

Index of biota and taxa

Note: *Pinus* taxa printed in **bold type** are those recognized in this volume (see Chapter 2). Taxa marked “#” are known only from fossils. Common names are given only for those taxa for which these are used in this volume and/or which are cited regularly in the literature. For pathogenic fungi, the common names listed refer to the diseases they cause. Page numbers in **bold type** indicate illustrations; there may also be textual references on these pages. Page numbers in { brackets } indicate definitions.

- Abies* (Pinaceae; firs) 3, 9–10, 13–15, 17–20, 24, 26, 28, 38, 51, 99–101, 107, 129–30, 138, 140–1, **146**, 165, 219–20, 228, 254, 310, 366, 386, 390, 397, 409–11, 482
- A. alba* (European silver fir) 118, **299**, 305
- A. amabilis* (Pacific silver fir) 306
- A. balsamea* (balsam fir) 210
- A. bornmulleriana* (Bornmüller's fir) 305
- A. cephalonica* (Greek fir) **155**
- A. concolor* (white fir) **25**, **26**, 29, 32, 198, 200, 301–2
- A. grandis* (giant/grand fir) 198, 300, **386**
- A. holophylla* (Manchurian fir) 19
- A. lasiocarpa* (subalpine fir) **26**, 131, 204, **222**, 285, 297, 302
- A. magnifica* (California red fir) **25**
- Acacia* (acacias, wattles) 38, 347, 409
- A. mearnsii* (black wattle) 346
- A. raddiana* (umbrella thorn) 304
- Acantholyda* (Hymenoptera: Pamphiliidae) 355, 367
- A. erythrocephala* 359
- A. nemoralis* 373
- Acer* (Aceraceae; maples) 38, 154
- A. rubrum* (red maple) **233**
- A. saccharum* (sugar maple) **233**
- A. triflorum* (rough-barked maple) 19
- Actinostrobus* (Cupressaceae) 219
- Aegeria* (Lepidoptera: Sesiidae) 364
- Agathis australis* (Araucariaceae; Kauri pine) 10
- Alangium* (Alangiaceae) 74
- Alces alces* (Cervidae; European moose) 34, 204
- alder – see *Alnus*
- Alnus* (Betulaceae; alders) 14, 18, **26**, 75, 99, 145–6, 195, 262
- A. glutinosa* (black alder) 116
- A. rubra* (red alder) 131, 347
- Amanita* (Agaricales: Amanitaceae)
- A. excelsa* 334
- A. muscaria* (fly agaric) 327, 333–4
- A. pantherina* (panther cap) 334
- A. rubescens* (blusher) 334
- Ambrosia* (Asteraceae; ragweeds) **146**
- Andropogon* (Poaceae) 201
- annosum root rot – see *Heterobasidion annosum*
- Aphelenchoides xylophilus* – see *Bursaphelenchus xylophilus*
- Aphelocoma coerulescens* (Corvidae; scrub jay) 290
- Aphididae (aphids) 373
- Aphrophora* (Homoptera: Cercopidae) 367
- A. saratogensis* (Homoptera: Cercopidae) 362
- Aradus cinnamomeus* (Hemiptera: Aradidae) 373
- Araucaria araucana* (Araucariaceae; Chile pine) 10
- Arbutus* (Ericaceae)
- A. andrachne* 207
- A. unedo* (strawberry tree) 107
- Arceuthobium* (Viscaceae; dwarf mistletoes) 237, 381–3, 384, 389, 398, 443
- A. americanum* (lodgpole pine dwarf mistletoe) 384
- A. bicarinatum* (Hipaniolan dwarf mistletoe) 382
- A. hawksworthii* (Hawkworth's dwarf mistletoe) 382
- A. minutissimum* (Himalayan dwarf mistletoe) 382
- A. pini* (alpine dwarf mistletoe) 382
- Arctostaphylos viscida* (Ericaceae; manzanita) 304
- Argyresthiidae 359
- Aristida* (Poaceae) 223
- A. stricta* 201
- Armillaria* (Agaricales: Tricholomataceae) 381, 385–7, 398
- A. mellea* (Armillaria root rot / honey fungus) 36, 387
- A. ostoyae* (Armillaria root rot) **385**, **387**
- A. tabescens* (mushroom root rot) 387
- Artemisia* (Asteraceae; sagebrush) 99–100, **146**, 162
- A. tridentata* (valley big sagebrush) 221, 307
- Ascalyx abietina* – see *Gremmeniella abietina*
- Astraeus pteridis* (Sclerodermatales: Asteraeaceae) 334
- Atropellis* (Helotiales: Atropellis canker) 390
- Attenuatae* (subsection of *Pinus*) 55, 58–9, 62–3, 65, 283, 358, 360, 434
- Australes* (subsection of *Pinus*) 4, 54–5, 58, 61–2, 64, 71, 76, 84, 85, 233, 283, 358–60, 489
- Balfourianae* (subsection of *Pinus*) 8, 16, 54–7, 59–60, 62, 65, 76, 79, 84, 86, 358, 360

- Banksia* (Proteaceae; banksias) 453, 457, 462
Battaristis (Lepidoptera: Gelechiidae) 365
 bears (*Ursus* spp.; Ursidae) 35
 beaver (*Castor canadensis*; Castoridae) 451
Betula (Betulaceae; birches) 14, 18, 20, 26–7, 75, 99–100, 116, 154, 202
 B. ermannii (Erman's birch) 19
 B. papyrifera (paper birch) 208, 210
 B. pubescens (white birch) 204
 B. verrucosa 204
 birch – see *Betula*
 black stain root disease – see *Leptographium wageneri*
Boletus edulis (Agaricales: Boletaceae; penny bun, cep) 334
 B. piperatus (peppery bolete) 334
Brachypodium pinnatum (Poaceae) 157
Bromus tectorum (Poaceae; cheat grass) 17, 36
Brunchorstia pinea – see *Gremmeniella abietina*
Bupalus piniarius (Lepidoptera: Geometridae) 374
 Buprestidae (flatheaded or metallic wood borers) 364, 366
Buprestis (Coleoptera: Buprestidae) 357
Bursaphelenchus xylophilus (Aphelenchoididae; pinewood nematode) 370, 382, 397–8

Calamagrostis rubescens (Poaceae) 200
Calluna vulgaris (Ericaceae; heather) 116, 164, 202, 204
Calocedrus (Cupressaceae; northern incense cedars) 17
 C. decurrens (incense cedar) 25, 32, 198, 388
Calyptorhynchus (Psittacidae; cockatoos)
 C. funereus latirostris (Carnaby's cockatoo) 291, 462
 C. lathami (glossy black cockatoo) 291, 461–2
Camptozygum aequale (Hemiptera: Miridae) 361
Canarienses (subsection of *Pinus*) 4, 56–7, 59–64, 71, 84, 154, 359
Carex (Cyperaceae; sedge) 200, 210
Carnegia gigantea (Cactaceae; giant saguaro cactus) 176
Carphoborus (Coleoptera: Scolytidae) 363
Carpinus (Betulaceae) 100
 C. betulus 99, 117
 C. cordata (cordate hornbeam) 19
 C. laxiflora (hornbeam) 19
 C. orientalis (Oriental hornbeam) 117
Carya (Juglandaceae; hickories) 17
Castanea dentata (Fagaceae; American chestnut) 17–18
Castanopsis (Fagaceae) 99, 101

Cathaya (Pinaceae; cathaya) 9, 51
 cattle (*Bos* spp.; Bovidae) 34, 457
Ceanothus (Rhamnaceae) 195
 Cecidomyiidae (gall midges) 367
Cecidomyia (Diptera: Cecidomyiidae) 367
 Cercopidae (Homoptera) 367
Cecropia (Cecropiaceae) 13
Cedrus (Pinaceae; cedars) 3, 9, 51, 165, 409–10, 412
 C. atlantica (Blue Atlas cedar) 305
 C. deodar (deodar) 305
Cembrae (subsection of *Pinus*; stone pines) 16, 55, 57, 59–62, 65, 83, 122, 238, 290, 358–60, 488
Cembroides (subsection of *Pinus*; pinyon pines) 4, 10, 12, 54–7, 59, 62–3, 65, 76, 79, 84, 85–6, 137, 171–80, 284, 290, 310, 358, 360, 485
 cockatoos – see *Calyptorhynchus*
Cenococcum geophilum (Elaphomycetaceae) 334
 Cerambycidae (longhorned or roundheaded wood borers) 355, 366, 397
Ceratocystis ulmi 381
Cercidium microphyllum (Fabaceae; foothills paloverde) 176
Cercis (Fabaceae; Judas trees) 154
 Chenopodiaceae 146, 162
 chestnut, American – see *Castanea dentata*
 chestnut blight – see *Endothia parasitica*
Chionaspis (Homoptera: Diaspididae) 367
Chionochloa rigida (Poaceae; narrow-leaved snow tussock) 465
Choristoneura (Lepidoptera: Tortricidae) 361, 364–5, 367–8
 C. pinus pinus (jack pine budworm) 364–5, 368, 372
Chrysobothris (Coleoptera: Buprestidae) 367
 Cicadellidae (leafhoppers) 361
Cinara (Homoptera: Aphididae) 355, 367, 373
Cirsium vulgare (Asteraceae; bull thistle) 31
Cistus (Fabaceae) 107
 C. clusii 207
 C. incanus 207
 C. monspeliensis (narrow-leaved cistus) 21
 C. salvifolius (sage-leaved cistus) 207
Cladonia (Cladoniaceae; reindeer moss) 16, 203
 Coccidae (soft scales) 363
Coelodonta (Rhinocerotidae) 99
 Collembola (springtails) 198, 349
 Coleoptera (beetles) 355, 356–7, 359, 361, 362–6
 Coleosporium (Uredinales; pine needle rust) 394
 Coleotechnites (Lepidoptera: Gelechiidae) 364

Conophthorus (Coleoptera: Scolytidae; cone beetles) 362–3, 365, 367, 467
Contortae (subsection of *Pinus*) 8, 55, 58, 60, 62, 64, 76, 79, 84, 122, 283, 358, 360
 Coreidae (coreid or leaf-footed bugs) 237
 Corvidae (crows, jays and magpies) 171, 238, 289
Corylus (Betulaceae; hazels) 100, 113, 116, 154
Cronartium (Uredinales; pine rusts) 394–6
 C. quercuum (fusiform rust) 36, 381, 389, 391, 398, 395–6
 C. ribicola (white pine blister rust) 35, 270, 381, 386, 395–6
Cryptomeria (Taxodiaceae; Japanese red cedar) 20, 101
Cunninghamia (Taxodiaceae; Chinese firs) 20
Cupressus (Cupressaceae; true cypresses) 21, 24, 219–20, 409, 412
 C. arizonica (rough-barked Arizona cypress) 175
 Curculionidae (snout beetles or weevils) 366
Cyanocitta stelleri (Corvidae; Steller's jay) 290
Cyanopicus cyanus (Corvidae; azure-winged magpie) 290
Cyclaneusma (Rhythmatales; Cyclaneusma needle cast) 393
Cyclobalanopsis (Cupuliferae) 99
Cydia (Lepidoptera: Tortricidae) 365, 367
Cylindrocopterus (Coleoptera: Curculionidae) 362
 Cyperaceae (sedges) 116, 146
Cytisus scoparius (Fabaceae; common broom) 164

Dacrycarpus (Podocarpaceae) 101
Dacrydium (Podocarpaceae) 99–101
Dasychyra (Lepidoptera: Lymantriidae) 364
 deer (*Cervus* spp.; Cervidae) 28, 108, 469
Dendroctonus (Coleoptera: Scolytidae) 203, 237, 363–4, 367–8, 373
 D. brevicornis (western pine beetle) 200, 373
 D. frontalis (southern pine beetle) 369–71, 373–5, 389
 D. ponderosae (mountain pine beetle) 204, 206, 363, 368–9, 373, 375, 384
Dendroica kirtlandii (Emberizidae; Kirtland's warbler) 37, 210
Desmococcus (Homoptera: Margarodidae) 361
 Diaspididae (armoured scales) 367
Dicranopteris (Gleicheniaceae) 101
Dioryctria (Lepidoptera: Pyralidae) 355, 357, 362, 364–5, 367
D. albovittella 237, 368

- Diplodia pinea* – see *Sphaeropsis sapinea*
 diploxylon pines {477} – see *Pinus*
 (subgenus of *Pinus*)
 Diprionidae (conifer sawflies) 359–61, 370
 Diptera (flies) 355, 356–7, 359, 361, 365–6
 Dipterothripidae 24, 224, 324
Dipterocarpus (Dipterocarpaceae) 25
Dothistroma acicola – see *Mycosphaerella*
 dearnessii
 D. pini (syn *D. septospora*) – see
 Mycosphaerella pini
Dracophyllum subulatum (Epacridaceae;
 monoao) 465
Dryopteris (Aspidiaceae) 216
 D. filix 216
 Dutch elm disease – see *Ceratocystis ulmi*
 dwarf mistletoe – see *Arceuthobium*
- Earomyia* (Diptera: Lonchaeidae) 365
 Elateridae (click beetles) 356
Elatobium (Homoptera: Aphididae) 359
 elms – see *Ulmus*
Elytroderma (Rhytismatales) 393
 E. deformans (Elytroderma needle cast)
 393
 E. torres-juanii 393
Endocronartium – see *Peridermium*
Endothia parasitica (chestnut blight) 381
Engelhardtia (Juglandaceae) 74
Ephedra (Ephedraceae) 162
Epilobium (Onagraceae; willowherbs) 210
Erica arborea (Ericaceae) 107
Ernobius (Coleoptera: Anobiidae) 365
Eucalyptus (Myrtaceae; eucalypts, gums)
 xv, 13, 38, 258, 291, 335, 346–7,
 447, 453–4, 455, 459
 E. blakelyi (Blakely's red gum) 465
 E. globulus (blue gum) 346–7
 E. leucocylon (yellow gum) 454
 E. marginata (jarrah) 453, 457
Eucosma (Lepidoptera: Tortricidae) 36, 365
 E. tocullionana 364
Eupithecia (Lepidoptera: Geometridae) 355
Eutamias sibirica (Sciuridae; chipmunk)
 292
Exotelia (Lepidoptera: Gelechiidae) 361,
 367
- Fagaceae 324
Fagus (Fagaceae; beeches) 18, 100, 102, 117,
 154, 233, 347
 F. sylvatica (common beech) 163
Festuca idahoensis (Idaho fescue) 17, 36
Ficus (Moraceae; figs) 74, 409
 firs – see *Abies*
Fitzroya (Cupressaceae) 219
 F. cupressoides
Fomes annosus – see *Heterobasidion annosum*
 F. pini – see *Phellinus pini*
Fouquieria columnaris (Fouquieriaceae;
 boojum tree) 178
- Frankliniella* (Thysanoptera: Thripidae) 365
Fraxinus (Oleaceae; ashes) 113, 117, 154
 F. pennsylvanica (red ash) 419
Fusarium (Tuberculariaceae)
 F. oxysporum 332–3
 F. subglutinans – see *Gibberella fujikuroi*
 fusiform rust – see *Cronartium quercuum*
- Gelechiidae (Lepidoptera; gelechiid
 moths) 359
Genista monspessulana (Fabaceae; broom)
 435, 437
 Geometridae (geometrid moths,
 measuring worms, loopers,
 spanworms and inchworms) 355
Gerardiana (subsection of *Pinus*) 4, 54–7,
 60, 62, 65, 85, 87, 291
Gibberella fujikuroi (Hypocreales; asexual
 state syn. *Fusarium subglutinans*;
 pitch canker) 382, 391, 398,
 443–4, 467
Glyptostrobus (Taxodiaceae) 74
 goats (*Capra* spp.; Bovidae) 28, 33–4, 435,
 437
 Gramineae – see Poaceae
Gremmeniella abietina (Helotiales;
 Scleroderris canker) 382, 390–1,
 398
Gymnorhinus cyanocephalus (Corvidae;
 Pinyon jay) 175, 239, 290, 368, 410
- Halepenses* (subsection of *Pinus*) 21, 55–7,
 60–1, 63–4, 154, 283
 haploxylon pines {480} – see *Strobus*
 (subgenus of *Pinus*)
 hard pines – see *Pinus* (subgenus of *Pinus*)
Hebeloma crustuliniforme (Agaricales;
 Cortinariaceae; poison pie) 327,
 329, 333–4
Helianthemum (Cistaceae; rock-roses) 162
Hemiberlesia pityophila (Diospididae; pine
 needle scale) 32
 Hemiptera (true bugs) 355, 356–7, 359,
 361, 363, 365
 hemlock – see *Tsuga*
Herculia (Lepidoptera: Pyralidae) 365
Heterobasidion annosum (Aphylliphorales,
 syn. *Fomes annosus*; annosum
 root rot) 381, 385, 387–8
 hickory – see *Carya*
 Homoptera (aphids, gall aphids) 355,
 356–7, 359, 361, 362–6
Hydnangium carneum (Agaricales;
 Tricholomataceae) 334
Hylastes (Coleoptera: Scolytidae) 367, 388,
 444
Hylobius (Coleoptera: Curculionidae) 362,
 364, 367
 H. abietis 373–4
 H. rhizophagus (pine root tip weevil)
 372–3
- H. warreni* (Warren's root collar weevil)
 363
Hylurgops (Coleoptera: Scolytidae) 367, 444
Hymenogaster albellus (Hymenogastrales;
 Hymenogastraceae) 334
 Hymenoptera (ants, bees, sawflies, wasps
 and allies) 355, 356–7, 359, 361,
 363, 365
Hyparrhenia (Poaceae) 457
- Imbrasia cytherea* (Saturniidae; pine
 emperor moth) 443
Imperata (Poaceae) 211
Ips (Coleoptera: Scolytidae) 363, 367, 444
 I. calligraphus (sixspined ips) 374
 I. gradicollis (eastern fivespined ips) 374
 I. mexicanus 391
 I. paraconfusus (California fivespined
 ips) 374, 391
- Jay
 Pinyon – see *Gymnorhinus cyanocephalus*
 Scrub – see *Aphelocoma coerulescens*
 Steller's – see *Cyanocitta stelleri*
Juglans (Juglandaceae; walnut) 100
Juniperus (Cupressaceae; junipers) 21,
 24–5, 26, 138, 146, 162, 171, 174,
 176, 179, 219, 303, 409
 J. californica (California juniper) 178
 J. communis (common juniper) 116
 J. monosperma (one-seed juniper) 304,
 306–7
 J. occidentalis (Sierra juniper) 28
 J. osteosperma (Utah juniper) 22, 173, 179
 J. standleyi (huito) 24
 J. turbinata 162, 165
 J. virginiana (red/pencil cedar) 301
- Keteleeria* (Pinaceae) 9, 20, 51, 99
Krempliana (subsection of *Pinus*) 56–7, 65,
 84
- Laccaria* (Agaricales: Tricholomataceae)
 L. bicolor 329
 L. laccata (The Deceiver) 327, 332, 334
Lactarius (Agaricales: Russulaceae)
 L. deliciosus (saffron milk cap, pine ring)
 333–4
 L. rufus 328
Lagarostrobus franklinii (Podocarpaceae;
 Huon pine) 303
 laminated root rot – see *Phellinus weirii*
Lantana camara (Verbenaceae; lantana) 31
 larches – see *Larix*
Larix (Pinaceae; larches) 3, 9, 14–15, 38, 51,
 97, 100, 303, 347, 365–6, 368
 L. dahurica (Dahurian larch) 15
 L. decidua (European larch) 18, 299, 308
 L. laricina (tamarack) 132
 L. lyallii (subalpine larch) 390
 L. occidentalis (western larch) 130

500 / Index of biota and taxa

- Larix* (Pinaceae; larches) (cont.)
Larix × eurolepis (Dunkeld larch) 300
Lecanosticta acicola – see *Mycosphaerella dearnessii*
Ledum (Ericaceae) 202, 210
Leiophyllae (subsection of *Pinus*) 55–6, 60, 62–3, 65, 71, 84, 137, 358, 360
 Lepidoptera (butterflies, moths and skippers) 355, 356–7, 359, 361, 362–6
Leptoglossus (Hemiptera: Coreidae) 361, 365, 367
Leptographium (*Verticicladiella*) *wagneri* (Hyphomycetes; black stain root disease) 381, 388–9, 398
Leptospermum (Myrtaceae; tea tree) 454
 lichens 202–3, 342
Linnaea borealis (Caprifoliaceae; twinflower) 204
Liquidambar styraciflua (Hamamelidaceae; sweet gum) 24, 140
Lithocarpus (Fagaceae) 20, 99
 littleleaf disease – see *Phytophthora cinnamomi*
Lophodermella (Rhytismatales; needle cast) 393
Lophodermium (Rhytismatales) 393
L. seditiosum (Lophodermium needle cast) 393
Loxia spp. (Fringillidae; crossbills) 39

