenguange). Trabajo de Grado, Departamento de Biología, Universidad Nacional de Colombia, Bogotá.
- [23] Beaman, J.H., 1991. *Arenaria*. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F., pp. 172–175.
- [24] Beard, J.S., 1955. The classification of tropical American vegetation. *J. Ecol.* 36, 89–100.
- [25] Bekker, R.P., Cleef, A.M., 1985. La vegetación del páramo de Laguna Verde (Municipio de Tausa, Cundinamarca). In: *Análisis Geográficos 14*. Instituto Geográfico Agustín Codazzi, Bogotá.
- [26] Bellingham, P.J., Tanner, E.V.J., Healey, J.R., 1995. Damage and responsiveness of Jamaican montane tree species after disturbance by a hurricane. *Ecol.* 76, 2562–2580.
- [27] Bello, A.L.K., 1994. Aspectos Ecológicos en la Sucesión Secundaria de la Vegetación Subandina (2010–2510 m) en Localidades del Municipio de Santa Rosa de Cabal, Risaralda Colombia. Trabajo de Grado, Departamento de Biología, Universidad Nacional de Colombia, Bogotá.
- [28] Berger, U., Hildenbrandt, H., 2000. A new approach to spatially explicit modelling of forest dynamics: spacing, ageing and neighbourhood competition of mangrove trees. *Ecol. Mod.* 132, 287–302.
- [29] Blackmore, S., 1984. Compositae – Lactuceae. In: Punt, W., Clarke, G.C.S. (Eds.), *The Northwest European Pollen Flora* No. 32. Elsevier, Amsterdam.
- [30] Blydenstein, J., 1967. Tropical savanna vegetation of the Llanos of Colombia. *Ecol.* 48, 1–15.
- [31] Bonilla, B.J., 2000. Sistemática del Genero *Nymphaea* (Nymphaeaceae) en México. Thesis Doctorado en Ciencias, Facultad de Ciencias, Universidad Nacional Autónoma, México.
- [32] Bonilla, B.J., Novelo, A., 1995. Manual de identificación de plantas acuáticas del Parque Nacional Lagunas de Zempoala, México. Cuadernos No. 26, Instituto de Biología, Universidad Nacional Autónoma, México.
- [33] Bonilla-Barbosa, J.R., Novelo-Retana, A., 1995. Manual de identificación de plantas acuáticas del Parque Nacional Lagunas de Zempoala. Cuadernos No. 26, Instituto de Biología, Univ. Nac. Auton. Mexico, México, D.F.
- [34] Bosman, A.F., van der Moien, P.C., Young, R., Cleef, A.M., 1993. Ecology of a páramo cushion mire. *J. Veg. Sci.* 4, 633–640.
- [35] Bowman, D.M.J.S., 1993. Tropical rainforest. *Prog. Phys. Geogr.* 17, 484–492.
- [36] Bush, M., 1991. Modern pollen-rain data from South and Central America: a test of the feasibility of fine-resolution lowland tropical palynology. *Holocene* 1, 162–167.
- [37] Bush, M.B., Colinvaux, P.A., 2001. Tropical forest disturbance: Paleocological records from Darien, Panama. *Ecol.* 75, 1761–1768.
- [38] Bustamante, R.O., Castor, C., 1998. The decline of an endangered temperate ecosystem: the rui (*Northofagus alexandrii*) forest in central Chile. *Biodiv. Conserv.* 7, 1607–1626.
- [39] Cabido, M., Breimer, R., Vega, G., 1987. Plant communities and associated soil types in a high plateau of the Cordoba Mountains, Central Argentina. *Mt. Res. Dev.* 7, 25–42.
- [40] Cabrera, A.L., 1971. Compositae. In: Correa, M.N. (Ed.), *Flora Patagónica. Colección Científica INTAT VIII*, Vol. VIII, Buenos Aires.
- [41] Cabrera, A.L., 1968. Vegetación de la Provincia de Buenos Aires. In: Cabrera, A.L. (Ed.), *Flora de la Provincia de Buenos Aires. Colección Científica INTA, Parte 1*, Buenos Aires.
- [42] Cabrera, A.L., 1976. Regiones Fitogeográficas Argentinas. *Encyclopedia Argentina de Agricultura y Jardinería I*, 2nd edn, II. Acme, Buenos Aires.
- [43] Cabrera, A.L., Zardini, E.M., 1978. Manual de la Flora de los Alrededores de Buenos Aires, 2nd edn. Acme, Buenos Aires.
- [44] Campos-Díaz, J.L., 1985. Plantaginaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas, IPN. México, D.F.
- [45] Cano-Santana, Z., Meave, J., 1996. Sucesión primaria

- en derrames volcánicos: El caso del Xitle. *Ciencias* 41, 58–68.
- [46] Carabia, J.P., 1945. The vegetation of Sierra de Nipe, Cuba. *Ecol. Monogr.* 15, 321–341.
- [47] Cardoso da Silva, J.M., Tabarelli, M., 2000. Tree species impoverishment and the future flora of the Atlantic forest of northeast Brazil. *Nature* 404.
- [48] Carey, E.V., Brown, S., Gillespie, A.J.R., Lugo, A.E., 1994. Tree mortality in mature lowland tropical moist and tropical lower montane moist forests of Venezuela. *Biotropica* 26, 255–265.
- [49] Carvajal, L.F.J., Posada, F.N., Molina, A.C., Delgado, A., Acero, L.E., Araujo, O., Rodríguez, F., 1979. Bosques. In: *La Amazonia Colombiana y sus Recursos. Proyecto Radargramétrico del Amazonas (Proradam. 1979). Tomo 1: Memoria Técnica; Tomo IV: Mapas de Bosques.* Instituto Geográfico Agustín Codazzi, Bogotá.
- [50] Cavelier, J., Aide, T.M., Santos, C., Eusse, A.M., Dupuy, J.M., 1998. The savannization of moist forests in the Sierra Nevada de Santa Marta, Colombia. *J. Biogeogr.* 25, 901–912.
- [51] Clark, D.A., Clark, D.B., Sandoval, M.R., Castro, C.M.V., 1995. Edaphic and human effects on landscape-scale distribution of tropical rainforest palms. *Ecol.* 76, 2581–2594.
- [52] Cleef, A.M., 1981. The vegetation of the páramos of the Colombian Cordillera Oriental. *Dissertationes Botanicae* 61. Cramer, Vaduz, p. 321.
- [53] Cleef, A.M., Da Silva, M.F.F., 1994. Plant communities of the Serra dos Carajás (Pará), Brazil. *Bol. Mus. Para Emílio Goeldi Nova Sér. Bot.* 10, 269–281.
- [54] Cleef, A.M., Hooghiemstra, H., 1984. Present vegetation of the area of the High Plain of Bogotá. In: Hooghiemstra, H. (Ed.), *Vegetational and Climatic History of the High Plain of Bogotá, Colombia.* *Dissertationes Botanicae* 79. Cramer, Vaduz.
- [55] Cleef, A.M., Rangel-Ch., J.O., 1984. La vegetación del páramo del NW de la Sierra Nevada de Santa Marta. In: van der Hammen, T., Ruiz, C. (Eds.), *La Sierra Nevada de Santa Marta Transecto Buritaca–La Cumbre. Estudios de Ecosistemas Tropicandinos 2.* Cramer, Vaduz, pp. 203–266.