Macaranga (Euphorbiaceae) 13
Magdalis (Coleoptera: Curculionidae) 367
Mammuthus[#] (Elephantidae) 99
 Margarodidae (Margarodid scales) 367
 maples – see *Acer*
Matsucoccus (Homoptera: Margarodidae) 367
M. feytaudi (Maritime pine bast scale) 164–5
Melaleuca viridiflora (Myrtaceae) 457
Melampsora (Uredinales; Melampsora rusts) 394
Melanogaster intermedius (Hymenogastraceae) 334
Melanophila (Coleoptera: Buprestidae) 367
 mistletoe, dwarf – see *Arceuthobium*
Monochamus (Coleoptera: Cerambycidae) 362
M. carolinensis 397
 Montezumae complex (Mirov 1967) 138
 Montezumae group (Martínez 1948) 59, 138–9
 moose – see *Alces alces*
Musanga (Cecropiaceae) 13
Mycosphaerella (Dothideales) 393
M. dearnessii (syn. *Scirrhia acicola*; brown spot needle blight) 200, 381, 394–5, 398, 444
M. gibsonii 393

M. pini (syn. *Scirria pini*; red band needle blight) 381, 393–4, 398, 439, 443
Myrica (Myricaceae; bayberries) 116
 Myrtaceae 324
Myrtus communis (Myrtaceae; myrtle) 107
 myxomatosis 29, 456

Narthecium ossifragum (Liliaceae; asphodel) 116
 needle casts – see *Lophodermium*
 nematode, pinewood – see *Busaphelenchus xylophilus*
 Neodiprion (Hymenoptera: Diprionidae) 355, 365, 367, 370
N. autumnalis 374
N. edulicolis (pinyon sawfly) 374
N. fulviceps 374
N. gillettei 375
N. lecontei (redheaded pine sawfly) 362
N. sertifer (European pine sawfly) 355, 368, 370–1, 373–4
N. swaini (Swaine jack pine sawfly) 372–3
Neotoma (Muridae; packrats) 9, 172–3, 181, 484
Nepytia (Lepidoptera: Geometridae) 365, 367
 Noctuidae (owlet moths and underwings) 355
Nothofagus (Fagaceae; southern beeches) 455, 457
Nothotsuga (Pinaceae; long-bracted hemlock) 9, 51
Nucifraga (Corvidae; nutcrackers) 238–9, 488
N. caryocatactes (Eurasian nutcracker) 20, 290, 292
N. columbiana (Clark's nutcracker) 35, 175, 177, 238–9, 260–1, 290, 409
Nuculaspis (Homoptera: Diaspididae) 367
N. californica 236
Nudaurelia cytherea – see *Imbrasia cytherea*
 Nutcracker
 Clark's – see *Nucifraga columbiana*
 Eurasian – see *Nucifraga caryocatactes*
Nypa (Araceae) 74
Nyssa (Cornaceae; sour gums) 74

 oaks – see *Quercus*
Ochropleura (Lepidoptera: Noctuidae) 364
Okanagana (Homoptera: Cicadidae) 362
Olea europaea (Oleaceae; olive) 21, 419
Oocarpae (subsection of *Pinus*) 8, 55, 58–63, 65, 85–6, 137, 142, 283, 359
Ophiostoma clavigerum (Ophiostomatales) 369
 orchids (Orchidaceae) 459
 Orthoptera (true locusts, katydids and crickets) 355, 356–7, 359, 361, 362, 366

Oryctolagus cuniculus (Leporidae; rabbits) 29, 33, 108, 454, 457
Oxalis (Oxalidae) 204
Oxythrips (Thysanoptera: Thripidae) 365

Pachylobius (Coleoptera: Curculionidae) 362
 packrat – see *Neotoma*
 Pamphiliidae (Hymenoptera; webspinning and leafrolling sawflies) 367
Panolis flammea (Lepidoptera: Noctuidae) (pine beauty moth) 370, 372
Parrya (section of *Pinus*) 10, 16, 49, 55–7, 60–1, 65, 86, 137, 480
Paxillus involutus (Agaricales: Paxillaceae; brown root rim) 331–4
P. panuoides 334
Peniophora gigantea – see *Phlebiopsis gigantea*
 Pentatomidae (stink bugs) 367
Peridermium (Uredinales) 394
P. harknessii (syn. *Endocronartium harknessii*; pine gall rust) 395, 443–4
Peromyscus leucopus (Muridae; white-footed mouse) 292
 Petrova – see *Retinia*
Phacidium infestans (Rhytismatales; snow blight) 204
Phaeolus schweinitzii (Polyporaceae/ Hymenochaetaceae) 369
Phellinus pini (syn. *Fomes pini*; Aphyllophorales; red ring rot) 385–6
P. weirii (laminated root rot) 386, 398
Phlebiopsis (= *Peniophora*) *gigantea* (Steriales: Meruliaceae) 387
Phyllophaga (Coleoptera: Scarabaeidae) 364
 Phylloxeridae (phylloxera or phylloxerans) 359
Phytophthora cinnamomi (Peronosporales; littleleaf disease) 332, 381, 389, 395, 398
Picea (Pinaceae; spruces) 3, 9–10, 13–15, 19, 26, 28, 38, 51, 62–3, 99–101, 107, 125, 128, 130–1, 140–1, 210, 219, 228, 347–8, 365–6, 397, 482
P. abies (Norway spruce) 15, 204, 287, 299, 301, 303, 305, 310
P. engelmannii (Engelmann spruce) 26, 129–30, 285, 302, 311
P. glauca (white spruce) 128, 132, 208, 210, 301
P. mariana (black spruce) 15, 208, 230, 283, 285
P. pungens (Colorado spruce) 26
P. rubens (red spruce) 300
P. sitchensis (Sitka spruce) 256, 300, 304, 432

- Picoides borealis* (Picidae; red-cockaded woodpecker) 37
- Pineae* (subsection of *Pinus*) 4, 54, 56–7, 60–4, 84, 154, 359
- Pinus* (Homoptera: Phylloxeridae) 359, 367
- P. pini* (Homoptera; pine woolly aphid) 371–2
- Pinus* (section of *Pinus*) 51, 64, 477
- Pinus* (subsection of *Pinus*) 4, 8, 12, 54–5, 57, 59–64, 71, 76, 79, 82, 84–5, 95, 122, 154, 258, 283, 358–60
- Pinus* (subgenus of *Pinus*; diploxylon or hard pines) 4, 49, 56–7, 59–64, 71, 107, 346–7, 358–60, 367, 477
- Pinus* (Pinaceae; pines)
- fossil pollen 141
 - origin and evolution 3–9, 69–86, 95
 - position within Pinaceae 50–1
 - P. adunea* – see *P. radiata* 434
 - P. albicaulis* 130, 250
 - age distribution 222
 - cone morphology 5, 285
 - co-occurring tree taxa 26, 227
 - diseases 31, 35, 397
 - distribution (natural) 5, 128, 186
 - fire adaptations 240
 - fossil record 131
 - genetic diversity 265
 - habitat 5, 16, 130
 - juvenile period 282
 - needle
 - longevity 5
 - morphology 5
 - pollination 285
 - postglacial migrations 131
 - seed(s)
 - biology 285
 - dispersal 238, 260–1, 290–1
 - food for animals 397
 - morphology 240, 285, 286
 - predation 292
 - stand structure 261
 - succession, role in 227
 - systematics and taxonomy 64–5
 - timberline 16
 - water relations 303
 - P. allisonii*# 76
 - P. alvordensis*# 76
 - P. amamiana* – see *P. armandii* var. *amamiana*
 - P. andersonii*# 76
 - P. anthravirus*# 79
 - P. apecheca* – see *P. engelmannii*
 - P. apulcensis* – see *P. pseudostrobus* var. *apulcensis*
 - P. aristata* 250, 354
 - afforestation 422
 - conductance, stomatal 298
 - cone morphology 5
 - distribution (natural) 5, 183
 - drought-tolerance 310
 - fire adaptations 240
 - genetic diversity 265
 - habitat 5, 16
 - human uses of 424
 - insect fauna 358, 360
 - juvenile period 282
 - longevity (whole-tree) 10
 - needle
 - longevity 5, 310
 - morphology 5
 - photosynthesis 298, 302
 - seed
 - dispersal 239
 - morphology 286
 - size (height) 5
 - stand structure 221
 - systematics 64–5
 - timberline 16, 221
 - P. arizonica* – see *P. ponderosa* var. *arizonica*
 - P. armandii*
 - afforestation 422
 - cone morphology 5
 - conservation status 37
 - co-occurring tree taxa 20
 - distribution (natural) 5, 188
 - habitat 5, 20
 - human uses of 424
 - insect fauna (in Canada and USA) 359
 - juvenile period 282
 - needle
 - longevity 5
 - morphology 5
 - seed
 - dispersal 20, 291
 - morphology 57, 286
 - size (height) 5
 - stand structure 20
 - systematics 64–5
 - P. armandii* var. *amamiana* 37, 65
 - P. armandii* var. *armandii* 65
 - P. armandii* var. *mastersiana* 37, 65
 - P. arnoldii*# 76
 - P. attenuata* 250
 - afforestation 422
 - climate 283
 - cone
 - morphology 5
 - serotiny 223, 226–7, 230, 283
 - distribution (natural) 5, 21, 186, 434
 - fire adaptations 223, 240
 - genetic diversity 265
 - habitat 5
 - hybridization 58
 - insect fauna 358, 360
 - juvenile period 282
 - needle
 - longevity 5
 - morphology 5
 - regeneration 230–1
 - reproductive system
 - linkage 254
 - segregation 254
 - seed
 - germination 236
 - morphology 286
 - size (height) 5
 - species/provenance trials 420
 - succession, role in 221
 - systematics 58, 64–5
 - P. australis* – see *P. palustris*
 - P. avonensis*# 79
 - P. ayacahuite* 84
 - afforestation 422, 468
 - cone morphology 5, 11, 57
 - conservation status 37
 - co-occurring tree taxa 24
 - distribution (natural) 5, 24, 186–7
 - fire suppression 28
 - genetic diversity 265
 - habitat 5, 24, 233
 - human uses of 424
 - insect fauna 358, 360, 366
 - needle
 - longevity 5
 - morphology 5
 - seed
 - dispersal 291
 - morphology 260
 - size (height) 5, 10
 - species/provenance trials 420
 - systematics 64–5
 - P. ayacahuite* var. *brachyptera* – see *P. ayacahuite* var. *strobiformis*
 - P. ayacahuite* var. *ayacahuite* 65, 260
 - P. ayacahuite* var. *novogaliciana* 65
 - P. ayacahuite* var. *strobiformis* 28, 65, 84, 186–7, 260, 265, 287, 291, 358, 360, 366
 - P. ayacahuite* var. *veitchii* 65, 261
 - P. bahamensis* – see *P. caribaea* var. *bahamensis*
 - P. balfouriana* 250
 - afforestation 422
 - cone morphology 5
 - conservation status 37
 - co-occurring tree taxa 26
 - distribution (natural) 5, 186
 - fire adaptations 240
 - genetic diversity 265
 - habitat 5, 16
 - insect fauna 358, 360
 - juvenile period 282
 - longevity (whole-tree) 10
 - needle
 - longevity 5
 - morphology 5
 - seed morphology 286

- Pinus* (Pinaceae; pines) (cont.)
- P. balfouriana* (cont.)
 size (height) 5
 stand structure 16
 systematics 64–5
 timberline 16, 26
- P. balfouriana* subsp. *austrina* 37
- P. balfouriana* subsp. *balfouriana* 37
- P. balfouroides*# 76, 79
- P. ballii*# 76
- P. banksiana* 38, 84, 86, 122, 132, 250, 354
 afforestation 422, 455
 climate 283
 cold-tolerance 125
 conductance, stomatal 298
 cone
 morphology 5
 serotiny 210, 223, 227, 283
 co-occurring tree taxa 14–15, 208, 210
 diseases 384, 390
 distribution (natural) 5, 126, 186–7, 189, 199
 fire
 adaptations 223, 240
 ecology 15
 regime 208–11, 229–30
 sensitivity 210
 fungi (mycorrhizal) 327
 genetic diversity 133, 265, 271
 glacial refuges 142
 habitat 5, 15, 17, 123–4, 126–7
 hybridization 58, 127
 insect
 fauna 355, 358, 360
 herbivory 370
 outbreaks 368
 pests 364, 368, 372–3
 invader, as 457, 462
 juvenile period 282
 longevity (whole-tree) 230
 mating system 255–7
 outcrossing estimates 256
 needle
 longevity 5
 morphology 5
 photosynthesis 298, 301
 pollen 123, 126
 population growth rates 127–8
 postglacial migrations 8–9, 123–5, 127, 132, 271
 regeneration 15, 29
 seed
 dispersal 125
 germination 236
 morphology 286
 size (height) 5
 soils 15, 126, 208, 348
 species/provenance trials 420
 stand structure 15, 208, 229–30
 succession, role in 15, 17, 210–11
 systematics 58, 64–5
 wildlife habitat 37, 210
- P. belgica*# 70–1
- P. bhutanica*
 cone morphology 5
 conservation status 37
 co-occurring tree taxa 20
 distribution (natural) 5
 habitat 5, 20
 needle
 longevity 5
 morphology 5
 size (height) 5
 systematics 64–5
- P. bifoliata*# 71
- P. bolanderi* – see *P. contorta* subsp. *bolanderi*
- P. brutia* 250
 afforestation 158, 453
 ancient plantings 31
 bark 223
 climate 283
 conductance, stomatal 298
 cone
 morphology 5
 serotiny 223, 230, 283
 conservation status 37
 co-occurring tree taxa 155, 163
 distribution
 adventive 31, 412
 natural 5, 21, 31, 153, 154–5, 189, 261, 412
 étage 160
 fire
 adaptations 223, 240
 regime 207
 genetic diversity 265
 habitat 5, 160, 161
 human uses of 410
 insect fauna (in Canada and USA) 359
 introgression 259
 invader, as 453
 juvenile period 282
 needle morphology 5
 photosynthesis 298
 pollen 162
 range expansions (Holocene) 162–3, 409
 seed
 dispersal 261, 290
 morphology 286
 self-pruning 223
 size (height) 5
 soils 159–60
 succession, role in 164
 systematics 55, 57, 60–1, 64–5, 158
- P. brutia* subsp. *brutia* 64
- P. brutia* subsp. *eldarica* 31, 37, 64, 158, 261, 298
- P. brutia* subsp. *pityusa* 37, 64
- P. brutia* subsp. *stankewiczii* 64
- P. buchananii*# 79
- P. bungeana* 85
 afforestation 422
 cone morphology 5
 conservation status 20, 37
 co-occurring tree taxa 20
 distribution (natural) 5
 growth form 10
 habitat 5
 human uses of 412
 needle
 longevity 5
 morphology 5
 seed
 dispersal 291
 morphology 286
 size (height) 5
 systematics 61, 64–5
 wood anatomy 56
- P. californiana* 433–4
 see also *P. radiata*
- P. californiarum* – see *P. monophylla* subsp. *californiarum*
- P. californiarum* subsp. *fallax* – see *P. monophylla* subsp. *fallax*
- P. canariensis*
 afforestation 422
 bark 223
 cone morphology 5
 conservation status 37
 distribution (natural) 5, 21, 155–6
 étage 160
 fire adaptations 223
 habitat 5, 160, 161
 hybridization 59
 insect fauna (in Canada and USA) 359
 invader, as 457–8, 460
 juvenile period 282
 needle
 longevity 5
 morphology 5, 13
 resprouting 223, 226, 251
 systematics 59, 61, 64–5
 wood anatomy 57
- P. caribaea* 462
 afforestation 421–2
 cone
 morphology 5
 ripening 284
 conservation status 37
 diseases 382
 distribution (natural) 5, 22, 143
 fire regime 23, 28, 211–12
 fossil record 141
 genetic diversity 265
 habitat 5, 138
 human uses of 424
 hybridization 59, 145
 insect fauna (in Canada and USA) 359
 invader, as 454, 456–8

- mating system
 outcrossing estimates 256
- needle
 longevity 5, 13
 morphology 5, 12
 plantations 212, 432
 postage stamp, depicted on 427
 seedlings 225
 size (height) 5, 10
 soils 22
 species/provenance trials 420
 systematics 59, 64–5
- P. caribaea* var. *bahamensis* 267
- P. caribaea* var. *caribaea* 37
- P. caribaea* var. *hondurensis* 10, 138, 143, 212, 284, 382, 456
- P. caribaea* × *P. elliottii* 469
- P. catarinae* – see *P. remota*
- P. cembra* 250, 462
 afforestation 422
 cold-tolerance 112, 307–9
 cone morphology 5
 diseases 390
 distribution (natural) 5, 107–8, 189
 fire adaptations 240
 fossil record 113
 genetic diversity 265
 habitat 5, 16, 18
 herbivore pressure 30
 human pressure 29
 human uses of 29, 34, 409, 424
 insect
 fauna (in Canada and USA) 359
 fauna (in natural range) 366
 pests 368
 juvenile period 282
 logging of 29
 longevity (whole-tree) 10
 mating system
 outcrossing estimates 256
- needle
 longevity 5, 13
 morphology 5
 photosynthesis 298, 308–9
 regeneration 29, 30
- seed
 dispersal 222, 290
 food for humans 34, 409, 418
 size (height) 5
 soils 18, 107
 stand structure 107, 111
 succession, role in 222
 systematics 51, 64–5
 timberline 16–17, 107, 111, 222, 308–10
 water relations 305
- P. cembroides* 180, 250, 462
 afforestation 422
 cone morphology 5
 conservation status 37
 co-occurring tree taxa 17
- discovery 171
 distribution (natural) 5, 23, 171, 186–7
- fire
 adaptations 240
 sensitivity 223
 habitat 5, 23, 138
 human uses of 23, 424
 insect fauna 358, 360
- needle
 longevity 5
 morphology 5
 seed morphology 284, 286
 size (height) 5
 stand structure 23
 systematics 64–5
- P. cembroides* subsp. *cembroides* 65
- P. cembroides* subsp. *lagunae* 37, 65, 138
- P. cembroides* subsp. *orizabensis* 37, 65
- P. cembroides* var. *remota* – see *P. remota*
- P. cembroides* var. *lagunae* – see *P. cembroides* subsp. *lagunae*
- P. chiapensis* 84
 afforestation 422, 468
 cone morphology 5
 conservation status 29, 37
 distribution (natural) 5
 habitat 5, 233
 herbivore pressure
 grazing 29
 human uses of 424
 logging of 29
 needle morphology 5
 regeneration 29
 size (height) 5
 species/provenance trials 420
 systematics 64–5
- P. chihuahuana* – see *P. leiophylla* var. *chihuahuana*
- P. clausa* 84, 250
 afforestation 422
 climate 283
 cone
 morphology 5
 serotiny 223, 229, 283
 co-occurring tree taxa 22
 distribution (natural) 5, 189
- fire
 adaptations 223, 240
 regime 28, 230
 suppression 28
- habitat 5
 human pressure 28
 hybridization 58
 insect fauna 358, 360
 juvenile period 282
 needle morphology 5
 postglacial migrations 124
 resprouting 223, 226
 seed morphology 286
- size (height) 5
 systematics 58, 64–5
- P. clausa* var. *clausa* 64
- P. clausa* var. *immuginata* 64
- P. clementsii*# 71, 139
- P. cliffwoodensis*# 71
- P. contorta* 38, 84–6, 122, 132, 250, 269–70, 354
 afforestation 415, 422, 455
 bark 206
 climate 283
 cold-tolerance 300, 309, 311, 445
 conductance, stomatal 298, 300, 311
 cone
 morphology 5
 serotiny 206, 210, 227, 283
 co-occurring tree taxa 14, 204
 disease(s) 204, 206, 383, 386, 389–90
 resistance 386
 distribution
 determinants of 25, 26
 natural 5, 26–7, 128, 186, 189, 199, 204
 adventive 211
- fire
 regime 28, 198, 204–6, 212–13
 scars 205
 sensitivity 196
- fungi (mycorrhizal) 329–30
- genetic diversity 9, 127, 132, 262, 265
- habitat 5, 17
- herbivore pressure
 browsing 28
 grazing 28, 469
- human uses of 424
- hybridization 58, 127
- insect
 fauna 355, 358, 360, 363
 herbivory 368, 370
 outbreaks 204–5, 368
 pests 372–3
- invader, as 211, 372, 454, 456–8, 462, 469
- juvenile period 282
- longevity (whole-tree) 204
- mating system 255–7
 outcrossing estimates 256
- needle morphology 5, 12
- phenology 445
- photosynthesis 14, 297–8, 300, 302, 309, 311, 315
- plantations 390
- pollen
 dispersal 264
 production 122
- pollination 282
- postglacial migrations 8–9, 262, 271
- regeneration 386
- reproductive system
 linkage 254
- respiration 306