- [56] Cleef, A.M., Rangel-Ch., J.O., Salamanca-V., S., 1983. Reconocimiento de la vegetación de la parte alta del transecto Parque Los Nevados. In: van der Hammen, T., Pérez, P.A., Pinto, E.P. (Eds.), *La Cordillera Central Colombiana, Introducción y Datos Iniciales. Transecto Parque los Nevados. Estudios de Ecosistemas Tropicandinos 1.* Cramer, Vaduz, pp. 150–173.
- [57] Cleef, A.M., Rangel-Ch., J.O., van der Hammen, T., Jaramillo, R., 1984. La vegetación de las selvas del transecto Buritaca. In: van der Hammen, T., Ruiz, P.M. (Eds.), *Estudios de Ecosistemas Tropicandinos 2.* Cramer, Berlin, pp. 267–406.
- [58] Colinvaux, P.A., 1996. Quaternary environmental history and forest diversity in the Neotropics. In: Jackson, J.B.C., Budd, A.F., Coates, A.G. (Eds.), *Evolution and Environment in Tropical America.* University of Chicago Press, Chicago, IL.
- [59] Colinvaux, P.A., De Oliveira, P.E., Moreno-Patino, J.E., 1999. *Amazon Pollen Atlas.* Hardwood Academic Publishers The Netherlands.
- [60] Colinvaux, P.A., Schofield, E.K., 1976. Historical ecology in the Galápagos Islands, 1. A Holocene pollen record from El Junco Lake, Isla San Cristobal. *J. Ecol.* 64, 989–1012.
- [61] Correa, M.N., 1984. Dicotyledones dialipétalas (Salicaceae a Cruciferae). In: *Flora Patagónica. Colección Científica INTA T.VIII, Parte IVa.* Buenos Aires.
- [62] Correa, M.N., 1984. Dicotyledones dialipétalas (Droseraceae a Leguminosae). In: *Flora Patagónica. Colección Científica INTA T.VIII, Parte IVb.* Buenos Aires.
- [63] Correa, M.N., 1988. Dicotyledones dialipétalos (Oxalidaceae a Cornaceae). In: *Flora Patagónica. Colección Científica INTA T.VIII, Parte V.* Buenos Aires.
- [64] Correa, M.N., 1998. Introducción, Clave general de familias, Pteridophyta y Gymnospermae. In: *Flora Patagónica. Colección Científica INTA T.VIII, Parte I.* Buenos Aires.
- [65] Correa, M.N., 1999. Dicotyledones Gamopétalas (Ericaceae a Calyceraceae). In: *Flora Patagónica. Colección Científica INTA T.VIII, Parte VI.* Buenos Aires.
- [66] Cortés, S.P., Rangel-Ch., J.O., 2000. Los relictos de vegetación en la Sabana de Bogotá. In: Aguirre, J. (Ed.), *Memorias del Primer Congreso Colombiano de Botánica, Bogotá (CD-Rom).*
- [67] Cortés, S.P., van der Hammen, T., Rangel-Ch., J.O., 1999. Comunidades vegetales y patrones de degradación y sucesión en la vegetación de los cerros occidentales de Chía-Cundinamarca-Colombia. *Rev. Acad. Col. Cs. Ex. Fis. Nat.* 23, 529–554.
- [68] Cuatrecasas, J., 1934. Observaciones geobotánicas en Colombia. *Trab. Museo Nacional Ciencias Naturales, Serie Bot.* 27, 144.
- [69] Cuatrecasas, J., 1958. Aspectos de la vegetación natural de Colombia. *Rev. Acad. Col. Cs. Ex. Fis. Nat.* 10, 221–268.
- [70] Cuatrecasas, J., 1958. Aspectos de la vegetación natural de Colombia. *Rev. Acad. Col. Cs. Ex. Fis. Nat. (Bogotá)* 10, 221–264.
- [71] Cuatrecasas, J., 1989. Aspectos de la vegetación natural en Colombia. *Perez-Arbelaezia* 2, 155–284.
- [72] Cuatrecasas, J., Barreto, A.J., 1988. Páramo. Villegas, Bogotá.
- [73] Cuervo-D.A., Barbosa, C.C., De la Ossa-V.J., 1986. Aspectos ecológicos y etológicos de primates con énfasis en *Alouatta seniculus* (Cebidae) de la región de Colosó, Serranía de San Jacinto (Sucre), Costa Norte de Colombia. *Caldasia* 14, 709–741.
- [74] Darien Prado, pers. commun.
- [75] Davalos, L.M., 2001. The San Lucas mountain range in Colombia: how much conservation is owed to the violence. *Biodiv. Conserv.* 10, 69–78.
- [76] De las Salas, G., 1986. Los ecosistemas del Carare-Opón. CONIF.
- [77] Dedin, L.O., Hetherington, E.D., 1995. Atmospheric and geologic constraints on the biogeochemistry of North and

- South American temperate rainforest. In: Heldmaier, G., Large, O.L., Moore, H.A., Sommer, U. (Eds.), High Latitude Rain Forest and Associated Ecosystems of the Western Coasts of the Americas. Ecol. Stud. 116. Springer, Berlin.
- [78] Díaz-Betancourt, M.A., Ortega-Rubio, de Rzedowski, G.C., 1985. Convolvulaceae. In: Rzedowski, J.C., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [79] Diego-Pérez, N., 1997. Cyperaceae, No. 5. In: Diego-Pérez, N., Fonseca, R.M. (Eds.), Flora de Guerrero. Prensas de Ciencias, México.
- [80] Dov Par, F., 1992. Sooretama: Atlantic Rain Forest of Brazil. SPB Academic Publishing, The Hague.
- [81] Drewa, P.B., Havstad, K.M., 2000. Effects of fire, grazing and the presence of shrubs on Chihuahuan desert grasslands. *J. Arid Envir.* 140, 1963.
- [82] Dugand, A., 1970. Observaciones botánicas y geobotánicas en la costa Caribe Colombiana. *Rev. Acad. Col. Cs. Ex. Fis. Nat.* 8, 415–465.
- [83] Duivenvoorden, J.F., 1995. Tree species composition and rain forest environmental relationships in the middle Caquetá area, Colombia, North-western Amazonia. *Vegetatio* 120, 91–113.
- [84] Duivenvoorden, J.F., Cleef, A.M., 1994. Amazonian savanna vegetation on the sandstone near Araracuara, Colombia. *Phytocoen.* 24, 197–232.
- [85] Duivenvoorden, J.F., Lips, J.M., 1993. Ecología del paisaje del medio Caquetá. Memoria explicativa y mapas. In: Saldarriaga, J.G., van der Hammen, T. (Eds.), Estudios en la Amazonia Colombiana. Tropenbos-Colombia, Bogotá.
- [86] Duivenvoorden, J.F., Lips, J.M., 1994. A Land-Ecological Study of Soils, Vegetation and Plant Diversity in Colombian Amazonia. Tropenbos-Colombia, Serie 12, Wageningen.