- Pinus* (Pinaceae; pines) (cont.)
- P. contorta* (cont.)
- roots 206
 - seed
 - biology 285
 - dispersal 260–1, 288–9
 - morphology 286, 288
 - predation 237, 291
 - production 206
 - seedlings 206
 - size (height) 5
 - soils 204, 372
 - specific leaf area 296–7
 - stand structure 206, 368
 - succession, role in 128, 204, 368–9
 - systematics 58, 61, 64–5
 - timberline 16
 - water relations 302–3, 305–6, 311
- P. contorta* subsp. *bolanderi*
- cone
 - morphology 5
 - serotiny 229–30
 - co-occurring tree taxa 21
 - distribution (natural) 5, 21, 27
 - genetic diversity 27, 271
 - habitat 5, 27, 229
 - needle morphology 5, 12
 - size (height) 5
 - soils 27
 - systematics 64–5
- P. contorta* subsp. *contorta* 229
- cone morphology 5
 - distribution (natural) 5, 20, 27, 126
 - habitat 5, 17, 27
 - needle morphology 5, 12
 - postglacial migrations 128–30
 - size (height) 5
 - systematics 64–5
- P. contorta* subsp. *latifolia* 250
- cone serotiny 223, 227–8, 237
 - diseases 384
 - distribution (natural) 5, 26–7, 126
 - drought 228
 - fire
 - adaptations 223, 240
 - ecology 196
 - regime 228
 - genetic diversity 27, 129
 - habitat 5, 17, 126–7, 129
 - needle morphology 5
 - pollen data 126
 - population growth rates 9
 - postglacial migrations 127–30, 133
 - seed
 - dispersal 129, 283, 290
 - predation 237
 - size (height) 5
 - soils 16
 - stand structure 227–8
 - succession, role in 228
 - systematics 64–5
- P. contorta* subsp. *murrayana* 16, 286
- cone
 - characteristics 227
 - morphology 5
 - co-occurring tree taxa 227
 - diseases 384
 - distribution (natural) 5, 27
 - fire
 - adaptations 238
 - regime 227, 238–9
 - habitat 5, 17, 227
 - herbivore pressure 238
 - longevity (whole-tree) 10–11, 227
 - needle morphology 5
 - size (height) 5
 - soils 227
 - stand structure 16, 26–7, 227
 - succession, role in 227
 - systematics 64–5
 - timberline 16
- P. contorta* × *P. banksiana* 314
- P. cooperi* 138
- afforestation 422
 - cone morphology 5
 - distribution (natural) 5
 - habitat 5
 - needle morphology 5, 12
 - size (height) 5
 - species/provenance trials 420
 - systematics 64–5
- P. coulteri* 462
- afforestation 422
 - bark 223
 - branching 229
 - cone
 - morphology 5, 11, 238
 - serotiny 21, 223, 227, 229
 - distribution (natural) 5, 21
 - fire
 - adaptations 223
 - regime 239
 - genetic(s)
 - diversity 262, 265
 - heterozygosity 262
 - habitat 5
 - human uses of 34, 409, 424
 - hybridization 58–9
 - insect fauna 358, 360
 - juvenile period 282
 - needle
 - longevity 5
 - morphology 5
 - Pleistocene 262
 - pollen
 - dispersal 268
 - pollution, impacts of 314
 - seed
 - dispersal 196, 234, 262, 284
 - food for humans 34, 409, 414
 - morphology 240, 290
 - size (height) 5, 238
 - systematics 59, 61, 64–5
 - water relations 302
- P. crossii*# 8, 76, 79
- P. cubensis* 84
- afforestation 422
 - cone morphology 5
 - conservation status 37
 - distribution (natural) 5, 23
 - fire regime 23
 - habitat 5
 - needle morphology 5
 - postage stamp, depicted on 427
 - systematics 64–5
- P. culminicola*
- cone morphology 5
 - conservation status 37
 - distribution (natural) 5, 24, 137
 - habitat 5
 - needle morphology 5
 - size (height) 5
 - systematics 64–5
- P. dabeshanensis*
- cone morphology 5
 - conservation status 37
 - distribution (natural) 5
 - habitat 5
 - needle morphology 5
 - size (height) 5
 - systematics 64–5
- P. dailatensis*
- cone morphology 5
 - conservation status 37
 - distribution (natural) 5, 25
 - habitat 5
 - needle morphology 5
 - systematics 64–5
- P. delmarensis*# 76
- P. densa* – see *P. elliotii* var. *densa*
- P. densata*
- cone morphology 5
 - diseases 382
 - distribution (natural) 5
 - genetic diversity 265
 - habitat 5, 16
 - hybridization 259
 - needle
 - longevity 5
 - morphology 5
 - size (height) 5
 - systematics 60, 64–5
- P. densiflora* 85
- afforestation 422
 - cone morphology 5
 - distribution (natural) 5, 101–2, 188
 - fire regime 197
 - genetic diversity 265
 - habitat 5, 19
 - human uses of 412, 424
 - insect fauna (in Canada and USA) 359
 - juvenile period 282

- needle
 longevity 5
 morphology 5
 origin 95
 plantations 456
 range expansions (late Holocene) 30, 102
 regeneration 30
 size (height) 5
 succession, role in 234
 systematics 64–5
- P. densiflora* var. *funnebris* 64
- P. densiflora* var. *densiflora* 64
- P. devoniana* 138–9, 142, 146
 afforestation 422
 bark 223
 cone morphology 5, 11
 distribution (natural) 5, 24
 fire
 adaptations 223
 regime 24
 habitat 5, 24
 hybridization 59, 143
 needle morphology 5
 seed dispersal 284
 seedlings
 grass stage 144, 223, 225
 self-pruning 223
 size (height) 5
 species/provenance trials 420
 stand structure 24
 systematics 59–60, 64–5
- P. discolor*
 cone morphology 5
 distribution (natural) 5, 175
 fossil record 175
 growth form 171
 habitat 5
 insect fauna 358, 360
 needle morphology 5
 size (height) 5
 systematics 64–5
- P. donnell-smithii* 138
 cone morphology 5
 co-occurring tree taxa 24
 distribution (natural) 5, 24
 habitat 5
 needle morphology 5, 12
 size (height) 5
 systematics 64–5
- P. douglasiana* 138
 afforestation 422
 cone morphology 5
 distribution (natural) 5
 habitat 5
 needle morphology 5
 seed dispersal 284
 size (height) 5
 species/provenance trials 420
 systematics 64–5
- P. driftwoodensis*# 76
- P. durangensis* 138
 cone morphology 5
 distribution (natural) 5
 habitat 5
 needle morphology 5, 12, 56
 seed dispersal 284
 size (height) 5
 species/provenance trials 420
 stand structure 138
 systematics 64–5
- P. echinata* 250, 354
 afforestation 422
 bark 223
 cone morphology 5
 co-occurring tree taxa 22
 diseases 389, 391
 distribution (natural) 5, 189
 fire adaptations 223, 240
 fungi (mycorrhizal) 332
 genetic diversity 265
 habitat 5, 17–18
 human uses of 424
 hybridization 58
 insect fauna 358, 360
 juvenile period 282
 mating system 255
 needle
 longevity 5
 morphology 5, 56
 postglacial migrations 124
 resprouting 223, 225–6, 251
 seed
 dispersal 289
 production 261
 self-pruning 223
 size (height) 5
 soils 22
 succession, role in 17
 systematics 64–5
 water relations 303
 wildlife habitat 37
- P. edulis* 250, 462
 afforestation 422
 conductance, stomatal 307
 cone
 morphology 5
 production 236
 co-occurring tree taxa 174
 diseases 388
 distribution
 determinants of 26
 natural 5, 22, 173, 186, 261
 drought stress 374
 fire
 adaptations 240
 suppression 28
 fossil record 174
 genetic diversity 265
 growth form 171
 growth rates 307
 habitat 5
- herbivore pressure
 grazing 28
 human pressure 29, 174
 human uses of 29
 hybridization 22, 172, 174–5, 178
 insect
 fauna 358, 360
 herbivory 236–7
 pests 368, 374
 juvenile period 282
 logging/clearing 411
 needle
 longevity 5
 morphology 5
 pollen dispersal 263
 pollination 282
 range expansions (Holocene) 173–5, 409–10
 range expansions (20th century) 179
 roots 303–4, 311
 seed dispersal 171, 175, 260–1, 290
 size (height) 5
 stand structure 22, 26
 systematics 64–5
 water relations 303, 306–7
 wood as fuel 29
- P. edulis* × *P. monophylla* 171
- P. eldarica* – see *P. brutia* subsp. *brutia*
- P. elliotii* 38, 250
 afforestation 30, 31, 419, 422, 453
 bark 223
 conductance, stomatal 298
 cone
 morphology 5
 production 236
 co-occurring tree taxa 201
 diseases 36, 391, 395–6
 distribution
 natural 5, 22, 189
 adventive 423
 domestication 271
 drought stress 236
 fire
 adaptations 223, 240
 regime 22, 28
 suppression 28
 habitat 5, 234
 human uses of 415, 424
 hybridization 58
 insect fauna 358, 360
 introgression 144
 invader, as 454, 456–7, 461–2
 juvenile period 282
 mating system 256
 mutation system 268
 needle
 longevity 5
 morphology 5
 photosynthesis 298–9, 302, 312
 plantations 212, 423, 452
 pollen dispersal 263–4, 264

- Pinus* (Pinaceae; pines) (cont.)
- P. elliotii* (cont.)
- pollination 282
 - postglacial migrations 124
 - regeneration 234
 - reproductive system 253
 - respiration 306
 - seed
 - dispersal 291, 461–2
 - morphology **286**
 - seedlings
 - grass stage 144, 223, 225
 - size (height) 5
 - species/provenance trials 420
 - stand structure 23
 - systematics 64–5
 - wildlife habitat 37
- P. elliotii* var. *densa* 23, 144, 223, **240**, 250
- P. elliotii* var. *elliotii* **240**, 284
- P. elliotii* × *P. tecunumanni* 469
- P. engelmannii* 138, 144, 250, 354, **462**
- afforestation 422
 - cone morphology 5
 - distribution (natural) 5, 23
 - fire adaptations **240**
 - genetic diversity 265
 - habitat 5, 23
 - hybridization 59
 - insect fauna 358, 360
 - juvenile period 282
 - mating system
 - outcrossing estimates 256
 - needle morphology 5
 - seedlings
 - grass stage 144
 - seed morphology **286**
 - size (height) 5
 - species/provenance trials 420
 - stand structure 138
 - systematics 59, 64–5
- P. escalantis*[#] 79
- P. estevezii* – see *P. pseudostrobus* var. *estevezii*
- P. excelsa* – see *P. wallichiana*
- P. fenzliana*
- cone morphology 5
 - conservation status 37
 - distribution (natural) 5, 20, **188**
 - habitat 5
 - needle morphology 5
 - size (height) 5
 - systematics 64–5
- P. flabellifolia*[#] 71
- P. flexilis* 85, 250, **462**
- cone morphology 6
 - co-occurring tree taxa 26
 - diseases 397
 - distribution (natural) 6, **186**
 - drought-tolerance 310
 - ecophysiology 39
 - fire adaptations **240**
 - fossil record 131
 - genetic diversity 265
 - habitat 6, 16, 127
 - insect fauna 358, 360
 - juvenile period 282
 - longevity (whole-tree) 10
 - needle
 - longevity 6
 - morphology 6, 12
 - pollen release 263
 - postglacial migrations 128
 - roots 303
 - seed
 - dispersal 238–9, 260, 288, 291
 - mast seeding 283
 - morphology 57, **286**
 - size (height) 6
 - stand structure 127
 - succession, role in 128, 221–2
 - systematics 64–5
 - timberline 221
- P. flexilis* var. *macrocarpa* – see *P. ayacahuite* var. *strobiformis*
- P. florissantii*[#] 76
- P. funebris* – see *P. densiflora* var. *funebris*
- P. gerardiana* 85
- afforestation 422
 - cone morphology 6
 - conservation status 29, 37
 - co-occurring tree taxa 20
 - distribution (natural) 6, **188**
 - habitat 6
 - human uses of 29, 34, 424
 - insect fauna (in Canada and USA) 359
 - needle morphology 6
 - regeneration 29
 - seed
 - dispersal 291
 - food for humans 34, 409, 418
 - harvesting 29
 - morphology **286**
 - size (height) 6
 - systematics 61, 64–5
 - tree breeding 418
- P. glabra*
- cone morphology 6
 - distribution (natural) 6, **189**
 - fire regime 234
 - habitat 6
 - insect fauna 358, 360
 - longevity (whole-tree) 234
 - needle
 - longevity 6
 - morphology 6, 12
 - regeneration 34
 - seed morphology **286**
 - size (height) 6
 - systematics 64–5
- P. greggii*
- afforestation 422, 468
 - bark 223
 - climate 283
 - cone
 - morphology 6
 - serotiny 223, 230, 283
 - conservation status 37
 - distribution (natural) 6
 - fire adaptations 223
 - habitat 6
 - hybridization 58
 - needle
 - longevity 6
 - morphology 6
 - size (height) 6
 - species/provenance trials 420
 - systematics 58–9, 64–5
- P. greggii* × *P. radiata* 469
- P. griffithii* – see *P. wallichiana*
- P. halepensis* 250, 410
- afforestation 158, 419, 421–2, 452–3, 455
 - bark 207, 223
 - climate 283
 - cone
 - morphology 6
 - serotiny 223, 230, 283
 - co-occurring woody plants 107, 155, 163, 165
 - distribution
 - natural 6, 21, **153–5**, **189**, **199**, 206, 261
 - adventive 211
 - drought-tolerance 160
 - étage* **160**
 - fire
 - adaptations 223, **240**
 - ecology 164, **230**
 - regime 206–8, 230
 - sensitivity 207
 - genetic diversity 265
 - growth rates 207
 - habitat 6, **160**, 161
 - herbivore pressure 207
 - human pressure 417
 - human uses of 409–10, 415, 424
 - insect
 - fauna (in Canada and USA) 359
 - outbreaks 166
 - introgression 259
 - invader, as 165, 211, 453–4, 455–8, **461–2**, **464**
 - invasion of abandoned fields **164**
 - juvenile period 282
 - needle
 - longevity 6
 - morphology 6
 - plantations 30
 - pollen data 162, 409
 - postage stamp, depicted on **427**
 - range contractions 162
 - range expansions (late Holocene) 33, 158, 162–3, 409

- range expansions (20th century) 30, 165
- seed
 dispersal 207, 262, 283–4
 germination 236
 morphology 286
- seedlings 207, 230
- self-pruning 223
- size (height) 6
- soils 107, 159–60, 206–7
- stand structure 21, 155, 208, 212
- succession, role in 163–4, 207–8
- systematics 55, 57, 60, 64–5, 158, 412
- P. halepensis* var. *brutia* – see *P. brutia*
- P. harborensis*# 71
- P. hartwegii* 138, 144
 afforestation 422
 cone morphology 6
 co-occurring tree taxa 24
 distribution (natural) 6, 24
 habitat 6, 24
 hybridization 59
 needle morphology 6
 seed dispersal 284
 size (height) 6, 10
 species/provenance trials 420
 stand structure 138
 systematics 58–9, 64–5
 timberline 24
- P. heldreichii*
 afforestation 422
 canopy architecture 13
 cone morphology 6
 conservation status 37
 co-occurring tree taxa 18
 distribution (natural) 6, 107, 109, 156–7
 étage 160
 genetic diversity 265
 habitat 6, 18, 160, 161
 insect fauna (in Canada and USA) 359
 longevity (whole-tree) 11
 mating system
 outcrossing estimates 256
 needle
 longevity 6
 morphology 6, 12
 seed
 germination 236
 morphology 286
 size (height) 6
 soils 19, 160
 stand structure 161
 systematics 63–5
 timberline 16, 161
- P. heldreichii* var. *heldreichii* 37
- P. heldreichii* var. *leucodermis* 18–19, 37, 156, 236, 256, 265, 422
- P. henryi* – see *P. massoniana* var. *henryi*
- P. herrerae* – see *P. herrerae*
- P. herrerae*
 afforestation 422, 468
 cone morphology 6
 distribution (natural) 6
 habitat 6
 needle morphology 6
 size (height) 6
 species/provenance trials 420
 systematics 64–5
- P. himekomatsu* – see *P. parviflora* var. *parviflora*
- P. hokkaidoensis*# 71
- P. hwangshanensis*
 cone morphology 6
 distribution (natural) 6, 20
 habitat 6
 needle morphology 6
 size (height) 6
 systematics 61, 64–5
- P. insignis* – see *P. radiata* 434
- P. insularis* – see *P. kesiya* / *P. kesiya* var. *insularis*
- P. jaltiscana*
 bark 223
 cone
 morphology 6
 serotiny 223, 230, 283
 distribution (natural) 6
 fire adaptations 223
 habitat 6
 needle morphology 6
 size (height) 6
 systematics 64–5
- P. jeffreyi* 138, 241, 250
 afforestation 422
 bark 223
 cold-tolerance 232
 conductance, stomatal 298, 313
 cone morphology 6
 co-occurring tree taxa 25, 227
 diseases 388–9
 distribution
 determinants of 25
 natural 6, 25
 drought stress 311
 fire adaptations 223, 240
 genetic diversity 9, 265
 growth rates 307
 habitat 6, 17
 human uses of 416, 418
 hybridization 58–9
 insect fauna 358, 360
 invader, as 456–7
 juvenile period 282
 longevity (whole-tree) 10
 mating system, outcrossing estimates 256
 needle
 longevity 6
 morphology 6
 photosynthesis 298, 310–11, 313–14
- pollen dispersal 264
- pollution, impacts of 32, 313–14
- postglacial migrations 263
- reproductive system
 linkage 254
- seed
 dispersal 238, 262, 285, 292
 mast seeding 282
 morphology 286
 predation 238, 291
 self-pruning 223
 size (height) 6, 10
 species/provenance trials 420
 succession, role in 227, 232
 systematics 59, 61, 64–5
 water relations 303, 311
- P. johannis*
 cone morphology 6
 distribution (natural) 6
 habitat 6, 138
 needle morphology 6
 size (height) 6
 systematics 64–5
- P. juarezensis* 172
 cone morphology 6
 distribution (natural) 6
 growth form 171
 habitat 6, 138
 hybridization 172, 175–6
 insect fauna 358, 360
 needle morphology 6, 12
 size (height) 6
 systematics 64–5
- P. juarezensis* × *P. monophylla* 176, 250
 cone morphology 6
 distribution (natural) 6
 fire adaptations 240
 habitat 6, 138
 needle morphology 6, 12
 seed morphology 287
 size (height) 6
 systematics 64–5
- P. kesiya*
 afforestation 422, 457
 cone morphology 6
 distribution (natural) 6, 24–5, 188
 fire regime 25, 28, 211
 habitat 6, 20
 human pressure 25
 human uses of 424
 insect fauna (in Canada and USA) 359
 invader, as 468
 juvenile period 282
 needle
 longevity 6
 morphology 6, 12
 regeneration 30
 seed morphology 286
 size (height) 6
 species/provenance trials 420
 stand structure 25

- Pinus* (Pinaceae; pines) (cont.)
- P. kesiya* (cont.)
 systematics 61, 64–5
- P. kesiya* var. *insularis* 64
- P. kesiya* var. *langbianensis* 64
- P. kesiya* var. *kesiya* 64
- P. khasia* – see *P. kesiya*
- P. khasya* – see *P. kesiya*
- P. koraiensis*
 afforestation 422
 cone
 harvesting 29
 morphology 6
 co-occurring tree taxa 19
 distribution (natural) 6, 101–2, 188
 fossil record 102
 genetic diversity 265
 habitat 6, 19
 human pressure 29, 34
 human uses of 29, 34, 409, 424
 insect fauna (in Canada and USA) 359
 juvenile period 282
 logging/land clearing 29
 mating system
 outcrossing estimates 256
 needle
 longevity 6
 morphology 6
 range expansions (Holocene) 100
 seed
 dispersal 29, 222, 238, 290–2
 food for humans 34, 409, 418
 harvesting 29
 morphology 286
 size (height) 6
 stand structure 19
 succession, role in 222
 systematics 64–5
 timberline 222
- P. krempffii* 49
 cone morphology 6
 distribution (natural) 6, 25, 84
 habitat 6
 needle morphology 6, 12, 54
 size (height) 6
 systematics 54, 59, 62, 64–5
- P. kwangtungensis* – see *P. fenzeliana*
- P. lagunae* – see *P. cembroides* subsp. *lagunae*
- P. lambertiana* 241, 250, 462
 afforestation 422
 bark 223
 cone morphology 6, 11, 57
 co-occurring tree taxa 198, 200
 disease(s) 31, 35, 396
 resistance 396
 distribution (natural) 6, 186
 fire
 adaptations 240
 sensitivity 196, 233
 genetic diversity 265, 270
- habitat 6, 17
 human uses of 34, 409, 424
 insect fauna 358, 360
 invader, as 456
 juvenile period 235, 282
 needle
 longevity 6
 morphology 6
 pollution, impacts of 314
 recombination system 258
 seed
 dispersal 288–9
 food for humans 34, 409
 morphology 240, 284–5, 286–7
 predation 238
 seedlings 233
 self-pruning 223
 shade tolerance 233
 size (height) 6, 10, 233
 succession, role in 232
 systematics 64–5
- P. laricio* – see *P. nigra* subsp. *laricio*
- P. latteri* – see *P. merkusii*
- P. lawsonii*
 afforestation 422
 cone morphology 6
 distribution (natural) 6
 habitat 6
 hybridization 59
 needle morphology 6, 12
 size (height) 6
 systematics 58–9, 64–5
- P. leiophylla* 250
 afforestation 422, 468
 bark 223
 cone
 morphology 6
 serotiny 223, 227, 230
 co-occurring tree taxa 17
 distribution (natural) 6, 186–7
 fire adaptations 223, 240
 habitat 6
 insect fauna 358, 360
 juvenile period 282
 needle
 longevity 6
 morphology 6
 resprouting 24, 223
 seed
 development 234
 morphology 286
 self-pruning 223
 size (height) 6
 species/provenance trials 420
 stand structure 138
 systematics 61–2, 64–5
- P. leiophylla* var. *leiophylla* 65
- P. leiophylla* var. *chihuahuana* 23, 65, 282, 286, 360
- P. leucodermis* – see *P. heldreichii* var. *leucodermis*
- P. longaeva*
 cold-tolerance 309
 cone morphology 6
 conservation status 37
 dendrochronology 11
 diseases 385
 distribution (natural) 6
 genetic diversity 265
 habitat 6, 16
 longevity (whole-tree) 10–11, 221, 385
 needle
 longevity 6, 13, 310
 morphology 6
 photosynthesis 308
 seed
 dispersal 291
 production 283
 seedlings 221
 size (height) 6
 soils 221
 stand structure 11
 systematics 60, 64–5
 timberline 16, 221, 308
- P. longifolia* – see *P. roxburghii*
- P. luchuensis*
 afforestation 422
 cone morphology 6
 conservation status 37
 diseases 391, 398
 distribution (natural) 6
 habitat 6
 needle morphology 6
 size (height) 6
 systematics 64–5
- P. lumholtzii*
 afforestation 422
 cone morphology 6
 distribution (natural) 6, 23
 habitat 6, 23
 needle morphology 6, 12
 size (height) 6
 systematics 62, 64–5
- P. macvaughii* – see *P. jaliscana*
- P. maestrensis* – see *P. cubensis*
- P. magothenis*# 71
- P. matkopiae*# 79
- P. maritima* – see *P. pinaster*
- P. martinezii* – see *P. durangensis*
- P. massoniana*
 afforestation 422
 cone morphology 6
 conservation status 37
 co-occurring tree taxa 20
 distribution (natural) 6, 101, 188
 habitat 6, 19
 human uses of 424
 insect pests 32
 needle morphology 6
 plantations 32
 range expansions (20th century) 30,

- size (height) 6
 systematics 64–5
 water relations 303
- P. massoniana* var. *massoniana* 64
- P. massoniana* var. *henryi* 64
- P. massoniana* var. *hainanensis* 37, 64
- P. mastersiana* – see *P. armandii* var. *mastersiana*
- P. maximartinezii*
 afforestation 422
 cone morphology 6, 11
 conservation status 34, 37
 distribution (natural) 6, 137
 genetic diversity 265
 growth form 10
 habitat 6, 138
 human pressure 29, 34, 469
 human uses of 29, 34, 424
 needle
 longevity 6, 32
 morphology 6
 plantations 32
 pollution, impacts of 32
 regeneration 29
 reproductive system 252
 seed
 development 234
 dispersal 290
 food for humans 34, 418
 harvesting 29
 size (height) 6
 systematics 64–5
- P. maximinoi* 138
 afforestation 422, 468
 cone morphology 6
 conservation status 37
 distribution (natural) 6, 24
 genetic diversity 266
 habitat 6
 mating system
 outcrossing estimates 256
 needle morphology 6
 seed dispersal 284
 size (height) 6, 10
 species/provenance trials 420
 systematics 64–5
- P. merkusiana* – see *P. merkusii*
- P. merkusii* 250
 afforestation 417, 422
 bark 223
 cone morphology 6
 conservation status 37
 co-occurring tree taxa 25
 distribution (natural) 6, 25, 49, **184**, **188**
 fire
 adaptations **240**
 regime 25, 28, 33, 224–5
 habitat 6, 224
 human pressure 28, 33
 human uses of 418
- insect fauna (in Canada and USA) 359
- needle
 longevity 6
 morphology 6, 12
- seed
 dispersal 284
 morphology **286**
- seedlings
 grass stage 223–5
 self-pruning 223
 size (height) 6
 soils 224
 species/provenance trials 420
 systematics 61, 63–5
 wood anatomy 57
- P. mesogeensis* – see *P. pinaster*
- P. michoacana* – see *P. devoniana*
- P. mitis* – see *P. echinata*
- P. monophylla* 176–8, 250
 afforestation 422
 age distribution **222**
 charcoal, use for 29
 cone morphology 6, **173**
 co-occurring tree taxa **173**
 diseases 388
 distribution
 natural 6, 22, 171, **177**, 179, **186–7**,
 409–10
 relict 25
 drought **222**
 fire adaptations **240**
 genetic diversity 177
 growth form 171
 habitat 6
 human pressure 29
 human uses of 29
 hybridization 172, 174, **175–6**, 178
 insect fauna 358, 360
 juvenile period 282
 logging of 29
 needle
 longevity 6
 morphology 6, 12, 56, 297
 range expansions (Holocene) 176–7,
 262
 range expansions (20th century) 179
 seed
 dispersal 171, **290**
 morphology **286**
 production 283
 shade tolerance 222
 size (height) 6
 stand structure **172**, **173**, **222**
 succession, role in 222–3
 systematics and taxonomy 64–5, 176
 water relations 303
- P. monophylla* subsp. *californiarum* 175–6,
 178, 307
- P. monophylla* subsp. *fallax* 22, 172, 175–6
- P. monophylla* subsp. *monophylla* 173,
 176–8
- P. montana* – see *P. mugo* (also *P. uncinata*;
 see p. 157)
- P. montereyensis* – see *P. radiata* 434
- P. montezumae* 138, 140, 142
 afforestation 422
 bark 223
 cone morphology 6
 co-occurring tree taxa 24
 distribution (natural) 6, 24, 142
 fire
 adaptations 223
 regime 24
 habitat 6, 24
 hybridization 59, 143–4, 146
 needle
 longevity 6
 morphology 6
 seed dispersal 284
 seedlings
 grass stage 144, 223, 225
 self-pruning 223
 size (height) 6
 species/provenance trials 420
 systematics 59–60, 64–5
- P. montezumae* var. *hartwegii* – see *P. hartwegii*
- P. montezumae* var. *rudis* – see *P. hartwegii*
- P. monticola* 84, 122, 250
 afforestation 422
 cone
 morphology 6
 production 236
 co-occurring tree taxa 25
 disease(s) 31, 35, **386**, 396
 resistance 386
 distribution (natural) 6, **128**, 130,
186–7
 drought stress 236
 fire adaptations **240**
 genetic diversity 9, 266
 growth rates 271
 habitat 6, 17, 130
 insect fauna 355, 357–9, 360
 invader, as 456
 juvenile period 282
 longevity (whole-tree) 11, 233
 mating system 255
 outcrossing estimates 256
 needle
 longevity 6
 morphology 6
 pollen dispersal 264
 postglacial migrations 130–1, 262
 range contractions 131
 regeneration 233
 seed
 mast seeding 282
 morphology **287**
 size (height) 6, 10
 succession, role in 130, 233
 systematics 64–5

- Pinus* (Pinaceae; pines) (cont.)
- P. morrisonicola*
 cone morphology 6
 distribution (natural) 6, 20
 habitat 6
 needle morphology 6
 size (height) 6
 systematics 64–5
- P. mughus* – see *P. mugo*
- P. mugo*
 afforestation 422, 455
 cold-tolerance 309
 cone morphology 6
 diseases 390
 distribution (natural) 6, 110, 157, 189
 genetic diversity 266
 growth form 10
 habitat 6
 hybridization 159
 insect fauna (in Canada and USA)
 359
 invader, as 454, 456–7
 needle
 longevity 6
 morphology 6, 12
 postage stamp, depicted on 426
 range expansions (Holocene) 113, 162
 size (height) 6
 systematics 64–5
 timberline 107
 water relations 305
- P. muricata* 250
 afforestation 422, 455
 bark 223
 climate 283
 cold-tolerance 445
 cone
 morphology 6
 serotiny 223, 226–7, 230, 283
 conservation status 37
 distribution (natural) 6, 20–1, 434
 fire adaptations 223, 240
 fungi (mycorrhizal) 327
 genetic diversity 266, 270
 habitat 6
 hybridization 58
 insect fauna 358, 360
 invader, as 456, 462
 juvenile period 282
 logging/land clearance 30
 needle
 longevity 6
 morphology 6
 phenology 445
 pollen dispersal 264
 seed
 dispersal 234
 morphology 287
 self-pruning 223
 size (height) 6
 soils 343
- species/provenance trials 420
 systematics 58, 64–5
- P. nelsonii*
 cone morphology 6
 conservation status 37
 distribution (natural) 6, 137
 habitat 6, 138
 needle morphology 6, 56
 seed dispersal 290
 size (height) 6
 systematics 62, 64–5
 wood anatomy 56
- P. nigra* 155, 410
 afforestation 31, 157–8, 422, 453, 455
 cone morphology 6
 conservation status 37
 diseases 390, 394
 distribution
 natural 6, 514–15, 156–7, 189, 206
 adventive 157, 211
 drought-tolerance 112
étage 160
 genetic diversity 266
 habitat 6, 18, 160, 161
 human uses of 411, 414, 424
 hybridization 59
 insect fauna (in Canada and USA) 359
 invader, as 211, 455–8, 462, 469–70
 juvenile period 282
 mating system 255
 needle
 longevity 6
 morphology 6, 12
 plantations 390, 392, 397
 pollen data 162
 pollination 486
 range contractions 165
 range expansions (Holocene) 113
 range expansions (20th century) 30,
 157
 regeneration 30
 reproductive system
 fertilization 253
 organelle inheritance 255
 seed
 dispersal 284
 morphology 287
 size (height) 6
 soils 18, 107, 160
 species/provenance trials 420
 stand structure 159
 succession, role in 234
 systematics 59, 64–5, 158–9
- P. nigra* subsp. *clusiana* 158–9
- P. nigra* subsp. *dalmatica* 37, 157
- P. nigra* subsp. *laricio* 157–8, 159–60
- P. nigra* subsp. *mauretanic* 155, 157, 160
- P. nigra* subsp. *nigra* 156–7, 159–60
- P. nigra* subsp. *nigricans* 158
- P. nigra* subsp. *pallastiana* 156–7, 158–9,
 160–1, 163
- P. nigra* subsp. *salzmannii* 18, 157, 159,
 160, 161–3, 165
- P. nubicola* 138
 cone morphology 6
 diseases 392
 distribution (natural) 6, 24
 habitat 6
 needle morphology 6, 12
 size (height) 6
 systematics 64–5
- P. oaxacana* – see *P. pseudostrabus* var.
apulcensis
- P. occidentalis*
 afforestation 422
 alien plants, impacts of 31
 cone morphology 6
 conservation status 37
 diseases 382, 391
 distribution (natural) 6
 fire regime 28
 habitat 6
 human pressure 28
 needle morphology 6
 size (height) 6
 systematics 64–5
- P. occidentalis* var. *cubensis* – see
P. cubensis
- P. occidentalis* var. *maestrensis* – see *P.*
cubensis
- P. oocarpa* 144
 afforestation 422, 457
 bark 223
 climate 283
 cone
 morphology 6
 serotiny 223, 230, 283
 conservation status 37
 co-occurring tree taxa 23, 165
 distribution (natural) 6, 23, 145
 fire
 adaptations 223
 regime 23, 211
 genetic diversity 266
 habitat 6
 human uses of 424
 hybridization 58–9, 145
 invader, as 468
 management 23
 mating system
 outcrossing estimates 256
 needle morphology 6
 resprouting 24, 223, 226
 self-pruning 223
 size (height) 6
 species/provenance trials 420
 stand structure 23, 138
 systematics 58–9, 61–2, 64–5
- P. oocarpa* var. *microphylla* – see *P.*
praetermissa
- P. oocarpa* var. *oocarpa* 65
- P. oocarpa* var. *trifoliata* 65

- P. orizabensis* – see *P. cembroides* subsp.
orizabensis
- P. pachydermata*# 71
- P. pallasiana* – see *P. nigra* subsp.
pallasiana
- P. palustris* 142, 250, **462**
 afforestation 422
 bark 201, 223–4
 cone morphology 6
 co-occurring tree taxa 22, 201, 395
 diseases 201, 394–5
 resistance 36
 distribution (natural) 6, **189**, **199**–202
 fire
 adaptations 223, **240**
 ecology 196–7
 regime 22, 198, 200–2, 223–4
 sensitivity **224**
 suppression 28, **225**, 394, 396
 genetic diversity 266
 habitat 6, 200, 223
 human uses of 424
 hybridization 58, 260
 insect fauna 358, 360
 introgression 144
 mating system 255
 needle
 longevity 6, 13
 morphology 6, 12
 plantations 394
 postglacial migrations 124
 seed
 dispersal 259–**60**, 289
 morphology **287**
 production 261
 seedlings
 grass stage 24, 31, 144, 201, 223–4, 394
 self-pruning 223
 size (height) 6
 soils 22
 stand structure 201
 succession, role in 201–2
 systematics 51, 64–5
 wildlife habitat 37
- P. palustris* × *P. taeda* (Sonderegger pine) 259, **287**
- P. parviflora* 85
 afforestation 422
 cone
 morphology 6
 production 236
 distribution (natural) 6, 101–2, **188**
 drought stress 236
 habitat 6, 19
 human uses of 412, 424
 insect fauna (in Canada and USA) 359
 needle
 longevity 6
 morphology 6, 12
 seed dispersal 291
 size (height) 6
 systematics 61, 64–5
- P. parviflora* var. *pentaphylla* 65
- P. parviflora* var. *parviflora* 65
- P. patula* 140, 144
 afforestation 421–2, 455
 bark 223
 climate 283
 cone
 morphology 6
 serotiny 223, 230, 283
 co-occurring tree taxa 24
 diseases 391–2
 distribution
 natural 6, 24, 145
 adventive 211, **423**
 fire adaptations 223
 fungi (mycorrhizal) 327
 habitat 6, 24
 hybridization 58–9
 insect fauna (in Canada and USA) 359
 invader, as 211, 456–8, **462**
 needle
 longevity 6
 morphology 6, 12
 plantations 212, 394, **423**, 432, 452
 postage stamp, depicted on **426**
 seed morphology **287**
 self-pruning 223
 size (height) 6
 soils 346
 species/provenance trials 420
 stand structure 138
 systematics 58–9, 61, 64–5
- P. patula* subsp. *tecunumanii* – see *P. tecunumanii*
- P. patula* var. *jaliscana* – see *P. jaliscana*
- P. patula* var. *longipedunculata* 65
- P. patula* var. *patula* 65
- P. patula* × *P. greggii* 469
- P. pentaphylla* – see *P. parviflora* var. *pentaphylla*
- P. peuce*
 afforestation 422
 cone morphology 6
 conservation status 37
 co-occurring tree taxa 19
 distribution (natural) 6, 26–7, 107–8, 154
 fossil record 118
 habitat 6, 19
 human uses of 424
 insect fauna (in Canada and USA) 359
 juvenile period 282
 needle morphology 6
 range expansions (Holocene) 113
 seed
 dispersal 291
 morphology **287**
 size (height) 6
 stand structure 19
 systematics 64–5
- P. pinaster* 38, **159**, 250, 410
 afforestation 31, 157–8, 164, 414, 416, 419, 421–2, 425, 452–6
 climate 282
 cone
 morphology 7
 serotiny 283
 distribution
 natural 7, 21, 107, 154–5, **189**, 206, 412
 adventive 412, 421, **423**
étage **160**
 fire
 adaptations **240**
 ecology 208
 regime 22
 fossil record 111
 fungi (mycorrhizal) 329
 habitat 7, 18, **160**, 161
 herbivore pressure 419
 human uses of 411, 414, 416, 424
 insect
 fauna (in Canada and USA) 359
 outbreaks 22
 resistance 372
 invader, as 211, 453, **455**–7, **461**, **462**, **464**
 needle
 longevity 7
 morphology 7, 12
 plantations 22, 212, **423**, 452
 pollen data 162
 pollination 484
 postage stamp, depicted on **426**
 range expansions (late Holocene) 164
 range expansions (20th century) 164
 seed
 dispersal 291
 morphology **287**
 size (height) 7
 soils 18, **160**
 stand structure **22**, **156**
 succession, role in 164–5
 systematics 56, 60, 63–5, 158
- P. pinaster* subsp. *hamiltonii* 155, 160
- P. pinaster* subsp. *maghrebiana* 155, **160**–1, 163
- P. pinaster* subsp. *pinaster* 160
- P. pinaster* subsp. *renoui* 155
- P. pinceana*
 cone morphology 7
 conservation status 37
 distribution (natural) 7, 137
 genetic diversity 266
 habitat 7, 138
 needle morphology 7
 seed dispersal 290
 size (height) 7
 systematics 64–5

Pinus (Pinaceae; pines) (cont.)