- [87] Duque, N.A., Rangel-Ch., J.O., 1989. Análisis fitosociológico de la vegetación paramuna del Parque Natural del Puracé. In: Herrera, L.F., Drennan, R., Uribe, C. (Eds.), Cacicazgos Prehispánicos del Valle de la Plata, Tomo 1. El Contexto Medioambiental de la Ocupación Humana. Univ. Pittsburgh Mem. Lat. Am. Arch. 2, 70–95.
- [88] Eden, M.J., McGregor, D.F.M., 1992. Dynamics of the forest savanna boundary in the Rio Branco-Rupunumi region of northern Amazonia. In: Furley, P.A., Proctor, J., Ratter, J.A. (Eds.), Nature and Dynamics of Forest Savanna Boundaries. Chapman and Hall, London.
- [89] Eiten, G., 1972. Cerrado vegetation of Brazil. *Bot. Rev.* 2, 10–341.
- [90] Ellenberg, H., 1979. Man's influence on tropical mountain ecosystems in South America. *J. Ecol.* 67, 401–416.
- [91] Espinosa de G., Rul, J., 1979. Gymnospermae. In: Rzedowski, J., Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. I. CECSA, México, D.F.
- [92] Espinosa de G., Rul, J., 1991. Berberidaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [93] Espinosa de G., Rul, J., 1991. *Cassia*. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [94] Espinosa de G., Rul, J., 1991. Gymnospermae. Coniferae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [95] Espinosa de G., Rul, J., 1991. Mimosoideae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [96] Espinosa de G., Rul, J., 1991. Salicaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [97] Espinoza-García, F.J., 1985. *Ambrosia*. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [98] Estrada, A., Cammarano, P., Coates-Estrada, R., 2000. Bird species-richness in vegetation fences and in strips of residual rainforest vegetation at Los Tuxtlas, México. *Biodiv. Conserv.* 9, 1399–1416.
- [99] Faceli, J.M., Montero, C.M., León, R.J.C., 1988. Effect of different disturbance regimen on seminatural grasslands from the subhumid Pampa. *Flora* 180, 241–249.
- [100] Fearn, M.L., Liu, K.-B., 1995. Maize pollen of 3500 yr B.P. from southern Alabama. *Am. Antiq.* 60, 109–117.
- [101] Fernández, J., 1970. *Polylepis tomentella* y *Orgaenia Reuestc*. *Bol. Soc. Argent. Bot.* 13, 14–30.
- [102] Fernández-Nava, R., 1985. *Rhamnus*. In: Rzedowski, J.C., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [103] Ferreira, L.V., Prance, G.T., 1998. species-richness and floristic composition in four hectares in the Jau National Park in upland forests in Central Amazonia. *Biodiv. Conserv.* 7, 1349–1364.
- [104] Ferreira, L.V., Prance, G.T., 1998. Structure and species-richness of low-diversity floodplain forest on the Rio Tapajos, Eastern Amazonia, Brazil. *Biodiv. Conserv.* 7, 585–596.
- [105] Figueroa, J.A., Castro, S.A., 2000. Effect of herbivores and pathogens on the survival and growth of seedlings in a fragment of the Chiloe rainforest, Chile. *Rev. Chil. Hist. Nat.* 73, 163–167.
- [106] Flores-Martínez, G., 1990. *Eriocaulon*. In: Rzedowski, J.C., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. III. Instituto de Ecología, México, D.F.
- [107] Fonseca, R.M., Velázquez, E., 1998. Betulaceae, No. 7. In: Diego-Pérez, N., Fonseca, R.M. (Eds.), Flora de Guerrero. Prensas de Ciencias, México.
- [108] Fosberg, F.R., 1950. Ecological notes on the Upper Amazon. *Ecol.* 31, 650–653.
- [109] Fraile, M.E., Somers, P., Morán, R., 1995. *Selaginella*. In: Morán, R.C., Riba, R. (Eds.), Flora Mesoamericana,

- Vol. 1, Pt. 22. Universidad Nacional Autónoma de México, Mexico.
- [110] Franco, R.P., Rangel-Ch., J.O., Lozano, G., 1986. Estudios ecológicos en la Cordillera Oriental, II. Las comunidades vegetales de los alrededores de la Laguna de Chingaza (Cundinamarca). *Caldasia* 15, 219–248.
- [111] Galeano, G., Suarez, S., Balslev, H., 1998. Vascular plant species count in a wet forest in the Chocó area on the Pacific coast of Columbia. *Biodiv. Conserv.* 7, 1563–1575.
- [112] Galvan, R., 1990. Juncaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. III. Instituto de Ecología, México, D.F.
- [113] Galvan, R., 1990. Liliaceae. In: Rzedowski, J.C., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. III. Instituto de Ecología, México, D.F.
- [114] Gamarro, J.C., 1997. *Flora Fanerogámica Argentina*, Fascículo 44, 11 a: Ruppiceae. Programa ProFlora, Secretaría de Recursos Naturales y Desarrollo Sustentable, Córdoba.
- [115] García Zuñiga, T. 1985. Labiatae. In: Rzedowski, J.C., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [116] Gentry, A.H., 1986. species-richness and floristic composition of the Chocó plant communities. *Caldasia* 15, 71–91.
- [117] Gentry, A.H., 1993. A field guide to the families and genera of woody plants of South America (Colombia, Ecuador, Perú). Conservation International, Washington, DC.
- [118] Gomez-Hinostrosa, C., Hernandez, H.M., 2000. Diversity, geographical distribution, and conservation of Cactaceae in the Mier y Noriega region in México. *Biodiv. Conserv.* 9, 403–418.
- [119] Grabandt, R.J., 1980. Pollen rain in relation to arboreal vegetation in the Colombian Cordillera Oriental. *Rev. Palaeobot. Palynol.* 29, 65–147.
- [120] Grabherr, G., 1997. *Farbatlas: Ökosysteme der Erde: natürliche, naturnahe und künstliche Land-Ökosysteme aus geobotanischer Sicht*. Ulmer, Mannheim.
- [121] Gual-Díaz, M., 1998. La Familia Tiliaceae Juss. en el Estado de Guerrero, México. M.Sc. Thesis, Facultad de Ciencias, Univ. Nac. Auton. Mexico, Mexico.
- [122] Gutierrez, J.R., Lopez-Cortes, F., Marquet, P.A., 1998. Vegetation in an altitudinal gradient along the Rio Loa in the Atacama Desert of northern Chile. *Arid Environ.* 40, 383–399.
- [123] Hanazaki, N., Tamashiro, J.Y., Leitao-Filho, H.F., Beggosi, A., 2000. Diversity of plant uses in two Caicara communities from the Atlantic Forest coast, Brazil. *Biodiv. Conserv.* 9, 597–615.
- [124] Harley, R.M., 1995. Introduction to the vegetation. In: Stannards, B.L. (Ed.), *Flora of the Pico das Almas*. Chapada Diamantina, Bahia.
- [125] Helmens, K.F., Kuhry, P., 1986. Middle and late Quaternary vegetational and climatic history of the páramo de Agua Blanca (Eastern Cordillera Colombia). *Palaeogeogr. Palaeoecol. Palaeoclimatol.* 56, 291–335.
- [126] Henderson, A., 1995. *The Palms of the Amazon*. Oxford University Press, Oxford.