- P. pinea* 171, 485
 afforestation 158, 419, 422, 452–3
 ancient plantings 31
 cone morphology 7
 distribution
 natural 7, 21, 31 154–5, 189, 206,
 409, 412
 adventive 31, 155–6, 412
étage 160
 habitat 7, 160, 161
 human uses of 34, 409, 412, 414, 424
 insect fauna (in Canada and USA) 359
 invader, as 451, 457–8, 461
 needle
 longevity 7
 morphology 7
 planting 155
 postage stamp, depicted on 427
 range expansions (20th century) 165
 seed
 development 234
 dispersal 290, 292
 food/medicine for humans 34, 409,
 411, 414, 416, 418–19
 mast seeding 416
 morphology 57, 287, 290
 size (height) 7
 soils 160
 systematics 51, 60–1, 64–5
 wood anatomy 57
P. pityusa – see *P. brutia* subsp. *pityusa*
P. ponderosa 38, 84, 250, 269, 354
 afforestation 419, 422, 455
 alien plants, impacts of 31, 36
 bark 223, 489
 conductance, stomatal 298, 300, 303,
 310
 cone
 morphology 7
 production 235
 co-occurring tree taxa 17, 198, 200
 CO₂, elevated 315
 dendrochronology 11, 195
 disease(s) 383, 388–9, 394
 resistance 382, 386
 distribution
 determinants of 25–6
 natural 7, 23, 25, 186–7, 199
 adventive 211
 domestication 271
 drought
 stress 374–5
 tolerance 198, 310
 fire
 adaptations 223, 240
 ecology 207
 prescribed 200
 regime 28, 195, 198–200, 212,
 231–2
 sensitivity 196
 suppression 28, 200, 388
 fossil record 128, 175
 fungi (mycorrhizal) 329
 genetic diversity 29, 36, 266
 growth rates 270, 307
 habitat 7, 17, 23, 310
 herbivore pressure (grazing) 28
 human pressure 29
 human uses of 29, 411, 424
 hybridization 58–9, 143, 146
 insect
 fauna 355, 357
 herbivory 236
 pests 373, 375
 invader, as 211, 456–8, 462
 juvenile period 282
 logging of 29, 31, 36, 272
 longevity (whole-tree) 10
 mating system 255
 outcrossing estimates 256
 needle
 longevity 7
 morphology 7, 56
 photosynthesis 297–9, 301, 302–3,
 310, 315
 pollen dispersal 264
 pollination 282, 486
 pollution, impacts of 32, 314
 regeneration 231–2
 reproductive system
 linkage 254
 respiration 306
 roots 303–4, 310
 seed
 biology 269
 dispersal 232
 germination 236
 mast seeding 283
 morphology 287
 predation 237–8, 291
 self-pruning 223, 231
 size (height) 7, 10
 soils 17, 270
 species/provenance trials 420
 specific leaf area 296–7
 stand structure 17, 22, 138, 200, 232,
 383
 succession, role in 232
 systematics 59–61, 64–5
 water relations 302–3, 306, 310
 wildlife habitat 200
P. ponderosa subsp. *washoensis* – see *P.*
washoensis
P. ponderosa var. *arizonica* 26, 138, 287,
 422
P. ponderosa var. *ponderosa* 28, 266, 282,
 287
P. ponderosa var. *scopulorum* 266, 282, 287
P. ponderosoides# 71
P. praetermissa
 cone morphology 7
 distribution (natural) 7
 habitat 7
 needle morphology 7
 size (height) 7
 systematics 64–5
P. prepityusa# 79
P. princetonensis# 76
P. pringlei
 afforestation 422, 468
 bark 223
 climate 283
 cone
 morphology 7
 serotiny 223, 230, 283
 distribution (natural) 7
 fire adaptations 223
 habitat 7
 needle morphology 7
 self-pruning 223
 size (height) 7
 species/provenance trials 420
 systematics 58, 61, 64–5
P. pseudoflabellifolia# 71
P. pseudostrobifolia# 71
P. pseudostrobus 138, 144
 afforestation 422
 bark 223
 cone morphology 7
 distribution (natural) 7, 24
 fire adaptations 223
 habitat 7
 hybridization 59, 144
 needle morphology 7, 12
 self-pruning 223
 size (height) 7
 species/provenance trials 420
 systematics 58–9, 64–5
P. pseudostrobus var. *pseudostrobus* 64
P. pseudostrobus var. *estevezii* 64
P. pseudostrobus var. *tenuifolia* – see *P.*
maximinoi
P. pseudostrobus var. *apulcensis* 24, 64
P. pseudotetraphylla# 71
P. pumila 15
 cold-tolerance 98, 102
 cone morphology 7
 co-occurring tree taxa 14, 97
 distribution (natural) 7, 97–8, 101–2,
 188
 fossil record 98
 genetic diversity 266
 growth form 10, 98
 habitat 7, 16, 19
 insect fauna (in Canada and USA)
 359
 needle
 longevity 7, 13
 morphology 7
 pollen data 98
 postglacial migrations 8, 97–8
 range expansions (Holocene) 102

- seed
 dispersal 290
 morphology **287**
 size (height) 7
 systematics 64–5
 timberline 16, 310
- P. pungens* 250
 afforestation 422
 bark 223
 climate 283
 cone
 morphology 7
 serotiny 223, 229, 283
 distribution (natural) 7, **189**
 fire
 adaptations 223, **240**
 regime 230
 genetic diversity 266
 habitat 7, 18
 insect fauna 358, 360
 juvenile period 282
 mating system
 outcrossing estimates 256
 needle
 longevity 7
 morphology 7
 regeneration **229**
 resprouting 223
 seed morphology **287**
 size (height) 7
 stand structure 229
 systematics 64–5
- P. quadrifolia* – see *P. juarezensis* × *P. monophylla* 175
- P. quenstedti*[#] 71, 138, 142, 144
- P. quinquefolia*[#] 71
- P. radiata* 38, 250, 354, 432–49
 afforestation 31, 158, 417, 421–2, 455
 alien plants, impacts of 31, 435, **437**
 bark 223
 chromosomes **258**
 climate 283, 420, 446
 cold-tolerance 445
 conductance, stomatal 14, 298
 cone
 morphology 7
 serotiny 223, 227, 230, 283
 conservation
 (*ex situ*) 437–8
 status 33–4, 37, 435, 437
 CO₂, elevated 315
 diseases 391–2, **393–5**, 398, 439, 442–3
 discovery 432–3
 distribution
 natural 7, 21, 26–7, 271, 435, **436–7**
 adventive 158, 211, 271, **423**, 432–49
 domestication 271
 drought 445
 ecophysiology 13
- fire
 adaptations 223, **240**
 ecology 445
 forestry, use in 432–49
 fungi (mycorrhizal) 327–9, 333–5
 genetic(s) 435
 contamination **437**
 diversity 266, 447
 tree breeding 271, 437–8, 439, 446
 habitat 7
 herbivore pressure 419
 browsing 28, 33, 435–7
 human pressure 31, 435, **437**
 human uses of 419, 424, 435
 hybridization 58
 insect 356
 fauna 358, 360
 pests 370–2, 443–4
 resistance, screening for 372
 invader, as 211–12, **257**, 455–61, **462**, 464, 468
 juvenile period 282
 leaf area index 13, **482**
 mating system 257
 needle
 longevity 7
 morphology 7, 12
 photosynthesis 297–9, 301
 plantations 31, 212, 394, **423**, 439–49, 452, 468
 pollen dispersal 264
 pollination 282, 439
 postage stamp, depicted on **426**
 recombination system 258
 regeneration 212
 reproductive system
 linkage 254
 roots 303
 seed
 dispersal 234, 260, 288
 morphology **287**
 production 261
 self-pruning 223
 size (height) 7
 soils 333, 347, 443–4
 species/provenance trials 420
 specific leaf area 296
 succession, role in 445, 447
 systematics and taxonomy 58, 61–2, 64–5, 433–6
- P. radiata* var. *binata* 28, 33–4, 37, 434–5, 437
- P. radiata* var. *radiata* 37, 433–5, **437**
- P. radiata* var. *cedrosensis* 434–5, **436**
- P. remorata* – see *P. muricata* 434
- P. remota*
 cone morphology 7
 distribution (natural) 7, **173**
 fossil record 174
 growth form 171
- habitat 7
 insect fauna 358, 360
 needle morphology 7
 range contractions 174
 range expansions (Holocene) **173**
 seed morphology 284
 size (height) 7
 systematics 64–5
- P. resinosa* 38, 84, 250, **462**
 afforestation 422
 bark 223, 232
 conductance, stomatal 298
 cone
 morphology 7
 production 236
 co-occurring tree taxa 15, 210
 disease(s) 332, 388, 390
 resistance 332, **397**
 distribution (natural) 7
 fire
 adaptations 223, **240**
 regime 28, 232
 sensitivity 210
 suppression 28, 30
 fungi (mycorrhizal) 332
 genetic diversity 266
 habitat 7, 15, 17, 122, 312
 herbivore pressure (browsing) 30
 human pressure 29
 human uses of 29
 hybridization 59
 insect
 fauna 355, 358, 360, **362**, 366
 herbivory 370
 pests 359
 logging of 29–30
 mating system 255–6
 mutation system 269
 needle
 longevity 7
 morphology 7, 12
 photosynthesis 298, **301**, 312
 plantations 388
 pollen 123
 postglacial migrations **123–4**
 regeneration 232
 respiration 306
 seed morphology **287**
 self-pruning 223
 size (height) 7
 soils 312, 346
 stand structure 17
 systematics 55, 57, 59, 62–3, 64–5
 water relations 304
- P. rigida* 250
 afforestation 422
 climate 283
 cone
 morphology 7
 serotiny 223, 227–9, 269, 283
 distribution (natural) 7, **189**

- Pinus* (Pinaceae; pines) (cont.)
- P. rigida* (cont.)
- fire
 - adaptations **240**
 - regime 230
 - fungi (mycorrhizal) 332
 - genetic diversity 266
 - growth form 18
 - growth rates 269
 - habitat 7, 18, 225
 - herbivore pressure (grazing) 29
 - human pressure 29
 - human uses of 29
 - insect fauna 358, 360
 - juvenile period 282
 - mating system 257
 - needle
 - longevity 7
 - morphology 7
 - recombination system 258
 - resprouting 223, 225, 251
 - seed
 - dispersal 288
 - morphology **287**
 - size (height) 7
 - soils 17–18
 - species/provenance trials 420
 - stand structure 229
 - succession, role in 17
 - systematics 58, 64–5
 - wood as fuel 29
- P. rigida* subsp. *serotina* – see *P. serotina*
- P. roigrande*[#] 79
- P. roxburghii*
- afforestation 422
 - alien plants, impacts of 31
 - cone morphology 7
 - distribution (natural) 7, **188**
 - fire
 - regime 20, 211
 - wildfires 20
 - habitat 7
 - herbivore pressure (browsing) 20
 - human uses of 424
 - hybridization 59
 - insect fauna (in Canada and USA) 359
 - invader, as 457
 - juvenile period 282
 - needle
 - longevity 7, 13
 - morphology 7
 - seed dispersal 284
 - size (height) 7
 - stand structure **20**
 - succession, role in 20
 - systematics 59, 64–5
- P. rudis* – see *P. hartwegii*
- P. rzedowskii* 37
- cone morphology 7
 - distribution (natural) 7, 137
 - fire regime 28
 - habitat 7
 - human pressure 28
 - needle morphology 7, 12
 - size (height) 7
 - systematics 55, 64–5
- P. sabiniana* 85, **462**
- afforestation 422
 - cone morphology 7, 235
 - co-occurring tree taxa 25
 - distribution (natural) 7, 21, 183, **186**
 - genetic diversity 266
 - growth form 10, 21
 - habitat 7
 - human uses of 34, 409, 424
 - insect (fauna) 358, 360
 - needle
 - longevity 7
 - morphology 7
 - seed
 - dispersal 196, 284
 - food for humans 34, 409
 - morphology 57, 284, **287**, 290
 - size (height) 7
 - systematics 59, 64–5
- P. salzmannii* – see *P. nigra* subsp. *salzmannii*
- P. sanjuanensis*[#] 79
- P. serotina* 250
- afforestation 422
 - bark 223
 - climate 283
 - cone
 - morphology 7
 - serotiny 223
 - distribution (natural) 7, **189**
 - fire
 - adaptations 223, **240**
 - regime 22, 230
 - habitat 7, 225
 - insect fauna 358, 360
 - juvenile period 282
 - needle
 - longevity 7
 - morphology 7
 - pollution, impacts of 314
 - postglacial migrations 124
 - resprouting 223, 225
 - seed morphology **287**
 - size (height) 7
 - systematics 58, 64–5
- P. sibirica* 250
- cone morphology 7
 - co-occurring tree taxa 14, 107
 - distribution (natural) 7, **97**, 107–8, 188–9
 - fire adaptations **240**
 - fossil record **97**
 - genetic diversity 266
 - habitat 7, 16, 19
 - human uses of 34, 409, 424
 - insect fauna (in Canada and USA) 359
 - juvenile period 282
 - mating system, outcrossing
 - estimates 257
 - needle morphology 7
 - pollen data 97
 - postglacial migrations 8, **97**
 - seed
 - dispersal 222, 290, 292
 - food for humans 34, 409, 418
 - morphology **287**
 - size (height) 7
 - stand structure 107
 - succession, role in 222
 - systematics 61, 64–5
 - timberline 16, 107, 222
- P. similkameensis*[#] 76
- P. spinosa*[#] 76
- P. squamata*
- cone morphology 7
 - distribution (natural) 7
 - habitat 7
 - needle morphology 7
 - systematics 63–5
- P. strobiformis* – see *P. ayacahuite* var. *strobiformis*
- P. strobus* 85, 122, 250, 354
- afforestation 422, 455
 - conductance, stomatal 298, 300, 312
 - cone
 - morphology 7
 - opening 283
 - diseases 35, 390, 397
 - distribution (natural) 7, 24, **189**
 - domestication 271
 - drought stress 374
 - fire
 - adaptations **240**
 - regime 241
 - sensitivity 210
 - suppression 30
 - fungi (mycorrhizal) 329
 - genetic diversity 266
 - habitat 7, 17, 24, 124
 - herbivore pressure (browsing) 30
 - human uses of 415, 424
 - insect
 - fauna 355, 357–60, **362**
 - pests **364**, 368, 373
 - invader, as 457, **462**
 - juvenile period 282
 - logging of 30
 - longevity (whole-tree) 232
 - mating system 255
 - needle
 - longevity 7
 - morphology 7
 - photosynthesis 298, 300–1, 312
 - plantations 291, 390
 - pollen 123
 - pollution, impacts of 32, 314

- postage stamp, depicted on **426–7**
 postglacial migrations **123–6**, 132
 range expansions (20th century) 30
 recombination system 258
 regeneration 232
 reproductive system, linkage 254
 seed
 biology 287
 dispersal 125, 232, 238, 241, 260,
 288, 291–2
 morphology **287**
 size (height) 7, 232
 soils 17, 126
 species/provenance trials 420
 specific leaf area 296
 stand structure **18**, **233**
 succession, role in 17
 systematics 51, 64–5
 water relations 302, 312
P. strobus var. *chiapensis* – see *P. chiapensis*
P. sturgisii[#] 76
P. sumatrana – see *P. merkusii*
P. sylvestris 38, 85, 250
 afforestation 31, 157, 414, 416, 422,
 455
 bark 204
 cold-tolerance 96, 300, 309
 conductance, stomatal 14, 298, 300
 cone morphology 7
 conservation status 37
 co-occurring tree taxa 14, 18, 107,
 163, 202, 210
 dendrochronology 16
 diseases 332, 388, 390, 394, 398
 distribution
 adventive 211
 determinants 26
 natural 7, 26, **96–7**, 107, **109**, 156–7,
 188–9, **199**, 202
 drought
 stress 374
 tolerance 112
 Eocene 95
 étage **160**
 fire
 adaptations **240**
 regime 16, **97**, 202–3, 204
 fossil record **96**, 110–11, **115**, 118
 fungi (mycorrhizal) 324–5, **326**, 328,
 330, 332
 genetic diversity 26, 266
 growth rates 204
 habitat 7, 15–16, 18–19, **97**, 159, **160**,
 234
 herbivore pressure
 browsing 29, 33–4
 grazing 28, 469
 Holocene 107–18
 human influences 15, 29, 30, 117–18
 human uses of 29, 394, 424
 hybridization 159
 insect fauna (in Canada and USA)
 355, 359
 fauna (natural range) 359, 366
 herbivory 370–1
 pests **363**, 368, 372–4
 invader, as 211, 456–8, **462**, 470
 juvenile period 282
 logging of 408
 longevity (whole-tree) 10, **97**
 mating system
 outcrossing estimates 256
 needle
 longevity 7
 morphology 7, 12
 nutrient content 270
 origin 95
 photosynthesis 14, 297–9, 300–1, 309
 pollen
 data 96, 162
 dispersal 264
 production 263
 pollination 282
 pollution, impacts of 32, 314, 373
 population growth rates 9
 postage stamp, depicted on **426–7**
 postglacial migrations 9, **96**
 range expansions (Holocene) 113, 115,
 117–18
 range expansions (20th century) 29,
 30, **165**
 regeneration 30
 roots 303
 seed
 biology 285
 dispersal 284, 288–9
 morphology **287**
 production 204, 261
 seedlings 204, **326**
 shade tolerance 234
 size (height) 7
 soils 15, 26, 107, 113, 159–60, 202
 species/provenance trials 420
 stand structure **16**, **97**, **111**, 202–4, 234
 succession, role in 15, 117, 204, 234
 systematics 51, 61, 63–5, 118, 159
 timberline 16, 117, 202, 204
 water relations 304–6
 wood as fuel 29
P. sylvestris subsp. *hamata* 64
P. sylvestris subsp. *kalundensis* 64
P. sylvestris subsp. *lapponica* 64
P. sylvestris subsp. *sibirica* 64
P. sylvestris subsp. *syvestris* 64
P. sylvestris var. *aquitana* 156
P. sylvestris var. *brigantica* 156
P. sylvestris var. *iberica* 156
P. sylvestris var. *mongolica* 37
P. sylvestris var. *nevadensis* 156
P. sylvestris var. *pyrenaica* 156
P. sylvestris var. *syvestrifformis* 37
P. tabulaeformis – see *P. tabuliformis*
P. tabuliformis
 afforestation 417, 422
 cone morphology 7
 co-occurring tree taxa 20
 distribution (natural) 7, 24, **188**
 genetic diversity 267
 habitat 7, 20
 hybridization 259
 needle morphology 7
 size (height) 7
 soils 111
 systematics 61, 64–5
P. taeda **38**, 250, 354
 afforestation 30, 31, 419, 422, 455
 conductance, stomatal 14, 298
 cone morphology 7
 conservation (*ex situ*) 272
 co-occurring tree taxa 22, 201, 395
 CO₂, elevated 315
 diseases 36, 389, 395–6
 distribution
 natural 7, **189**
 adventive **423**
 drought stress 374–5
 fire
 adaptations **240**
 regime 28, 198, 234
 suppression 28
 fungi (mycorrhizal) 329, 332, 335
 genetic(s) 264, **268**
 diversity 267
 habitat 7, 17
 human uses of 413, 415
 hybridization 58, 259
 insect
 fauna 358, 360
 herbivory 370
 pests 375
 invader, as 456–7
 juvenile period 282
 longevity (whole-tree) 234
 mating system 255
 mutation system 268
 needle
 longevity 7
 morphology 7
 photosynthesis 297–9, **300**, 312, 315
 plantations 389, **423**, 432, 452
 pollen dispersal 264
 pollution, impacts of 32, 314
 postglacial migrations 124
 reproductive system
 linkage 254
 seed morphology **287**
 size (height) 7
 soils 22, 347, 348
 species/provenance trials 420
 succession, role in 17, 35
 systematics 51, 61, 64–5
 water relations 303, 305–6
 wildlife habitat 37

Pinus (Pinaceae; pines) (cont.)*P. taiwanensis*

- afforestation 422
- cone morphology 7
- distribution (natural) 7, 20
- habitat 7
- needle morphology 7
- size (height) 7
- systematics 64–5

P. taiwanensis var. *damingshanensis* 64*P. taiwanensis* var. *taiwanensis* 64*P. tecunumanii* 420

- afforestation 422, 468
- cone morphology 7
- conservation status 37
- distribution (natural) 7, 24
- habitat 7
- hybridization 145
- needle morphology 7, 12
- size (height) 7, 10
- species/provenance trials 420
- systematics 64–5

P. tecunumanii × *P. caribaea* 469*P. tenuifolia* – see *P. maximinot**P. teocote*

- afforestation 422, 468
- cone morphology 7
- distribution (natural) 7
- habitat 7
- human uses of 411
- hybridization 59
- needle
 - longevity 7
 - morphology 7
- size (height) 7
- species/provenance trials 420
- systematics 58–9, 62, 64–5

P. tetraphylla[#] 71*P. thunbergiana* – see *P. thunbergii**P. thunbergii* 85

- afforestation 422
- cone morphology 7
- diseases 398
- distribution (natural) 7, 101–2, **188**
- habitat 7, 19
- human uses of 412, 424
- insect fauna (in Canada and USA) 359
- juvenile period 282
- needle
 - longevity 7
 - morphology 7
- origin 95
- pollution, impacts of 32
- size (height) 7
- systematics 62, 64–5

P. torreyana 462

- afforestation 422
- bark 223
- cone
 - morphology 7
 - serotiny 223, 227

conservation status 37

distribution (natural) 7, 21, 183

fire

- adaptations 223
- regime 239, 410

genetic diversity 267, 462

habitat 7

human uses of 410, 424

insect fauna 358, 360

invader, as 456

juvenile period 282

longevity (whole-tree) 239

mutation system 269

needle

- longevity 7
- morphology 7

planting, by Native Americans 31

pollen dispersal 264

reproductive system 252

seed

- dispersal 196, 284
- morphology 57, 284, **287**, 290

self-pruning 223

size (height) 7

systematics 61, 64–5

P. torreyana subsp. *insularis* 37*P. torreyana* subsp. *torreyana* 37*P. triphylla*[#] 71*P. tropicalis*

- afforestation 422
- cone 7
- distribution (natural) 7, 23
- fire regime 23
- habitat 7
- needle morphology 7
- seedlings
 - grass stage 144, 225
 - systematics 55, 57, 63–5

P. tuberculata – see *P. radiata* 434*P. uncinata*

- afforestation 31, 157, 422
- cone morphology 7
- distribution
 - natural 7, 107, **110**, 156–7
 - adventive 156
- étage **160**
- genetic diversity 267
- habitat 7, **160**, 161
- needle
 - longevity 7
 - morphology 7, 12
- range expansions (Holocene) 162
- regeneration 30
- size (height) 7
- soils **160**
- stand structure **158**
- systematics 64–5, 159

P. virginiana 84, 250, 354

- afforestation 422
- bark 223
- climate 283

cone

- morphology 7
- serotiny 223, 283

diseases 391

distribution (natural) 7, **189**

fire

- adaptations **240**
- regime 230

fungi (mycorrhizal) 328, 332

genetic diversity 267, 462

habitat 7, 18

human uses of 413

hybridization 58

insect fauna 358, 360

invader, as 456

juvenile period 282

mating system 255

needle

- longevity 7
- morphology 7, 12

pollination 282

postglacial migrations 124

range expansions (20th century) 30

resprouting 223

seed morphology **287**

size (height) 7

systematics 58, 61, 64–5

P. wallichiana

- afforestation 422
- cone morphology 7
- co-occurring tree taxa 20
- diseases 382
- distribution (natural) 7, 24, **188**
- habitat 7, 20
- insect fauna (in Canada and USA) 359
- juvenile period 282
- needle
 - longevity 7
 - morphology 7
- regeneration 31
- seed
 - dispersal 284, 288
 - morphology **287**
- size (height) 7
- systematics 64–5

P. wangii

- cone morphology 7
- conservation status 37
- distribution (natural) 7, 20, 24
- habitat 7
- needle morphology 7
- size (height) 7
- systematics 64–5

P. washoensis

- cone morphology 7
- conservation status 37
- distribution (natural) 7
- genetic diversity 37, 267
- habitat 7, 17
- insect fauna 358, 360

- needle
 longevity 7
 morphology 7
 seed morphology **287**
 size (height) 7
 systematics 60, 64–5
- P. wheeleri*[#] 76
- P. winchesteriana* – see *P. devoniana*
- P. wolfei*[#] 76
- P. wohlgenmuthi*[#] 71
- P. yezeensis*[#] 71
- P. yunnanensis* 85
 cone morphology 7
 co-occurring tree taxa 20
 diseases 382
 distribution (natural) 7, 24
 genetic diversity 267
 habitat 7, 20
 human pressure 36
 logging/land clearing 36
 needle morphology 7
 range expansions (20th century) 30, 34
 size (height) 7
 systematics 61, 64–5
- P. yunnanensis* var. *pygmaea* 64
- P. yunnanensis* var. *temuifolia* 64
- P. yunnanensis* var. *yunnanensis* 64
- Pitsolithus tinctorius* (Sclerodermatales: Sclerodermataceae) 328, 331–2, 334–5
- Pissodes* (Coleoptera: Curculionidae) 362, 366–7
- P. nemorensis* (eastern pine weevil) 391
- P. strobi* (Engelmann spruce weevil, Sitka spruce weevil, white pine weevil) **362**, 367–8, 373–4
- Pistachia lentiscus* (Anacardiaceae; mastic) 207, 411
- pitch canker – see *Gibberella fujikuroi*
- Pityoborus* (Coleoptera: Scolytidae) 363
- Pityococcus* (Homoptera: Margaradidae) 361
- Pityogenes* (Coleoptera: Scolytidae) 367
- Pityophthorus* (Coleoptera: Scolytidae) 355, 362–3, 367
- P. antillicus* 374
- P. pinavorous* 374
- Pityostrobus*[#] (Pinaceae) 70, 73, 83
- Plantago lanceolata* (Plantaginaceae; buckhorn plantain) 216
- Platanus* (Platanaceae; planes) 412
- P. orientalis* (oriental plane) **155**
- Platycarya* (Juglandaceae) 74
- Ploioderma* (Helotiales; Ploioderma needle cast) 393
- Poaceae (grasses) 116, **146**
- Podocarpus* (yellow-woods) 24, 99–100, **141**
- Ponderosa complex (Mirov 1967) 138
- Ponderosa group (Martínez 1948) 138–9
- Ponderosae* (subsection of *Pinus*) 4, 8, 55, 58–64, 71, 76, 79, 84, 85–6, 122, 137–8, 142–3, 358, 360, 489
- Populus* (poplars and cottonwoods) 14, 18, **26–7**, 38, 297, 347–8
- P. tremuloides* (Salicaceae; American quaking aspen) 130, 208, 210
- Poria asiatica* (Polyporaceae) 206
- Potentilla* (Rosaceae; cinquefoils) 216
- Prosopis velutina* (Fabaceae; velvet mesquite) 304
- Protea nitida* (Proteaceae; waboom) 465
- Protolachnus agilis* (Homoptera: Aphididae) 373
- Pseudoaraucaria*[#] (Pinaceae) 70, 83
- Pseudolarix* (Pinaceae; golden larch) 9, 51
- Pseudostrobus complex (Mirov 1967) 138
- Pseudostrobus group (Martínez 1948) 58–9, 138
- Pseudotsuga* (Pinaceae; Douglas-firs) 9–10, 13, 38, 51, 63, 138, 254, 331, 482
- P. menziesii* (Douglas-fir) **26**, 130–1, 175, 198, 204, 269, 289, **299–300**, 302–3, 304–5, **386**, 388, 391, 432, 445, 448, 470
- Pterocarya* (Juglandaceae) 74
- Pyralidae (pyralid moths) 367
- Pythium* (Pythiaceae) 332
- Quercus* (oaks) 14, 17–18, 20–4, 36, 38, 99–102, 113, 116–17, 138, 140, 145–6, 154, 162–3, 176, 207, 224, 235, 335, **346–8**, 395–6, 412, 445
- Q. agrifolia* (California live oak) **25**
- Q. aliena* (Oriental white oak) 19
- Q. calliprinos* 163
- Q. cerris* (European turkey oak) **224**
- Q. douglasii* (blue oak) **25**
- Q. gambelii* (Gambel oak) **22**, **26**
- Q. ilex* (holm oak) 21, 163
- Q. laevis* (American turkey oak) 201
- Q. leucotrichophora* (banj oak) 31
- Q. petraea* (sessile oak) 118
- Q. pubescens* (downy oak) 163
- Q. robur* (English oak) 107, 118
- Q. rotundifolia* 163
- Q. serrata* 19
- Q. suber* (cork oak) 163–4, 206
- rabbits – see *Oryctolagus cuniculus*
- red ring rot – see *Phellinus pini*
- red band needle blight – see *Mycosphaerella pini*
- Retinia* (Lepidoptera: Tortricidae) 362–3, 367
- R. (= Petrova) resinella* 373
- Rhizinia undulata* (Pezizales; Rhizina root diseases) 388
- Rhizophora mangle* (Rhizophoraceae; red mangrove) 269
- Rhizopogon* (Boletales: Rhizopogonaceae)
- R. luteolus* 327, 329, 333–5
- R. occidentalis* 334
- R. roseolus* (= *R. rubescens*) 333–4
- R. vinicolor* 334
- R. vulgaris* 334
- Rhododendron ferrugineum* (Ericaceae; alpine rose) 309
- Rhyacionia* (Lepidoptera: Tortricidae) 357, 361, 365, 367
- R. buoliana* (European pine shoot moth) 355, 371, 373, 444
- R. frustrana* (Nantucket pine tip moth) 374
- R. subtropica* (subtropical pine tip moth) 391
- Ribes* (Saxifragaceae; currants and gooseberries) 237, 396
- Rosmarinus officinalis* (Labiatae; rosemary) 21, 207
- Rumex acetosa* (Polygonaceae; sorrel) 116
- Russula* (Agaricales: Russulaceae) **326**
- R. amoenolens* 327
- R. caerulea* 334
- R. capensis* 334
- R. cyanoxantha* 334
- R. sardonica* 334
- Rzedowskiana* (subsection of *Pinus*) 55, 63, 65, 137, 177, 485
- Sabina* (Coniferae) 101
- Sabinianae* group 59, 61–4
- Salix* (willows) **26**, 116
- Scarabaeidae (scarab beetles) 366
- Scirrhia acicola* – see *Mycosphaerella dearnessii*
- S. pini* – see *Mycosphaerella pini*
- Sciuridae (Sciuridae)
- S. aberti* (tassel-eared squirrel) 237
- S. carolinensis* (grey squirrel) 292, 461
- S. vulgaris* (Old World red squirrel) 29, 292
- Sciuridae (squirrels) 35, 235, 237–8, 240, 261
- Scleroderma lagerbergii* (= *Brunchorstia pinea*) – see *Gremmeniella abietina*
- Scleroderma bovista* (Sclerodermataceae) 334
- S. citrinum* (common earthball) 334
- S. laeve* 334
- S. verrucosum* 327, 334
- Scolytidae (bark beetles) 355, 366
- Selidosema suavis* (Lepidoptera: Geometridae) 374
- Semiothisa* (Lepidoptera: Geometridae) 367
- Sequoia* (Taxodiaceae) 10, 13, 74
- Sequoiadendron* (Taxodiaceae) 10, 17
- S. giganteum* (giant sequoia) 25, 262
- Sesiidae (clearwings) 367
- sheep (*Ovis* spp.; Bovidae) 28–9, 34, 108, 179, 457, 469

- Shorea* (Dipterocarpaceae) 25
S. robusta 20
Sirex noctilio (Hymenoptera: Siricidae;
Sirex wood wasp) 370, 372–3, 444
Sitta krueperi (Sittidae; Krüper's nuthatch)
 290
 soft pines – see *Strobos* (subgenus of *Pinus*)
Sphaeropsis (Sphaeropsidales)
S. sapinea (= *Diplodia pinea*; Sphaeropsis
 canker) 381, 391–2, 398, 442–4
Sphagnum (Sphagnaceae; sphagnum
 moss) 116, 216
 spruce – see *Picea*
 squirrels – see Sciuridae
Stipa gigantea (Poaceae) 156
 stone pines {488} – see *Cembrae*
 (subsection of *Pinus*)
Strobi (subsection of *Pinus*; white pines) 4,
 12, 54–5, 57, 59–60, 62, 65, 71, 76,
 79, 82, 84–5, 122, 232–3, 290–1,
 358, 360, 396, 408, 489
Strobos (section of *Pinus*) 16, 26, 49, 51–2,
 55–7, 65, 101, 122, 137, 290, 408,
 480, 489
Strobos (subgenus of *Pinus*; haploxyton or
 soft pines) 4, 49, 56, 59–63, 65,
 71, 76, 107, 223, 252, 259–60,
 282, 290, 358–60, 367, 480, 488
Suillus bovinus (Boletales: Boletaceae) 326,
 327–9, 330–1, 334
S. brevipes 333–4
S. granulatus 333–5
S. grevillei (larch bolete) 334
S. lakei 334
S. luteus 332–5
S. pungens 327
S. tomentosus 334
Sylvestres (subsection of *Pinus*) – see *Pinus*
 (subsection of *Pinus*)
Synanthedon (Lepidoptera: Sesiidae) 363,
 367
Syzygium jambos (Myrtaceae; rose apple) 31
Tamias (Sciuridae; chipmunks) 261, 284–7
T. amoenus (yellow pine chipmunk) 292
T. speciosus (Lodgepole pine chipmunk)
 292
Tamiasciurus hudsonicus (Sciuridae; North
 American red squirrel) 39, 237,
 292
Taxodium (Taxodiaceae; swamp cypresses)
 24, 74, 219
Taxus (Taxaceae; yews) 24, 100
Tetraclinis articulata (Cupressaceae; arar)
 22
Tetyra (Hemiptera: Pentatomidae) 365, 367
Thaumetopoea pityocampa
 (Thaumetopoeidae;
 processionary caterpillar) 444
Thelephora terrestris (Aphyllophorales:
 Thelephoraceae) 327, 331–2, 334
 Thripidae (common thrips) 367
Thuja (Cupressaceae; arborvitae) 10, 219
T. occidentalis (white cedar) 301
 Thysanoptera (thrips) 355, 356–7, 359,
 361, 365
Tilia (Tiliaceae; limes) 113, 117, 154
Tomicus minor (Coleoptera: Scolytidae)
 367
T. piniperda (Coleoptera: Scolytidae)
 367
 Tortricidae (leafroller and olethreutine
 moths) 355, 359, 361
Toumeyella (Homoptera: Coccidae) 359, 367
T. pinicola (irregular pine scale) 362
T. resinosa 362
Tradescantia (Commelinaceae;
 spiderworts) 272
Trillium (Liliaceae) 272
Truncocolumella citrina
 (Truncocolumellaceae) 334
Tsuga (Pinaceae; hemlocks) 9–10, 51,
 99–101, 131, 219–20, 233
T. canadensis (eastern hemlock) 125, 132,
 233
T. heterophylla (western hemlock) 130,
 299, 303, 306
T. mertensiana (mountain hemlock)
 129–30, 386
Tuber rapaeodurum (Tuberales) 334
 Tubuliflorae 146
Ulex parviflorus (Fabaceae; furze) 207
Ulmus (Ulmaceae; elms) 75, 100, 113,
 116–17, 154
Vaccinium (Ericaceae) 210
V. myrtillus 204
V. vitis-idaea 204
 voles (Muridae) 204
 walnut – see *Juglans*
 white pines {489} – see *Strobi* (subsection
 of *Pinus*)
 white pine blister rust – see *Cronartium*
ribicola
Xyela (Hymenoptera: Xyelidae) 364–5, 367
 Xyelidae (xyelid sawflies) 367
 yellow pines 388, 398, {489}
 Yponomeutidae (web spinners, ermine
 moths) 359
Zea (Poaceae; maize) 146, 235, 258, 408
Zeiraphera dimiana (Lepidoptera:
 Tortricidae; larch budmoth) 368

Subject Index

Note: Page numbers in **bold** type indicate illustrations; there may also be textual references on these pages. Page numbers in {brackets} indicate definitions.

- acid rain – see **pollution**
 Adriatic Sea 153, 412
 Afghanistan 6, 20
 age distribution **222**
 agriculture – influence on pine
 distribution 28–30, 35, 102,
 117–18, **145–6**, 194, 211
 see also **shifting cultivation**
 Alabama (USA) 74, 84
 fossil pines 75–6
 Alaska (USA) 7, 27, 73–5, 129–32
 amber deposits 70
 fossil pines 70–1, 75–6, 79, 82
 Gulf of 78
 MacKenzie Delta 75
 Wrangell Mountains 81
 Albania 18, 27
 alien plants – impacts on pine dynamics
 31, 36, 435, **437**
 see also **invaders, pines as**
 Algeria 155, 164–5, 415, 417
 Alps 10, 16, 18, 26, 30, 107, 156, 158, **308**
 see also **Austria, Italy, France**
 Altai mountains – see **China**
 Anasazi 29, 174, 411
 Anatolia – see **Turkey**
 angiosperms 3–8, 63, 74–5, 78, 81, 83–4,
 95, 219–20, 226, 235, 237, 251–5,
 259, 297, 299, 304–6, 343
 Antarctica 74, 78
 Appalachian Mountains, E North America
 17–18, 138, 140, 142
 Apennine Mountains – see **Italy**
 Argentina 470
 pines as invaders 457–8
 plantations 421, 439, 444, 457
 mycorrhizal fungi 334
 species/provenance trials 420
 arid habitats 12, 14–15, 21–3, 26, 33, 74,
 96–7, 99–100, 125, 128, 138, 140,
 158, **160–1**, 163, 171–2, 220–3,
 232, **235**, 239–41, 306–7, 417, 447
 Arizona (USA) 5, **173–7**, 179
 Chimney Springs 198
 Flagstaff 11
 Grand Canyon 174
 Laboratory of Tree Ring Research,
 University of Arizona 11
 Navajo Indian Reservation 28
 Pinaleno Mountains 28
 range expansion of pines (20th century)
 22, 451
 Santa Catalina Mountains 174–6
 Wupatki National Monument 174
 Arkansas (USA)
 Ouachita Mountains 140
 Asia 5–7, 15, 19–20, 34, 49, 81, 204, 265,
 393, 397, 408, 413
 eastern 7–8, 10, 12, 16, 49, 69, 73–4, 83,
 86, 341
 central 7, 16
 northeastern 95–103, 202
 northern 8, 107, 122
 South East 24, 28, 33, 82, 84, 211, 224,
 312, 342–3
 range expansions (20th century) 451
 Asia Minor 155, 417
 Atlas Mountains, High – see **Morocco**
 Australia
 Australian Capital Territory xv, 440,
 453, **455–7**, 459
 New South Wales 440, **442**
 Queensland 291, 440, 453–4, 456–8,
 461
 pines as invaders xv, 211–12, **454**, 457,
 459
 plantations 31, 219, 421, 439–41, 446
 afforestation history 333, 417, 421,
 433, 436, 453
 bioclimatic modelling 445–6
 diseases 398
 impacts on soil properties 347–8
 insect pests 370–3
 mycorrhizal fungi 326, 333–4
 silviculture **442**, 445
 South Australia 417, 440, 453–4, 457
 species/provenance trials 420
 Tasmania 440
 tree breeding 271, 437–8, 439
 Victoria 440, 457–8, 465, 467
 Western Australia 291, 419, **438**, 440,
 445, 453, 457, 459, 462
 Austria 18, 159, 266
 Alps 16, 285, **308–9**
 Institute for Subalpine Forest Research
 308
 Tyrol (Tirol) 29
 Zirbenwald **111**
 Azerbaijan 30, 158
 ancient plantings 30
 Eliar-Ugi 261
 Bahama Islands 22, 212, 265
 Balkan Peninsula 6, 18–19, 26, 107, 118,
 154–6
 bark
 thickness (adaptation to fire) 14, 196,
 198, 201–2, 204, 207, 210, 212,
 223–6, **231–2**, 237, 250
 see also **human uses of pines: food**
 Belgium 70, 74