- [127] Henderson, A., Galeano, G., Bernal, R., 1995. *Field Guide to the Palms of the Americas*. Princeton University Press, Princeton, NJ.
- [128] Henry Hooghiemstra, pers. commun.
- [129] Hermann Behling, pers. commun.
- [130] Hernández-Reyna, A., Rzedowski, J., 1985. *Baccharis*. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas, IPN, México, D.F.
- [131] Herrera, Y., Rzedowski, J., 1990. *Zea*. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. III. Instituto de Ecología, México, D.F.
- [132] Hoffman, A.E., 1979. *Flora Silvestre de Chile, Zona Araucana*. Edic. Fundación Claudio Gay, Santiago.
- [133] Hooghiemstra, H., Cleef, A.M., 1984. Development of vegetational and climatic sequence of the area of the High Plain of Bogotá. In: Hooghiemstra, H. (Ed.), *Vegetational and Climatic History of the High Plain of Bogotá*, Colombia. *Dissertationes Botanicae* 79. Cramer, Vaduz.
- [134] Hooghiemstra, H., van der Hammen, T., 1998. Neogene and Quaternary development of the neotropical rainforest: the forest refugia hypothesis, and a literature overview. *Earth Sci. Rev.* 44, 147–103.
- [135] Huber, O., 1992. El Macizo del Chimantá, Escudo de Guayana. Oscar Todtmann Edit., Caracas.
- [136] Huber, O., Rinna, R., 1997. *Glosario fitoecológico de las Américas*. Vol. I, América del Sur: países hispanoparlantes. UNESCO, Fundación Instituto Botánico de Venezuela, Caracas.
- [137] Islebe, G.A., Hooghiemstra, H., 1997. Vegetation and climate history of montane Costa Rica since the Last Glacial. *Quat. Sci. Rev.* 16, 589–604.
- [138] Joergensen, P.M., Ulloa, C.U., Mahen, J.E., Valencia, R.R., 1998. A floristic analysis of the high Andes of Ecuador. In: Churchill, S.P. (Ed.), *Biodiversity and Conservation of a Neotropical Montane Forest*. New York Botanic Gardens, Bronx, New York, NY.
- [139] Johnston, M., 1998. Tree population studies in low-diversity forests, Guyana. II. Assessments on the distribution and abundance of non-timber forest products. *Biodiv. Conserv.* 7, 73–86.
- [140] Kahn, F., De Granville, J.J., 1992. *Palms in the Forest Ecosystems of Amazonia*. Springer, Berlin.
- [141] Kappelle, M., 1995. *Ecology of Mature and Recovering Talamancan Montane Quercus Forests*, Costa Rica. Ph.D. Thesis, University of Amsterdam, Amsterdam.
- [142] Keating, P.L., 2000. Chronically disturbed páramo vegetation at a site in southern Ecuador. *J. Torrey Bot. Soc.* 127, 162–171.
- [143] Kellman, M., Meave, J., 1997. Fire in the tropical gallery forest of Belize. *J. Biogeogr.* 24, 23–34.
- [144] Kenoyer, L.A., 2001. General and successional ecology of the lower tropical rain-forest at Barro Colorado Islands, Panama. *Ecol.* 10, 201–222.

- [145] Kershaw, A.P., McGlone, M., 1995. The Quaternary history of the southern conifers. In: Enright, N.J., Hill, R.S. (Eds.), *Ecology of Southern Conifers*. Melbourne University Press, Melbourne.
- [146] Killeen, T., Garcia, E.E., Beck, S.G., 1993. *Guía de arboles de Bolivia*. Missouri Botanical Garden, St. Louis, MO.
- [147] Koford, C.B., 1957. The Vicuña and the puna. *Ecol. Monogr.* 27, 153–219.
- [148] Kress, W.J., Heyer, W.R., Acevedo, P., Coddington, J., Cole, D., Erwin, T.L., Meggers, B.J., Pogue, M., Thorington, R.W., Vari, R.P., Weitzman, M.J., Weitzman, S.H., 1998. Amazonian biodiversity: assessing conservation priorities with taxonomic data. *Biodiv. Conserv.* 7, 1577–1587.
- [149] Kuhry, P., 1988. Palaeobotanical-palaeoecological studies of tropical high Andean peatbog sections (Cordillera Orientales, Colombia). *Dissertationes Botanicae* 116. Cramer, Berlin.
- [150] Lamberto, S.A., Valle, A.F., Aramayo, E.M., Andrada, A.C., 1997. *Manual ilustrado de las plantas silvestres de la región de Bahía Blanca*. Departamento de Agronomía, Universidad Nacional del Sur, Bahía Blanca.
- [151] Lellinger, D.B., 1995. *Plagiogyra*. In: Morán, R.C., Riba, R. (Eds.), *Flora Mesoamericana*, Vol. 1. Universidad Nacional Autónoma de México, Mexico.
- [152] León, R.J.C., 1991. Setting and Vegetation. In: Coupland, R.T. (Ed.), *Natural Grassland. Introduction and Western Hemisphere*. Elsevier, Amsterdam.
- [153] Leyden, B.W., 1985. Late Quaternary aridity and Holocene moisture fluctuations in the Lake Valencia basin, Venezuela. *Ecol.* 66, 1279–1295.
- [154] Lindenmayer, D.B., Mackey, B.G., Cunningham, R.B., Donnelly, C.F., Mullen, I.C., McCarthy, M.A., Gill, A.M., 2000. Factors affecting the presence of the cool temperate rainforest tree myrtle beech (*Northofagus cunninghamii*) in southern Australia: integrating climatic, terrain and disturbance predictors of distribution patterns. *J. Biogeogr.* 27, 1001–1009.
- [155] Lot, A., Novelo Retana, A., Olvera, M., Ramírez-García, P., 1999. *Catálogo de angiospermas acuáticas de México*, Cuadernos 33. Instituto de Biología, Univ. Nac. Auton. Mexico, Mexico.
- [156] Lozano, C.G., 1984. Comunidades vegetales el flanco Norte del cerro El Cielo y la flora vascular del Parque Nacional Tayrona (Magdalena, Colombia). In: van der Hammen, T., Ruiz, C.P. (Eds.), *Estudios de Ecosistemas Tropoandinos 2*. Cramer, Vaduz.
- [157] Lozano, C.G., Schnetter, G.R., 1976. Estudios ecológicos en el páramo de Cruz Verde, Colombia, II. Las comunidades vegetales. *Caldasia* 11, 53–68.
- [158] Lucia Almeida, pers. commun.
- [159] B. Ludlow-Wiechers, pers. commun.
- [160] Ludlow-Wiechers, B., 1978. Chloranthaceae. In: Gomez-Pompa, A., Sosa, V. (Eds.), *Flora de Veracruz*, Fascículo 2.
- [161] Luisa Fernanda Herrera, pers. commun.
- [162] Lusk, C.H., 1996. Stand dynamics of the shade-tolerant conifers *Podocarpus nubigena* and *Saxegothaea conspicua* in Chilean temperate rainforest. *J. Veg. Sci.* 7, 549–558.
- [163] Maarten Kappelle, pers. commun.
- [164] Mabberley, D.J., 1997. *The Plant-Book: a Portable Dictionary of the Higher Plants*. Cambridge University Press, 2nd. edn., Cambridge.