- Belize 10, 22-3, 138, **143-5**, 212, 265-6, 284, 382
- Beringia 69
 trans-Beringian immigrants 291
- Bering Sea 73
- Bhutan 20
- bioclimatic modelling 420, 445-6
- biological invasions - see **invaders, pines as**
- birds
 pine forest as habitat for 37, 210, 459
 seed dispersers 238-9, 260, **260-1**, 272-3, 289, **290-1**
 seed predators 238
- bogs 30
- Bolivia 444
- boreal forest 3, 12, 14-15, 16-19, 84, **99**, **102**, 107, **111**, 114, 124-5, 202-4, 208-9, 210-11, 229, 329-31, 341-3, 418, 420, {476}
- Brazil
 pines as invaders 457
 plantations 212, 421, 457
 afforestation history 421
 mycorrhizal fungi 334-5
 species/provenance trials 420
- Britain - see **United Kingdom**
- Bulgaria 19, 27, 266
 Rhodope Mountains 112-13, 118
 Rila Mountains 118
- Burma - see **Myanmar**
- California (USA) 5-7, 10-11, 13, 20-1, 27, 36-7, 49, 78, 85, 130, 164, **177**, 198, 229-30, 235, 255, 265-7, 270-2, 327, 388-9, 394, 436, 439, 447
 Año Nuevo 435, 437
 Cambria 434-5, 437
 Cascade Mountains 271
 Channel Islands 21, 434
 Coast Ranges 21, 129, 131, 262
 diseases 270, 391, 398, 444
 fossil pines 76
 historic land use 31
 Inyo National Forest **291**
 Joshua Tree National Monument 175
 Kings Canyon National Park 11, 178
 Kumenay Indians 31, 410
 Laguna Mountains 262
 logging 29, 272
 high-grading 386
 Mendocino County 27, **343**
 Monterey 31, 432-3, 435, **437**
 Mount Diablo 262
 Oakland 212
 Peninsular Ranges 227, 262
 Pico Creek 435
 pollution **313-14**
 range expansion of pines (20th century) 451
- San Bernardino Mountains 32, 314
 San Diego 21, 75, 175, 443
 San Jacinto Mountains 175
 San Joaquin Valley 178
 Santa Barbara County 30, 178
 Santa Cruz County 391, 435
 Santa Cruz Island (California Channel Islands) 434
 Santa Lucia Mountains 262
 Santa Rosa Island (California Channel Islands) 21, 434
 Sequoia National Park **311**, **313-14**
 Sierra Nevada 5-7, 10-11, **16-17**, 21, 25-7, 31, 83, 84, **128**, 130-1, 178, 227, **261**, **269**, 292, 306, 310-11, **313-14**, 389
 Transverse Ranges 227, 262
 University of, 438
 White Mountains 11, 13, **221**, 308-9
 Yosemite Valley 388
- CAMCORE 37, 273, {476}
- Cambodia 24-5, 284
- Canada 5-7, 17, 27, 74, 122-3, 127, 132, 143, 265, 335, 346, 354-75, 394, 419
 Alberta **126-8**, 132, 265, 283, 397
 British Columbia 5, 75-6, 78-9, 84, 122, **126-7**, 129-31, 255, 265-6, 324, 384, 386, 388, 416, 443
 Cordillera 131
 Ellsmere Island 75-6
 fossil pines 76, 79, 82, 138
 Great Slave Lake **126**
 Labrador 132
 Manitoba 124, 265
 McKenzie Delta 76, 81-2, 127
 New Brunswick 266
 Northwest Territories **15**, **126-8**
 Banks Island 81
 Nova Scotia 15, 124, 266
 Ontario 30, 32, 125-6, 265-6, 271, 368, 390, 470
 plantations 421
 pollution 32
 Quebec 125, 265-6
 Saskatchewan **126-8**
 Yukon Territory 26, **126-7**, 132-3, 265
- Canary Islands - see **Spain**
- Caribbean region 5, 22, 55, 84, 312-13, 382
- Carpathian Mountains, C and E Europe 18, 107, 159
- Cascade Mountains 27, 84, 129-31, 310
 see also **California, Oregon, Washington**
- Caucasus Mountains 26
- Cedros Island - see **Mexico: Baja California**
- Cenozoic 70-1, 73, 137, 141, {476}
 see also **Quaternary, Tertiary**
- Central America 5-7, 22-4, 33, 49, 55-6, 82, 84-7, 137-47, 171, 211, 230, 265-6, 312-13, 333, 341-3, 393, 408-10, 412-13
- chaparral 21, **25**, 175, 229, **231**, 445
- charcoal
 see also **human use of pines**
 fossil 111, 131, 162, 177, 232, 409, 411
- Chile
 pines as invaders **455**, 457-8
 plantations 31, 35, 421, 439-41, 446
 afforestation history 421, 433
 diseases 394, 398
 insect pests 371-2
 mycorrhizal fungi 334
 silvo-pastoral systems 419
 tree breeding 438
- China, People's Republic of 5-7, 10, **19-20**, 29, 36, 49, 74-5, 98-9, 265, 267, 335, 407, 412, 415
- central 5, 20
 Han Jiang delta **99**
 Hubei Province **99**, 101
 diseases 394, 398
 distribution of *Pinus* in **99**
 eastern 5, 19, 95
 Lower Yangtze River valley **99**
 fossil pines 75-6, 79
 logging 30
 northern/northeastern/northwestern 5, 27, 29, 79, 81, 84, 202-3, 292
 Altai mountains 99, 107
 Beijing **99-100**
 Changbai Mountain **99-100**
 Fushun 75-6
 Gansu 79, 81
 Inner Mongolia 20, 26, 95, 99
 Liaodong Peninsula **99-100**
 Loess Plateau 100
 Manchuria 19-20
 Heilongjiang Province 19
 Quidam 79, 81
 Xiao Xingan **99**
 Xingan Range 100
 Xinjiang 96
 plantations 394, 421
 range expansions (20th century) 451
 southern/southeastern/southwestern 19, 24, 30, 101, 382
 Fujian **99**, 101
 Guangdong Province 32, 98, 100
 Leizhou Peninsula **99-100**
 Hainan 20, 98
 Hong Kong **19**
 Sichuan 20, **99**, 101
 Yangtze River delta **99-100**
 Yunnan Province 20, 36, 98-9, 100
- western 5
 Qinghai 95, **99-100**
- climate 4, 73, 282
 role of pine forests on 3

- role in promoting flammability 202, 207
- climate change
 implications for plantation forestry 421
 influence on disturbance regimes 204, 211
- role in pine migrations (historical) 8, 73–83, 86, 95–6, 99, 101–3, 113, 115–18, 122–3, 125–6, 128–9, 131–2, 142
- role in pine migrations (recent) 30, 180, 451
- shifts in physiology and morphology in response to 39
- cline {477}
 cone serotiny 228–9, 270
 gene frequency 262, 270
 growth 270
 needle longevity 13
- closed-cone pines – see **serotiny**
- CO₂ – elevated 315
- cold-tolerance 16, 96, 98, 102, 112, 125, 232, 300, 306–9, 311, 445
- Colombia 444, 457
 species/provenance trials 420
- Colorado (USA) 27–8, 75, **128**, **173–4**, 265–6, 384, 389, 411
- Creede 8, 75, 79, 82
- fossil pines 8, 75–6, 79, 82, 84
- Mesa Verde National Park 11, 389
- Owl Canyon 175
- range expansion of pines (20th century) 451
- Rocky Mountain National Park **290**
- Rocky Mountains 263, **283**
- Colorado Plateau (USA) 174, 176
- Commonwealth Agricultural Bureau 38
- Commonwealth Scientific and Industrial Research Organization (CSIRO) 437
- conductance, stomatal 14, 298–9, 300, **303**, 307, 310–13, {488}
- cone
 development 234–5
 length 5–7, 250, **287**
 morphology 9, 11–12, 57, **235**
 pollen **252**
 production 235–6, 241
 seed **252**
- Congo 335
- Conifer Specialist Group (IUCN) 37–8, 40
- Connecticut (USA) **18**
- conservation 272
ex situ 37, 147, 272, 437–8
in situ 19, 147, 272
 status 33–4, 37, 435, 437
- Costa Rica 141, 212
- Cretacean Sea 138–**40**, 142
- Cretaceous 3–4, 69–74, 81, 83, 86–7, 95, 138–9, 142, {477}
- Crimea 158
- Critchfield, William Burke (1923–1989) xv, 39, 122, 133
- Croatia 18
- Cuba 5–7, 22–3, 141, 144, **427**
 Isle of Youth 144
- Cyprus 417
- dendroarchaeology 162–3, {477}
- dendrochronology 11, 16, 117
- desert 222, 239, 310, **435**
 Chihuahuan 173–4
 Mojave 176, 178
 Sonoran 176, 178
- DNA 39, 49, 54, 56–8, 60–3, 154, 254, 258–9, 268, 331, 390, 462
- Delaware (USA) 71
- Denmark 408, 419
- Devonian 3, {477}
- disease(s) 381–99, 420–1
 canker diseases 389–92, **392**, 398, {476}
 fire, interactions with 381–2, 384, 388
 littleleaf 332, 381, 389, 395, 398
 milestones 398
 needles **392–3**, 398, 439, 443
 nematodes, caused by 397–8
 resistance **436**
 ring rots 385, 398
 root rots 381, **385–6**, 387–8
 rusts 31, 35–6, **386**, 394–8, **436**, {487}
 stem rots 384–5, 398, {488}
 wildlife habitat 37, 398
- dolomite 18, 159–**60**, 163, **221**
- domestication 271–2
- Dominican Republic **427**
- drought **222**, 228, 300, 445
 avoiders 306–7, {478}
 impact on population structure **222**
 insects and 374–5
 stress 236, 311, 374–5
 tolerance 112, 160, 198, 305, 307, 309–10, **436**
 see also **water relations**
- East Africa 334, 393
- ecological plasticity 17–19, 26–7, 39, 161, 165–6
- ecophysiology 13–14, 296–316
- ecotypes 14, 26–7, 187, 236, 251, 271–2, 311
- Ecuador
 agroforestry 419
 plantations 439, 444
- Egypt 74, 408–9, 417
- El Salvador 34, 138, 140, **143–4**, 266
- England
 afforestation 18, 416, 444
 fossil pollen 74, 109–10
 Surrey **347**
 see also **United Kingdom**
- Eocene 8, 69–70, 74–8, 82–6, 95, 122, 141–2, 172, 324, {478}
- étage* **160**, 161, {478}
- Eurasia 12, 27, 49, 59–60, 81–2, 84–5, 366, 407
- Europe 5–8, 34, 36, 81, 107–18, 204, 265, 309, 349, 387, 394, 409, 415, 417
 central 5, 16, 36, 107, 111–13, 159, 312, 372
 eastern 74, 267, 415
 northeastern 113
 northern 15–16, 26, 113, 116, 118, 122, 344–5
 northwestern 113
 southern 85, 107, 111–13, 117, 342, 387, 393, 408, 412
 southeastern 75, 82
 southwestern 165
 western 15, 70, 73–4, 84, 122, 421
 see also **Mediterranean Basin**
- European Union 165
- Fennoscandia 14, 107, 113
- fertilization **252–3**
- Fiji 212, 420–1
- Finland **111**, 113, 202, 270, 291, 373, 414, **426–7**
- fire
 cigarette burns **205–6**
 crown 202, 205, 207–10, 212, 220–1, 225–6, 228–32, 239, 241
 early use by humans 33, 164, 193–4, 408
 frequency **220**
 decreased 28, 30, 33, 36, 179, 200, 211–12, **225**, 231, 388, 396–8, 451
 increased 28, 33, 164–5, 212
 grazing/browsing interactions 28, 29, 30, 33–4, 165, 179, 451
 hazard 166
 history 11, **195**, 198, 202, 232
 ignition sources 33, 193–4
 see also **lightning**
 insect interactions **203–6**, 368, 451
 intensity **97**, 196–7, **201**, **209**, 220
 invasions, role in 211–12, 460–1, 463–7
 morphological adaptations of pines to 193, 196, 220, 223
 nutrient cycling, role in 194–5, 343
 pathogen interactions 204–6, **383–4**
 prescribed 200, 207, 211–12, 435, {486}
 regimes 16, 20, 22, **23–5**, 28, 33, **97**, **195**, 196–**203**, 204–13, 223–5, 227–32, 234, 238–9, 241, 250
 changes due to human activities 20, 25, 33
 see also **fire: frequency**
- scars **205**
 inferring fire history from 11, **195**, 198, 202, 232
 see also **dendrochronology**
- stand-replacing 202–3, 204, 207–8, **220**, **239**
- stand-thinning 202, **220**, **239**
- suppression – see **fire frequency**

522 / Subject Index

- fire (*cont.*)
 surface 23, 28, 201–2, 205, 207–10, {488}
- fog 12, 435–6, 445, 447
- Food and Agriculture Organization (FAO) 438
- forest protection and management – see **silviculture**
- forestry 35
 see also **plantations**
- founder effect 83, 133, 262, 273
- Florida (USA) 28, 144, 229, 298, 391, 395
 Everglades National Park 23
 plantations 312
- France 18, 74, 155–8, 163, 165, 284, 412–15
 afforestation 18, 22, 31, 156–7, 164, 416, 421
 Alps 159
 Bordeaux 416
 Cévennes Mountains 31, 164
 Corsica 18, 155, 158–9, 162, 266
 diseases 393–4
 fossil pines 71
 Gascony 411, 414, 416, 419
 Hérault region 18
 Jura Mountains 30
 Landes 158, 416, 418–19, 424–5
 Languedoc 30, 163
 Lascaux Cave 409
 Massif Central 31, 156
 Mont Aigoual 31
 Montpellier 4, 21, 164, 208
 mycorrhiza 335
 plantations 444–5
 pollen records 111
 Provence–Alpes–Côte D'Azur 165
 Maures–Estérel region 22, 158, 164
 Provence 155, 162
 Riviera 207
 Pyrenees 29, 387
 range expansions (20th century) 165, 451
 Restauration des Terrains de Montagne 35
 species/provenance trials 420
 frost 166, 210, 300, 308–10, 312, 445
 fuelwood – see **human use of pines**
- fynbos (South Africa), pines as invaders
 in xv, 211–12, 452–3, 455, 458–70
- genetic(s)
 contamination 435
 diversity 9, 26–7, 36–7, 127, 129, 132–3, 177, 262, 265–7, 270, 446, 462
 drift 103, {478}
 founder effect 262
 electrophoresis 60, 254–5, 259, {478}
 genome 60–3, 255, 258–9, 268, 462, {478}
- Hardy–Weinberg equilibrium 254, {480}
- heterozygosity 262
- hybridization and introgression 22, 58–9, 127, 137–8, 143–6, 159, 172, 174, 175–6, 178, 259–60, {481}
- inbreeding 10, 255–7, 263, 269–70, {481}
- isozymes 251, 254–6, 260–2, 264, 271, 273, {481}
- lethal equivalents 268
- linkage 254, {482}
- mating system 255–7
- mutation system 264, 268–9
- organelle inheritance 254–5
- pollution 165–6
- recombination system 257–64
- segregation 254
- system 251–69
- variation 86, 269–71
- Genus Pinus, The* (book) xvi, 38–40, 193, 180, 296
- Georgia (USA) 202, 335
 Macon 4
- Germany 18, 36, 74, 266, 270, 284, 345, 346, 414–16, 419–20, 426
 silviculture 424
- Ghana 335
- glacial maximum 95, 98–102, 127–8, 129–30, 140
- glacial periods 95, 86
- Glacier National Park – see **Montana**
- goats – role of browsing by 28
- Gondwanaland 70
- gradients – altitude 13, 138, 270
- Grand Canyon – see **Arizona**
- Great Basin (USA) 9, 29, 37, 39, 84, 128, 130–1, 176–7, 179, 306–7, 310
 logging 29
- Great Lakes region, North America 17, 124–5, 127, 132–3, 342, 390
- Greece 18–19, 26–7, 34, 107, 112, 154–5, 156, 159, 207, 265–6, 413, 415, 444
 Classical Greece 408–13
 Crete 408, 424
 forest destruction 417
 forest recovery 30
 fossil pines 82
 Greek Civilization 424
 Minoan Culture 408–9
 Mount Olympus 161
 Pindus Mountains 118
 Rhodes 413, 417
- Greenland 74–6, 117
- growth form 10–11
 Massart's model 13
 Rauh's model 13
- Guadalupe Island – see **Mexico: Baja California**
- Guatemala 5–7, 24, 29, 138–40, 143, 144–5, 146, 411
- Guernsey 426
- gymnosperms
 comparisons between pines and other 9–10
 decline of 3
 origin of 3
- hail damage 390–2, 422, 442
- Haiti 28, 31, 142, 391
- Hawaii (USA)
 pines as invaders 457
 species/provenance trials 420
- herbivory
 browsing 20, 28, 30, 33–4, 435–7, 465
 granivory 237–8
 grazing 28–9, 33–4, 179, 211, 457, 465, 469
 insects 236–7, 368, 370–1
- Himalayas 5–7, 16, 78, 82, 382, 393
 see also **Tibet**
- Hispaniola 6
- HIV – the role of pine cone extracts in combating 37
- Holocene 9–10, 18, 21, 26–7, 30, {70}, 96, 98–103, 110, 112–18, 123–5, 128, 130–2, 142, 171–8, 180, 348, 408–9, {481}
 climate 21, 112–17, 174
- Hong Kong – see **China**
- Honduras 10, 22–3, 138, 140, 143–5, 212, 225–6, 284
- human use of pines 179
 agroforestry 419
 ancient 27, 408, 424
 charcoal 29, 179, 415, 417, 424
 Christmas trees 392–4, 424, 443, 445
 cone extracts 37
 erosion control 157–8, 455
 firewood 29, 34, 174, 179, 211, 407–9
 food
 bark 34, 416, 424
 seeds (nuts) 23, 29, 31, 34, 156, 171, 175, 178–9, 209, 408–19, 411, 414, 416, 418–19, 424
 needles 416, 424
 ornamental 411–12, 414, 416, 419, 424
 religious and ceremonial uses 409, 411
 resin and derived products 409, 411, 413, 415–16, 418–19, 424
 retsina 411
 ship building 34, 409–11, 413–14
 solid wood products 410, 413, 415, 417–18, 424
 wood fibre products 415, 418, 424
- Hungary 111, 113, 266
- hurricane, damage to pine forests 23, 234, 241, 313
- hybridization – see **genetics**
- hybrid zone 22, 155, 174–5, 176

- Iberian Peninsula 107, 112–13, 412
 see also **Portugal, Spain**
- Iceland 75–6, 420
- Ice Sheet
 Cordilleran 129
 Laurentide 125
- Idaho (USA) 35, 171, 177–8, 386, 266, 388
 fossil pines 75–6, 79, 81, 84, 122
 range expansion of pines (20th century)
 451
 Snake River Plain 128–31
 Thunder Mountain 75–6, 82
- India 29, 418–19
 Assam Hills 24
 Kumaun 31
 Kunawar 409
 plantations
 mycorrhizal fungi 327, 334–5
 Punjab 6
 range expansions (20th century) 451
 species/provenance trials 420
 Uttar Pradesh 20
- Indonesia 418
- insect(s)
 bark beetles 36, 200, 203–4, 206, 237,
 355, 363–4, 366–71, 373–5, 384,
 388–9, 391, 398, 443–4
 budworms 364–5, 368, 372
 click beetles 356
 community structure 356–65
 cone beetles 362–3, 365, 367, 467
 counter-offensives to pine defences
 370–1
 diversity 355–6
 fauna
 Canada 354–5, 356–7, 358–75
 USA 354–5, 356–7, 358–75
 herbivory, effect on pines 367–9
 host-specificity 357–9
 life-history adaptations 365–6
 management 371, 372–4
 monophagous 355, 357–61
 oligophagous 355, 357–61
 outbreaks 22, 32, 237, 354, 368–9,
 374–5
 pathogen interactions 388, 398
 polyphagous 355, 357–61
 sawflies 355, 359–61, 362, 368, 370–3,
 373–5,
 tree defence against 369–70
 weevils 362–3, 364, 366–8, 372–4
 wood borers 364, 366, 397
 see also **Index of biota and taxa**
- Institute of Forest Genetics, Placerville,
 California 58, 259
- interglacials 86, 142, 171, 175, 262,
 {482}
- invaders, pines as
 biological control, prospects for 372,
 467–8
 coastal dunes 457–8
- colonization 257
 determinants of weediness 460–2, 465
 disturbance, the role of 463, 465–6
 fire, role of 211–12, 463–7
 forest 457–8, 463–6
 fynbos xv, 452–3, 455, 458–70
 grassland 457–8, 466
 hybrids 459, 469
 impacts 457–8
 in the natural range of *Pinus* 451
 in the southern hemisphere 211–12,
 444, 450–73
 invasion patterns 463
 management 212, 466–9
 modelling 463–6
 mycorrhiza, role of 33, 463, 465
 savanna 457
 screening protocols 469
 shrublands 457
 see also **invaders, pines as: fynbos**
- Iran 158, 412
- Ireland 30, 110, 113, 115–16, 408, 444
- Isle of Skye – see **Scotland**
- Isle of Youth, Cuba – see **Cuba**
- Israel 162–3, 265, 427
 afforestation 30, 419, 421, 444
 range expansion of pines (20th century)
 30, 451
- Italy 18–19, 107, 110, 112, 156, 158–9, 164,
 265–6, 390, 411–14, 418
 afforestation 30, 156–7, 444
 Alps 113, 118
 Apennine Mountains 26
 Bergama 159
 Calabria 11, 30, 157–9, 413
 Mount Amiata 30
 plantations 439
 Roman Civilization 424
 Rome 112
 Sicily 159
 Tuscany 157–8
- Jamaica 141, 393
- Japan 5–8, 10, 13, 16, 19, 34, 70, 73–4, 95,
 97–8, 101–2, 194, 197, 265
 diseases 370, 390–1, 397–8
 fossil pines 75–6, 81, 83, 85
 Hokkaido 71, 101–2, 292
 Honshu 19, 30, 102
 Kyushu 30, 102
 pines as ornamentals 412, 414
 pollen records 30
 Ryukyu Islands 6, 20
 Shikoku 19, 30, 102
 species/provenance trials 420
- Jurassic 3, 69–70, 95, {482}
- juvenile period 204, 235–6, 240, 281–2,
 462, 465
- Kansas (USA) 71, 138–9
- Kazakhstan 79, 113
- Kenya
 plantations 443, 457
 mycorrhizal fungi 334
 species/provenance trials 420
- Korea 97–8, 417
 North 19
 South 5–7, 19, 34
 mycorrhiza 335
 pollution 32
 species/provenance trials 420
- krummholz 10, 16, 130, 285, 308–10,
 {482}
- land abandonment 30, 35, 126, 163–4,
 165, 412, 421, 451
 see also **old fields**
- land clearance 29–30, 179, 412, 451
- landraces 271, 456, {482}
- Lanner, Ronald M. xvi
- Laos 24–5
- Lapland 115
- Latvia 267
- Laurasia 4, 70, 73
- leaf area index (LAI) 13–14, 35, {482}
- leaves, of pine – see **needles**
- Lebanon 155, 163, 409, 412, 414, 417
- Liberia 335
- Libya 158
- life-history strategies 10, 220–34
 fire 197
- lightning 193, 200–11, 207
- limestone 20, 107, 139, 159–60, 173, 453,
 457
- Little Ice Age 204
- logging 29–31, 34, 36, 272, 413, 451
- longevity (whole-tree) 10–11, 17, 97, 204,
 221, 227, 230–1, 233–4, 239–40,
 250, 385
- Louisiana (USA) 259, 395
- Macedonia 411
- macroecology 183–90, {482}
- Madagascar, pines as invaders 457–8
- Maine (USA) 266, 396
- Malawi
 mycorrhiza 335
 pines as invaders 457–8
 species/provenance trials 420
- Malaysia 25, 74, 421
 Borneo 83
 fossil pines 75–6, 79, 81–2, 84
- Malta 153
- marls 159–60, 163
- Maryland (USA) 71, 395
- Massachusetts (USA) 71, 266
- Nantucket Island 29, 34
- Mediterranean Basin 5–7, 10, 12, 21, 26–7,
 31, 82, 107, 153–70, 206–8, 230,
 265–6, 407–10, 412–13, 417, 419,
 421
 pollen analyses 161–2