- [165] Mares, M.A., Morello, J., Goldstein, G., 1985. The Monte Desert and other subtropical semi-arid biomes of Argentina, with comment on their relation to North American arid areas. In: Evenari, M. (Ed.), *Hot Desert and Arid Shrublands*. Elsevier, Amsterdam.
- [166] Maria Lea Salgado-Labouriau, pers. commun.
- [167] Marie-Pierre Ledru, pers. commun.
- [168] Mark Bush, pers. commun.
- [169] Markgraf, V., Romero, E., Villagrán, C., 1996. History and paleoecology of South American *Nothofagus* forest. In: Veblen, T.T., Hill, R.S., Read, J. (Eds.), *The Ecology and Biogeography of Nothofagus Forests*. Yale University Press, New York.
- [170] Marroquin, J., 1985. Sapindaceae. In: Rzedowski, J., de Rzedowski, C.G. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [171] Martin, L., Fournier, M., Mouguiart, P., Sifeoldine, A., Turcq, B., Absy, M.L., Flexor, J.M., 1993. Oscillation signal in South American palaeoclimatic data of the last 7000 years. *Quat. Res.* 39, 338–346.
- [172] Mauchamp, A., Aldaz, I., Ortiz, E., Valdebenito, H., 1998. Threatened species, a re-evaluation of the status of eight endemic plants of the Galápagos. *Biodiv. Conserv.* 7, 97–107.
- [173] McMullen, C.K., 1999. *Flowering Plants of the Galápagos*. Comstock Publishing Associates, Cornell University Press, New York.
- [174] Medina, M., 1985. Ericaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [175] Melief, A.B.M., 1985. Late Quaternary Paleocology of the Parque Nacional los Nevados (Cordillera Central), and Sumapaz (Cordillera Orientales) Areas, Colombia. Ph.D. Thesis, Univ. of Amsterdam, Amsterdam.
- [176] Mendoza, E., Dirzo, R., 1999. Deforestation in Lacandonia (southeast México): evidence for the declaration of the northernmost tropical hot-spot. *Biodiv. Conserv.* 8, 1621–1641.
- [177] Mendoza, C.H., 1999. Estructura y riqueza florística del bosque seco tropical en la región Caribe y el valle del río Magdalena, Colombia. *Caldasia* 21, 70–94.
- [178] Monasterio, M., Sarmiento, G., 1991. Adaptive radiation of *Espeletia* in the cold Andean tropics. *Trends Ecol. Evol.* 6, 387–391.
- [179] Moore, D.M., 1974. *Catálogo de las plantas vasculares nativas de Tierra del Fuego*. *Ann. Inst. Patagon.* 5, 105–121.
- [180] Moore, D.M., 1983. *Flora of Tierra del Fuego*. Anthony Nelson.
- [181] Moore, D.M., 1983. The flora of the Fuego-Patagonian Cordilleras: its origins and affinities. *Rev. Chil. Hist. Nat.* 56, 123–136.

- [182] Moore, D.M., Williams, C.A., Yates, B., 1972. Studies on bipolar disjunct species, II: *Plantago maritima*. Bot. Not. 125, 261–272.
- [183] Morán, R., 1995. *Ctenitis*. In: Morán, R.C., Riba, R. (Eds.), Flora Mesoamericana, Vol. 1. Universidad Nacional Autónoma de México, Mexico.
- [184] Morán, R., 1995. Cyatheaceae. In: Morán, R.C., Riba, R. (Eds.), Flora Mesoamericana, Vol. 1. Universidad Nacional Autónoma de México, Mexico.
- [185] Morán, R., 1995. Dryopteridaceae. In: Morán, R.C., Riba, R. (Eds.), Flora Mesoamericana, Vol. 1. Universidad Nacional Autónoma de México, Mexico.
- [186] Morán, R., 1995. *Polypodium*. In: Morán, R.C., Riba, R. (Eds.), Flora Mesoamericana, Vol. 1. Universidad Nacional Autónoma de México, Mexico.
- [187] Moreira, A.G., 2000. Effects of fire protection on savanna structure in Central Brazil. J. Biogeogr. 27, 1021–1029.
- [188] Moreno, P.I., Lowell, T.V., Jacobson, G.L., Denton, G.H., 1999. Abrupt vegetation and climate changes during the last glacial maximum and last termination in the Chilean Lake District: A case study from Canal de la Puntilla (41°S). Geogr. Ann. Ser. A Phys. Geogr. 81A, 285–311.
- [189] Nadkarni, N.M., Matelson, T.J., Haber, W.A., 1995. Structural characteristics and floristic composition of a Neotropical montane rainforest, Monteverde, Costa Rica. Trop. Ecol. 11, 481–495.
- [190] Narváez, R.L.H., Olmos, S.J.R., 1990. Caracterización fitoedafológica de algunos salados en el Parque Nacional Natural Amacayacu, Amazonas, Colombia. Dept. de Biología, Universidad Nacional de Colombia, Bogotá.
- [191] Nascimento, M.T., Proctor, J., 1997. Soil and plant changes across a monodominant rainforest boundary on Maraca Islands, Roraima, Brazil. Glob. Ecol. Biogeogr. Lett. 6, 387–395.
- [192] Nelson, B.W., Kapos, V., Adams, J.B., Oliveira, W.J., Braun, O.P.G., Amaral, I.L., 1994. Forest disturbance by large blowdowns in the Brazilian Amazon. Ecol. 75, 853–858.
- [193] Nicora, E., 1978. Gramineae. In: Correa, M.N. (Ed.), Flora Patagónica. Colección Científica INTA T VIII, Vol. III, Buenos Aires.
- [194] Nixon, C.K., 1993. The genus *Quercus* in México. In: Ramamoorthy, T.P., Bye, R., Lot, A., Fa, J. (Eds.), Biological Diversity of México, Origins and Distribution. Oxford University Press, Oxford.
- [195] Nores, M., Cerena, M.M., 1990. Biogeography of forest relics in the mountains of north-west Argentina. Rev. Chil. Hist. Nat. 63, 37–46.
- [196] Oliveira, A.A., Daly, D.C., 1999. Geographic distribution of tree species occurring in the region of Manaus, Brazil: implications for regional diversity and conservation. Biodiv. Conserv. 8, 1245–1259.
- [197] Oliveira, A.A., Mori, S.A., 1999. A central Amazonian *terra firme* forest. I. High tree species-richness on poor soils. Biodiv. Conserv. 8, 1219–1244.
- [198] Orozco, C.I., 2001. *Brunellia* – Evolutionary Biology of *Brunellia* (Brunelliaceae, Oxalidales). Ph.D. Thesis, University of Amsterdam, Amsterdam.
- [199] Pacheco, L. 1995. *Hymenophyllum*. In: Morán, R.C., Riba, R. (Eds.), Flora Mesoamericana, Vol. 1. Universidad Nacional Autónoma de México, Mexico, p. 63.
- [200] Paez, M.M., Villagrán, C., Stutz, S., Hinojosa, F., Villa, R., 1997. Vegetation and pollen dispersal in the Subtropical-Temperate climatic transition of Chile and Argentina. Rev. Palaeobot. Palynol. 96, 169–181.
- [201] Palacios-Chávez, R., 1977. Lluvia de polen moderno en diferentes habitats del Valle de México. Bol. Soc. Bot. Méx. 36, 45–70.
- [202] Paulo De Olivera, pers. commun.
- [203] Pennington, R.T., Prado, D.E., Pendry, C.A., 2000. Neotropical seasonally dry forests and Quaternary vegetation changes. J. Biogeogr. 27, 261–173.
- [204] Pennington, T.D., Sarukhán, J., 1998. Árboles Tropicales de México. Universidad Nacional Autónoma de México, FCE, México.
- [205] Pereira, B.A.S., de Mendonça, R.C., Filgueiras, T.S., de Paula, J.E., Heringer, E.P., 1990. Levantamento florístico da área de proteção ambiental (APA) da bacia do Rio São Bartolomeu, Distrito Federal. Anais XXXVI Congresso Brasileiro de Botânica, Soc. Bot. Brazil, 1985, Vol. 1. IBA-MA, Curitiba.
- [206] Perez, C., Villagrán, G., 1983. Distribución de abundancias de especies en bosques relictos de la zona mediterránea de Chile. Rev. Chil. Hist. Nat. 56, 157–170.
- [207] Pessenda, L.C.R., Gomes, B.M., Aravena, R., Ribeiro, A.S., Boulet, R., Gouveia, S.E.M., 1998. The carbon isotope record in soils along a forest-cerrado ecosystem transect: implications for vegetation changes in the Rondonia state, south-western Brazilian Amazon region. Holocene 8, 599–603.
- [208] Pires, J.M., Prance, G.T., 1985. The vegetation types of the Brazilian Amazon. In: Prance, G.T., Lovejoy, T. (Eds.), Key Environments of Amazonia. Pergamon Press, Oxford.
- [209] Pivello, V.R., Shida, C.N., Meirelles, S.T., 1999. Alien grasses in Brazilian savannas: a threat to the biodiversity. Biodiv. Conserv. 8, 1281–1294.
- [210] Prance, G.T., 1985. The Changing Forest. In: Prance, G.T., Lovejoy, T. (Eds.), Key Environments Amazonia. Pergamon Press, Oxford.
- [211] Prance, G.T., 1996. Islands in Amazonia. R. Soc. London B 351, 823–833.
- [212] Premoli, A.C., Kitzberger, T., Veblen, T.T., 2000. Isozyme variation and recent biogeographical history of the long-lived conifer. J. Biogeogr. 27, 251–260.
- [213] Prieto, A.R., 2000. Vegetational history of the Late Glacial–Holocene transition in the grasslands of eastern Argentina. Palaeogeogr. Palaeoclimatol. Palaeoecol. 157, 167–188.
- [214] Ran, O., 1995. The relationships between the desert flora of Chile and México. Rev. Chil. Hist. Nat. 65, 157–170.
- [215] Rangel-Ch., J.O., 1991. Vegetación y Ambiente en Tres Gradientes Montañosos de Colombia. Ph.D. Thesis, University of Amsterdam, Amsterdam.
- [216] Rangel-Ch., J.O., 1994. Diversidad y frecuencia de las

- familias, géneros y especies de plantas superiores en el transecto del Parque Los Nevados. In: van der Hammen, T., dos-Santos, A. (Eds.), *La Cordillera Central, Estudios de Ecosistemas Tropandinos 4*. Cramer, Berlin.
- [217] Rangel-Ch., J.O., 1998. *Flora Orinoques*, Bogotá.
- [218] Rangel-Ch., J.O., Aguirre, C.J., 1983. Comunidades acuáticas altoandinas, I. Vegetación sumergida y de ribera en el Lago de Tota, Boyacá, Colombia. *Caldasia* 13, 719–742.
- [219] Rangel-Ch., J.O., Aguirre, C.J., 1986. Estudios ecológicos en la Cordillera Oriental Colombiana III. Vegetación de la cuenca del Lago de Tota (Boyacá). *Caldasia* 15, 263–312.
- [220] Rangel-Ch., J.O., Cleef, A.M., Salamanca, V.S., 1989. La vegetación de las regiones de vida subandina y ecuatorial del transecto Parque Los Nevados (Cordillera Central Colombiana). Pérez-Arbelaesía 2, 329–382.
- [221] Rangel-Ch., J.O., Cleef, A.M., Salamanca, V.S., in press. The equatorial interandean and subandean forest of the parque Los Nevados transect, Cordillera Central Colombia. *Ecoandes* 5. Cramer, Berlin.
- [222] Rangel-Ch., J.O., Franco, R.P., 1985. Observaciones fitoecológicas en varias regiones de vida de la Cordillera Central de Colombia. *Caldasia* 14, 211–249.
- [223] Rangel-Ch., J.O., Lozano, C.G., 1986. Un perfil de vegetación entre La Plata (Huila) y el Volcán Puracé. *Caldasia* 14, 535–547.
- [224] Rangel-Ch., J.O., Lozano, C.G., 1989. La vegetación selvática y boscosa del Valle de la Plata (entre el río Magdalena y el Parque Natural Puracé). In: Herrera, L.F., Drennan, R., Uribe, C. (Eds.), *Cacicazgos Prehispánicos del Valle de la Plata*, Tomo 1. El Contexto Medioambiental de la Ocupación Humana. Univ. Pittsburgh Mem. Lat. Am. Arch. 2, 95–118.
- [225] Rangel-Ch., J.O., Sturm, H., 1995. Consideraciones sobre la vegetación, la productividad primaria neta y la artropofauna asociada en regiones paramunas de la Cordillera Oriental. In: Mora, L.E., Sturm, H. (Eds.), *Estudios Ecológicos del Páramo y del Bosque Altoandino Cordillera Oriental de Colombia*. Acad. Rev. Acad. Col. Cs. Ex. Fis. Nat. 6, 47–71.
- [226] Ratter, J.A., Ribeiro, J.F., Bridgewater, S., 1997. The Brazilian cerrado vegetation and threats to its biodiversity. *Ann. Bot.* 80, 223–230.
- [227] Read, T., Hill, R.S., 1985. Photosynthetic responses to light of Australian and Chilean species of *Nothofagus* and their relevance to rainforest dynamics. *New Phytol.* 101, 731–742.
- [228] Riba, R., 1981. Cyatheaceae. In: Gomez-Poma, A., Moreno, N.P. (Eds.), *Flora de Veracruz*, Fascículo 17. INIREB, Xalapa.
- [229] Rieger, W. 1976. Vegetationskundliche Untersuchungen auf der Guajira-Halbinsel. *Gressener Geogr. Schr.* 40, 1–142.
- [230] Rodgers, J.C., II, Horn, S.P., 1996. Modern pollen spectra from Costa Rica. *Palaeogeogr. Palaeoecol. Palaeoclimatol.* 121, 53–71.
- [231] Rodríguez-Jiménez, C., 1985. Cucurbitaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [232] Rodríguez-Jiménez, C., 1991. Scrophulariaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [233] Roig, F.A., 1976. Las comunidades vegetales del piedemonte de la PreCordillera de Mendoza. *Ecosur.* 3, 1–45.
- [234] Roig, F.A., 1998. La vegetación de la Patagonia. In: *Flora Patagónica, Colección Científica INTA*, Tomo VIII, Vol. 1, Buenos Aires.
- [235] de Rzedowski, G.C., 1979. Nymphaeaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. I. CECSA, México, D.F.
- [236] de Rzedowski, G.C., 1979. Cruciferae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. I. CECSA, México, D.F.
- [237] Rzedowski, G.C., 1979. Rosaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [238] de Rzedowski, G.C., 1983. *Vegetación de México*, 2nd edn. Limusa, México.
- [239] de Rzedowski, G.C., 1985. *Berula erecta*. In: Rzedowski, J.C., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [240] de Rzedowski, G.C., 1985. Euphorbiaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [241] de Rzedowski, G.C., 1985. *Ludwigia*. In: Rzedowski, J.C., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [242] de Rzedowski, G.C., 1991. Urticaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [243] de Rzedowski, G.C., 1991. Polygonaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [244] de Rzedowski, G.C., 1991. Rosaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [245] de Rzedowski, G.C., 1991. *Thalictrum*. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F.
- [246] de Rzedowski, G.C., 1991. Loranaceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), *Flora Fanerogámica del Valle de México*, Vol. I. Escuela Nacional de Ciencias Biológicas IPN, México, D.F., pp. 119–120.
- [247] de Rzedowski, G.C., Rzedowski, J., 1990. Commelinaceae. In: Rzedowski, J.C., de Rzedowski, G.C. (Eds.), *Flora*

- Fanerogámica del Valle de México, Vol. III. Instituto de Ecología, México, D.F.
- [248] Rzedowski, J., 1978. Vegetación de México, 1st edn. Limusa, México.
- [249] Rzedowski, J., 1985. Rubiaceae. In: Rzedowski, J.C., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F., p. 390.
- [250] Rzedowski, J., 1978. Vegetación de México. Limusa, México, D.F.
- [251] Rzedowski, J., 1985. Asteraceae. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México. Primera reimpression, Vol. II. Escuela Nacional de Ciencias Biológicas IPN, Instituto de Ecología, México, D.F.
- [252] Rzedowski, J., 1985. *Solanum*. In: Rzedowski, J., de Rzedowski, G.C. (Eds.), Flora Fanerogámica del Valle de México, Vol. II. Escuela Nacional de Ciencias Biológicas IPN e Instituto de Ecología, México, D.F.
- [253] Salamanca, V.S., Cleef, A.M., Rangel-Ch., J.O., 1991. The páramo vegetation. In: Salamanca, S. (Ed.), The Vegetation of the Páramo and its Dynamics in the Volcanic Massif Ruiz-Tolima. *Anál. Geogr.* 21, 38–63.
- [254] Salgado-Labouriau, M.L., 1973. Contribuição à palinologia dos Cerrado. Academia Brasileira de Ciências, Rio de Janeiro.
- [255] Salgado-Labouriau, M.L., 1979. Modern pollen deposition in the Venezuelan Andes. *Grana* 18, 53–68.
- [256] Salgado-Labouriau, M.L., 1982. Pollen morphology of the Compositae of the northern Andes. *Grana* 24, 397–452.
- [257] Salgado-Labouriau, M.L., 1986. Estudios paleoecológicos de la región de Rancho Grande, Venezuela. In: Huber, O. (Ed.), La Selva Nublada de Rancho Grande, Parque Nacional. Henri Pittier, Fondo Editorial Acta Científica Venezolana, Caracas.
- [258] Salgado-Labouriau, M.L., Rinaldi, M., 1990. Morphology of Gramineae of the Venezuelan mountains. *Grana* 29, 119–128.
- [259] Sanchez, M.R., Rangel-Ch., J.O., 1990. Estudios ecológicos en la Cordillera Oriental Colombiana, Vol. V. Análisis fitosociológico de la vegetación de los depósitos turbosos paramunos de los alrededores de Bogotá. *Caldasia* 16, 155–192.
- [260] Sanchez, P.H.R., Alvarez, L., 1997. Diagnóstico y zonificación preliminar de los manglares del caribe de Colombia. Ministerio del Medio Ambiente-Organización Internacional de Maderas Tropicales, Bogotá.
- [261] Sarmiento, G., 1975. The dry plant formations of South America and their floristic connections. *J. Biogeogr.* 2, 233–251.
- [262] Schmidt, M.U., 1988. Vegetación acuática y palustre de la parte alta de la hoya del río Namay (Albán, Cundinamarca). *Perez-Arbelaezia* 2, 9–41.
- [263] Schmithüsen, J., 1976. Atlas zur Biogeographie. Bibliographisches Institut, Mannheim.
- [264] Schofield, K., 1984. Plants of the Galápagos Islands. Universe Books.
- [265] Seibert, P., 1996. Farbatlas Südamerika-Landschaften und Vegetation. Verlag Eugen Ulmer, Mannheim.
- [266] Seifriz, W., 1943. The Plant Life of Cuba, Vol. 13. University of Pennsylvania, Philadelphia, PA.
- [267] Simpson, B.B., 1983. A historical biogeography of the High Andean Flora. *Rev. Chil. Hist. Nat.* 56, 109–122.
- [268] Smith, J.M., Klinger, L.F., 1985. Above ground below ground phytomass ratios in Venezuelan páramo vegetation and their significance. *Arct. Alp. Res.* 17, 189–198.
- [269] Socorro Lozano-García, pers. commun.
- [270] Solbrig, O.T., 1976. The origin and floristic affinities of the South American temperate desert and semi-desert regions. In: Goodall, D.W. (Ed.), Evolution of Desert Biota. University of Texas Press, Austin, TX.
- [271] Sousa, M., Delgado, A., 1993. Mexican Leguminosae: phytoecography, endemism, and origins. In: Ramamoorthy, T.P., Bye, R., Lot, A., Fa, J. (Eds.), Biological Diversity of México. Origins and Distribution. Oxford University Press, Oxford.
- [272] Steege, H.T., 1998. The use of forest inventory data for a National Protected Area Strategy in Guyana. *Biodiv. Conserv.* 7, 1457–1483.
- [273] Steege, H.T., Jansen-Jacobs, M.J., Datadin, V.K., 2000. Can botanical collections assist in a National Protected Area Strategy in Guyana? *Biodiv. Conserv.* 9, 215–240.
- [274] Steyermark, J.A., 1950. Flora of Guatemala. *Ecol.* 31, 368–372.
- [275] Strahl, J., 1998. Palynological study of Borehole CB 297 in the Valle Central of Cochabamba, Bolivia. *Bol. Serv. Nac. Geol. Min.* 14, 21–27.
- [276] Sturm, H., Abouchaar, A., de Bernal, R., de Hoyos, C., 1970. Distribución de animales en las capas bajas de un bosque húmedo tropical de la región Carare-Opón (Santander, Colombia). *Caldasia* 10, 529–578.
- [277] Sturm, H., Rangel-Ch., J.O., 1985. Ecología de los páramos Andinos: Una visión preliminar integrada. Instituto de Ciencias Naturales, Bogotá.
- [278] Styles, B.T., 1993. Genus *Pinus*: A Mexican purview. In: Ramamoorthy, T.P., Bye, R., Lot, A., Fa, J. (Eds.), Biological Diversity of México. Origins and Distribution. Oxford University Press, Oxford.
- [279] Sugden, A.M., 1982. The ecological, geographic and taxonomic relations of the flora of an isolated Colombian cloud forest with some implications for island biogeography. *J. Arnold Arbor Harv. Univ.* 63, 31–61.
- [280] Sugden, A.M., 1982. The vegetation of the Serranía de Macuira, Guajira, Colombia: A contrast of arid lowlands and an isolated cloud forest. *J. Arnold Arbor. Harv. Univ.* 63, 1–30.
- [281] Svenning, J.C., 1998. The effect of land-use on the local distribution of palm species in an Andean rainforest fragment in northwestern Ecuador. *Biodiv. Conserv.* 7, 1529–1537.
- [282] Swente Björk, pers. commun.
- [283] Thomas, W.W., 1999. Conservation and monographic research on the flora of Tropical America. *Biodiv. Conserv.* 8, 1007–1015.

- [284] Thouret, J.C., Faivre, P., 1989. Suelos de la Cordillera Central, transecto Parque Los Nevados. In: van der Hammen, T., Díaz, P.S., Alvarez, V. (Eds.), *La Cordillera Central Colombiana, Transecto Parque Los Nevados. Estudios de Ecosistemas Tropandinos 3*. Cramer, Berlin.
- [285] Tryon, R.M., Tryon, A.F., 1982. *Ferns and Allied Plants with Special Reference to Tropical America*. Springer, New York.
- [286] Urrego, L.E., 1990. Apuntes preliminares sobre la composición y estructura de los bosques inundables en el medio Caquetá, Amazonas, Colombia. *Colomb. Amazon.* 4, 23–30.
- [287] Urrego, L.E., 1994. *Los Bosques Inundables del Medio Caquetá (Amazonia Colombiana)*. Ph.D. Thesis, University of Amsterdam, Amsterdam.
- [288] Valencia, R., Joergensen, P.M., 1992. Composition and structure of a humid montane rainforest on Pasochoa volcano, Ecuador. *Nord. J. Bot.* 12, 239–247.
- [289] Van Andel, T., 1992. *Caracterización y Clasificación de Bosques Inundables en una Llanura Aluvial en el Medio Caquetá, Amazonas, Colombia*. University of Amsterdam, Amsterdam.
- [290] van der Hammen, T., 1963. A Palynological study on the Quaternary of British Guyana. *Leidse Geol. Meded.* 29, 126–168.
- [291] van der Hammen, T., 1972. Changes in vegetation and climate in the Amazon Basin and surrounding areas during the Pleistocene. *Geol. Mijnb.* 51, 641–643.
- [292] van der Hammen, T., 1983. The palaeoecology and paleogeography of the savanna. In: Bourlière, F. (Ed.), *Ecosystems of the World-Tropical Savannas*. Elsevier, Amsterdam.
- [293] Van Devender, T., Burgess, T.L., Feldger, R.S., Turner, R.N., 1990. Holocene vegetation of the Hornaday Mountains of north-western Sonoran, México. *Proc. S. Diego Soc. Nat. Hist.* 2, 1–19.
- [294] Vargas, O., Rivera, D., 1990. El páramo un ecosistema fragil. In: *Cuadernos de Agroindustria y Economía Rural*. Universidad Pontificia Javeriana, Bogotá.
- [295] Vargas, O., Zuluaga, S., 1985. La vegetación del páramo de Monserrate. In: Sturm, H., Rangel, J.O. (Eds.), *Ecología de los Páramos Andinos*, Bogotá.
- [296] Veblen, T.T., Burns, B.R., Kitzberger, T., Lara, A., Villalba, R., 1995. The ecology of the conifers of southern South America. In: Enright, N.J., Hill, R.S. (Eds.), *Ecology of Southern Conifers*. Melbourne University Press, Melbourne.
- [297] Vera Markgraf, pers. commun.
- [298] Vervoorst, F., 1967. La vegetación de la República Argentina. VII. Las comunidades vegetales de la depresión del Salado (Provincia de Buenos Aires). *Serie Fitogeográfica 7*. INTA, Buenos Aires.
- [299] Villagrán, C.M., 1990. Historia de los bosques templados de Chile durante el tardiglacial y postglacial. *Rev. Chil. Hist. Nat.* 63, 59–65.
- [300] Villalba, R., Cook, E.R., Jacoby, G.C., D'Arrigo, R.D., Veblen, T.T., Jones, P.D., 1998. Tree-ring based reconstructions of northern Patagonia precipitation since AD 1600. *Holocene* 8, 659–674.
- [301] Ward, R.T., Dimitri, M.J., 1966. Alpine tundra on Mount Cathedral in the southern Andes. *N.Z. J. Bot.* 4, 42–56.
- [302] Webb, E.L., Peralta, R., 1998. Tree community diversity of lowland swamp forest in Northeast Costa Rica, and changes associated with controlled selective logging. *Biodiv. Conserv.* 7, 565–583.
- [303] Wijmstra, T.A., van der Hammen, T., 1966. Palynological data on the history of tropical savannas in northern South America. *Leidse Geol. Meded.* 38, 71–90.
- [304] Wijninga, V.M., Rangel-Ch., J.O., Cleef, A.M., 1989. Botanical ecology and conservation of Laguna de la Herrera (Sabana de Bogotá, Colombia). *Caldasia* 16, 23–40.
- [305] Willis, J.C., 1966. *A Dictionary of the Flowering Plants and Ferns*, 7th edn. Cambridge University Press, Cambridge.
- [306] Wingenroth, M., Suárez, J., 1984. Flores de los Andes-Alta Montaña de Mendoza. IANIGLA, Instituto Argentino de Nivología y Glaciología, Mendoza.
- [307] Witte, H.J.L., 1994. Present and Past Vegetation and Climate in the North Andes (Cordillera Central, Colombia); a Quantitative Approach. Ph.D. Thesis, University of Amsterdam, Amsterdam.
- [308] Wolf, J.H., 1993. Ecology of Epiphytes and Epiphyte Communities in Montane Rainforest, Colombia. Ph.D. Thesis, University of Amsterdam, Amsterdam.
- [309] Wright, S.J., 1991. Seasonal drought and the phenology of understory shrubs in a tropical moist forest. *Ecol.* 72, 1643–1657.
- [310] Yatskivych, R., Moran, R., 1995. *Cheilantes*. In: Morán, R.C., Riba, R. (Eds.), *Flora Mesoamericana*, Vol. 1. Universidad Nacional Autónoma de México, Mexico, p. 121.
- [311] Young, S.B., 1972. Subantarctic rainforest of Magallanic Chile: distribution, composition, ecology and growth rate studies of common forest trees. In: Llaas, G.A. (Ed.), *Antarctic Terrestrial Biology*, Antarctic Research Series, Vol. 20, Washington, DC.
- [312] Zeilhofer, P., Schessl, M., 1999. Relationship between vegetation and environmental conditions in the northern Pantanal of Mato Grosso, Brazil. *J. Biogeogr.* 27, 159–168.
- [313] Zizka, G., Klemmer, K., 1994. Pflanzen- und Tierwelt der Galápagos-Inseln. Volkmar, Teir.
- [314] Zuluaga, R.S., 1987. Observaciones fitoecológicas en el Darién Colombiano. *Perez-Arbelaezia* 1, 85–145.