524 / Subject Index

- mediterranean-climate habitats 20-1
 megagametophyte 252-5, 257
 Mesopotamia 408, 410, 417
 Mesozoic 4, 39, 69-73, 75, 78, 81, 83-5, {483}
 see also **Cretaceous, Jurassic, Triassic**
 Mexico 5-10, 12, 21, 27, 29, 33-4, 49, 55, 69, 78, 82, 84, 85-6, 137-47, 172-3, 230, 266, 272-3, 284, 306, 335, 382, 409, 412-14
 Baja California 5-7, 12, 21, 138, 175, 178, 227, 230, 262, 265, 270
 Cedros Island 12, 21, 27, 34, 271, 434-5, **436**, 439
 Guadalupe Island 21, 27-8, 271, 434-5, 436-7, 439
 La Cataviña 175
 La Rumorosa **172**
 Paso San Matías **178**
 Sierra Juárez **143**, **176**
 Sierra San Pedro Mártir **143**, 175
 Chiapas 79, 81, 82, 141, 145
 City 32
 Coahuila 174
 diseases 391, 398
 Durango **139**, 174
 fossil Pinaceae 79, 81-5, **141**
 Gulf of 138-9
 Hidalgo **23**
 Isthmus of Tehuantepec 138-9
 Lake Patzcuaro
 Macizo de Oaxaca **143**
 Michoacan 28
 Nuevo Leon, 265
 Oaxaca 24
 plantations 32
 Puebla 171
 San Luis Potosí 175
 Sierra de Morones 29
 Sierra Madre de Chiapas 85, **143**
 Sierra Madre del Sur 85, **143**
 Sierra Madre Occidental 17, 23-4, 85, 138-9, 140, 142-3
 Sierra Madre Oriental 24, 85, 138-40, 142-3, **145**
 Sonora 144, 179
 Spanish conquest of 146
 Tamaulipas 140, 175
 Transvolcanic Belt 85, 138-9, **143-5**
 Veracruz 81-2, **141**, 146
 Yucatán Peninsula 138, 146
 Michigan (USA) 126, 210, 233, 271
 migration
 postglacial 8-9, **96**, **97-8**, **123-8**, **129**, 130-3, 142, 262, 271
 rates 9, 130, 132, 262
 mining, impacts on pine forests 29, 30, 34-5, 417, 450
 Minnesota (USA) 30, 71, 124, 138-9, 232, 266, 348
 Minoan Culture - see **Greece**
 Miocene 70, 78, 81-2, 85, 140-2, 161-2, {483}
 Mirov, Nicholas Tiho (1893-1980) xvi, 180, 298
 Mississippi (USA) 71, 78, 259
 monocultures - see **plantations**
 monoterpenes 118, 158, 236-7, 369-70, 373
 Montana (USA) 35, **128**, 266, 388
 fossil pines 79, 81, 84, 122
 Glacier National Park 35, 130-1
 Morocco 22, 155, 158, 165-6, 412
 afforestation 158, 444
 High Atlas Mountains **161**, 162
 Rif Mountains 156
 Myanmar (Burma) 20, 24-5, 211
 range expansions (20th century) 451
 mycorrhiza 33, 324-36, 463, 465
 colonization process 325-6
 early experiments 324-5
 epidemiology 326-7
 evolutionary implications for pines 39, 336
 extramatrical mycelial system **326-7**, 328
 fungal successions 326-7
 Hartig net **324**, **326**, {480}
 nutrient capture, enhancement of 328-32
 resistance to fungal pathogens, enhancement of 332-3
 resistance to toxicity, enhancement of 332
 soil type, influence of 343
 mythology, pines in 411
 Namibia 421
 Nantucket Island - see **Massachusetts**
 Near East 111, 155, 163
 Nebraska (USA) 74, **128**
 range expansion of pines (20th century) 451
 needles, pine (leaves)
 longevity 5-7, 13, 32, 310
 morphology 5-7, 12-13, 54, 56, 297, 303
 nutrient content **300**
 Neogene 70, 78, 83, {484}
 see also **Pliocene, Miocene**
 Nepal, range expansions (20th century) 31, 451
 Netherlands 346
 Nevada (USA) 37, **128**, **173**, **177**, 265, 267, 417
 fossil pines 75-6, 83, 131
 range expansion of pines (20th century) 451
 Sierra Nevada 292
 Toquima Range 177
 Truckee **4**
 New Caledonia **454**, 456-7
 New England (USA) 17, 35
 New Hampshire (USA) 265-6, 291-2
 New Jersey (USA) 71, 266
 Pine Barrens 18, 228, 270, 312
 Pine Plains 270
 New Mexico (USA) 5-7, **173-4**, 176, 179, 307
 Chaco Canyon 11, 29
 Coyote Hills 174
 Florida Mountains **172**
 fossil pines 75-6, 79
 historic use of pines 29
 range expansion of pines (20th century) 451
 New York (USA) 71, 265
 diseases 390-1, 398
 Pine Barrens 18, 312
 range expansion of pines (20th century) 451
 New Zealand **419**, **426**
 agroforestry 419
 pines as invaders 211-12, **257**, **454-5**, 457-9
 plantations 31, 421, 432, 439-41, 446
 afforestation history 417, 421, 433, 436, 453-5
 diseases **393-4**, 398
 impacts on soil properties 347-8
 insect pests 370-1
 mycorrhizal fungi 333-4
 silviculture **441**
 species/provenance trials 420
 tree breeding 37, 437-9
 New Zealand Forest Research Institute 438
 Nicaragua 10, 22, 28, 138-9, **143-4**, 212, 225, 266
 Nigeria
 agroforestry 419
 plantations
 mycorrhizal fungi 333-5
 North Africa 155, 162-3, 407, 417
 see also **Algeria, Egypt, Morocco, Tunisia**
 North America, see **Canada, USA** (and individual states)
 North Carolina (USA) 267
 North Dakota (USA) 76, 79, **128**
 Norway 15, 115-16, 415, 418-19
 nutrient(s)
 cycling 194, 211, 343, 347-9, 354, 363, 368, 459
 role in photosynthesis **301**
 nuts - harvesting 29, 209
 see also **human use of pines**
 old fields 17, 30, 381, 451
 see also **land abandonment**
 Oligocene 69-70, 75, 78-81, 82-5, 122, 142, {484}
 Olympic Peninsula - see **Washington**

- Oregon (USA) 5-7, 129, 130-1, **200**, 204, 230, 265, 306, 384, 444-5
 Cascade Mountains **128**, 227, 271, **386**
 Crater Lake **205**
 fossil pines 79, 81
 Fremont National Forest **205**
 range expansion of pines (20th century) 451
 Willamette Valley **128-9**
 Oxford Forestry Institute, UK 38, 272
 Ozark Plateau (USA) 138, 140, 142
- Pacific Northwest (North America) 8, 10, 17, 36, 78, **128-33**, 198, 303, 386
 packrat middens 9, 39, 172-8, {484}
 Pakistan 6, 20, 29, 284, 444
 ancient plantings 30, 412-13
 Suleiman Mountains 34, 418
 Palaeocene 69-70, 74, 78, 83, {484}
 Palaeogene 69-70, 74-5, 78, 81, 83, 86, {484}
 see also **Eocene, Oligocene, Palaeocene**
 Palaeozoic 70, {484}
 palmettos 22
 Panama 141, 212
 Pangaea 70, 73
 Papua New Guinea 393
 pastoralism 20, 408
 peat 95-6, 98, 100, 107, 108, 115-17, 122, 202, 372, 470
 blanket 115-17
 cutting, influence on pine regeneration 30
 Pennsylvania (USA) 124, 266
 permafrost 111, 113, 342
 Peru 444
 'peuke' 410
 Philippines
 Luzon 24-5
 Mindoro 25
 range expansions (20th century) 451
 species/provenance trials 420
 photosynthesis 14, 296-9, **303**
 effects of leaf and tree age 301-2
 impact of pollution **314**
 nutrients **301**
 response to soil and atmospheric water deficits 300
 seasonal variation 14, 298-300, **308**, **311**
 temperature 299-300
 phylogeny 39, 49-68, 85, 461
 Piedmont region, eastern USA 17, 312, 389
 pine barrens 18
 see also **New Jersey, New York, Wisconsin**
Pines of Rome, The (O. Respighi) 3
 pinyon-juniper woodlands 21-2, 26, 28, 29, 33, 174-5, 179, 306, 389, 411
 chaining **179**
 pinyon pines 21-2, 33, 55, 171-80, 222-3, 409, 411, 414, 416-18, 424, {485}
 see also *Cembroides* in *Index of biota and taxa*
 'pitys' 410
 plantations 35, 333-5, 345, 371, 388, 396-8, 419-20, 439-**443**, 444-6, **464**
 impacts on ecosystems and biodiversity 35, 419-20
 see also **forestry** and country accounts
 Pleistocene 8, 26, 69-70, 86, 95, 99, 101, 132, 140-3, 172-8, 238, **262**, 270, 408, {485}
 Pliocene 70, 140-2, {485}
 Poland 18, 266-7, 413, **426-7**
 pollen
 accumulation rate **126**
 diagrams **112**, **116**
 dispersal 108, 123, 162, 262-3, 273
 fossils 95, **96-7**, **99**
 maps 9, 112, **114**, 124-5
 morphology 108, 122
 production 122, 262-4, 273
 release 234
 pollination **252**, 282
 controlled **386**, 439
 open- 282
 self- 282
 pollution
 air (including acid rain) 32, 36, **313-14**
 changes in soil acidity 344-6
 ecophysiological impacts 313-15
 insect attack and 36, 373-4
 ozone 313-15
 SO₂ 313-15
 Portugal 18, 26, **157**, 412-14, 416, 418-19
 afforestation 158, 164, 419, 421, 425, 444
 fossil charcoal 111
 Leiria forest 414, **424**
 Madeira 413, 416
 see also **Iberian Peninsula**
 postage stamps - pines depicted on **426-7**
 Puerto Rico 142
 mycorrhizal fungi 333-4
 species/provenance trials 420
 Pyrenees 107, 156
 see also **France**
- Quaternary 9, 21, 25, 69-70, 74, 85, 86, 95-103, 107-18, 122-33, 141-2, {486}
 see also **Holocene, Pleistocene**
- range expansion of pines (Holocene) 30, 33, 100, 102, 113, 115, 117-18, 158, 162-4, **173-5**, 176-7, 262
 range expansion of pines (20th century) 29-30, 34, 157, 164-5, 179
- Rapoport's Rule 184-9, {486}
 refugia 8, 82-6, 95, 97, 100, 111, 124, 127-8, 131-2, 142
 reproductive system 251-5
 life cycle **252**
 resinosis 20
 respiration
 foliage 306, 308
 woody tissue 306
 resprouting 24, 196, 223, 225-6, 241, 250, 251
 Rhodope Mountains - see **Bulgaria**
 Rif Mountains - see **Morocco**
 Rila Mountains - see **Bulgaria**
 Rocky Mountains 5, 8-10, 15, 17, 26-7, 75-8, 84, 122, 127-8, 129-31, 140, 174-5, 196, 204, 227-8, 266, 289, 307, 310-11, 314, 382
 see also **Colorado**
 Romania 82
 Russia 15, 74, 97-8, 202, 265-7, 270, 413, 415
 fossil pines 76
 Kamchatka Peninsula **96-8**, 266
 Sakhalin Island **96-8**, 266
 Siberia 8, 15-16, 19, 26, 73-6, 85, 95-7, 98, 102, 107, 202-3, 266, 409, 418
 Transurals 204
- sandhill communities 28, 201
 sandstone **160**, 341
 San Marino, S Europe **427**
 Santa Cruz Island - see **California**
 Santa Rosa Island - see **California**
 savanna, pine 12, 14, **19**, 22-4, 28, 198, **201**, 211-12
 Scandinavia 15, 18, 107, 115-16, 159, 212, 270, 390
 species/provenance trials 420
 SCOPE programme on biological invasions 39
 Scotland 18, 28, 113-16, 202, 267, 469
 afforestation 416
 Cairngorm Mountains **115**
 diseases 390
 Hebrides (Western Islands) 115
 insect pests 372
 Isle of Skye **116**
 plantations 390
 Rannoch Moor **115**
 Scottish Highlands 26, 414
 species/provenance trials 420
 see also **United Kingdom**
 'secret extinctions' 36
 sedge meadows 28
 seed(s)
 accumulation 467
 altitude **269**, 285
 coat 240
 crops, intervals between **462**, 465
 development 234

526 / Subject Index

- seed(s) (*cont.*)
 dispersal 234–5, 238–9, **260–3**, 272–3,
 281–95, 467
 by birds 238–9, 260–1, 273, 289,
290–1
 by mammals 238–9, 261, 291–2, 461
 by wind 232, 238, 240, 288–9, 292–3,
 463
 distance **260**
 genetic implications 260–3
 long-distance 261–3
 over ice and snow 289
 rate of fall 288
 dormancy 291, 412
 germination 236, 466
 length **235**, 285
 mass 250, 285, **462**, 465
 role of altitude 285
 mast seeding 235–6, 250, 282–3, 416
 morphology 9, 11–12, 284, 285, **286–7**
 predation 235–6, 238, 240, 467
 production 204, 206, 262, 283
 release from cones 283–4, 467
 soundness 282, 287–8
 wings 240, 250, 284, **286–6**, 287–90
 wing loading **129**, 288
- seedling(s)
 clusters **291**
 establishment **230**, 466
 'grass stage' 24, 31, 144, 196, 201, 223–4,
 225, 250, 394, {480}
 self-pruning 222–5, 228, 230–1, 232–3,
 239, 240–1, 250
 serotiny 21, 62, 196, 207, 211, 223, 226–7,
 241, 250, 283, {487}
 shifting (slash-and-burn) cultivation
 28–30, 33, 194, 211, 451
 Sierra Nevada – see **California, Nevada**
 silviculture 412, 414, 416, 419–20
 Dauerwald system 416, 420, {477}
 size (tree height) 10–11, 250
 Slovenia 159
 snow 3, 112, 241, 281, 289, 307–9, **310–11**,
 390
 soil 219–20, 341–50
 acidity, sources of 344–7
 as determinant of range limits 15
 cation exchange capacity 344
 exchangeable acidity 344
 humic acids 342–3, 349
 mineralization – immobilization
 349
 organisms 349–50
 pedogenesis 341, {485}
 physical properties 350
 pH 271, 344–6, **347–9**
 podzolization 341, 343–4, 347–9
 podzols 21, 341–2, 444, {486}
 serpentine 21, 231, **270**, {486}
 types and processes 341–3
 water repellency 459
- South America 393–4, 421
 plantation area 421
 South Carolina (USA) 395
 South Dakota (USA) **128**, 198
 range expansion of pines (20th century)
 451
 Southern Oscillation
El Niño 199–200
La Niña 199–200
 Southwest, American 11, 171–182, 306
 Spain 18, 26, 107, 155–6, 158, 164, 394,
 412–13, 415, 418–19, **426**
 afforestation 156–8, 165, 416, 419, 421
 Andalusia (Malaga) 163
 Canary Islands 5, 13, 21, 156, **161**
 Catalonia **156**
 fossil pines 82
 insect pests 444
 Navarra **158**
 País Vasco 442, 444
 pines as invaders 470
 plantations 212, 439, 442, 445
 Sierra de Javalambre 156
 see also **Iberian Peninsula**
 speciation 8, 83, 85–6, 95, 102–3, 122,
 127, 132–3, 145–6, 172, 260, 272,
 336
 specific leaf area 296–7
 Spitsbergen – see **Svalbard**
 South Africa
 Cape Peninsula 452–3, **461**
 diseases 391–2
 Jonkershoek Valley **443**, **464**
 pines as invaders xv, 211–12, **455**, 457,
461, **464**
 plantations 31, 421, **423**, 439, 442–3
 afforestation history 417, 421–3, 433,
 452, 452–3
 diseases 423, 398
 impacts on soil properties 346
 insect pests 370–1
 mycorrhizal fungi 334–5
 silviculture 422–3
 species/provenance trials 420
 tree breeding
- Strait of Gibraltar 153
 subalpine habitats 5–7, 12–13, 16–19, 22,
 24, 26–8, 33, 98, 101, 129–31, 204,
 221–2, 227, 238, 307, 310–11, 451,
 456
 Suleiman Mountains – see **Pakistan**
 Sumatra 25, 49, 284, 417
 Surinam, mycorrhizal fungi 334
 Svalbard (Spitsbergen) 75–6
 Swaziland 346, **426**
 species/provenance trials 420
 Sweden 34, 202, 212, 266–7, 270, 309, 328,
 346, 359, 415
 Scandes Mountains 202
 Switzerland 13, 36, 266–7, 368, 414
 Syria 163, 412, 414, 417
- systematics of *Pinus* 49–68
 cytology and crossability studies 57–9
 DNA analyses 39, 57, 60–3
 history
 early classifications 51–2
 20th century classifications 52–6
 morphological characters 56–7
 secondary product chemistry 39,
 59–60
- taiga {489}
 see also **boreal forest**
 Taiwan 5–7, 19–20, 82, 99, 291
 Tajikistan 413
 Takhtajan's floristic regions 10
 Tanzania 394, 443–4, 457
 Taurus Mountains – see **Turkey**
 temperate forest habitats 312
 Asia 19–20
 Eastern North America 17–18
 Europe 18
 Western North America 17
 Tertiary 3, 8, 25, 27, 70, 73–87, 137–44,
 {489}
 see also **Neogene, Palaeogene**
 Tethys 85, 87
 Texas (USA) 7, 74, 140, 173, 175, 179, 395
 Chisos Mountains 140
 Edwards Plateau 140, 173
 Glass Mountains 173
 Hueco Mountains 174
 plantations 443
 Wichita Mountains 140
 Tibet 16, 20, 95–6, **99**
 timberline 10, 12–14, **16–17**, 19, 24, 26,
 107, **111**, 117, 131, **144**, **161**, 202,
 204, 221–2, 239, 285, 307–10,
 457
 Thailand 24–5, 28, 211, 284, 335
 topographic-moisture gradients **25**, **26**
 Transcaucasia 79, 81
 tree line – see **timberline**
 Triassic 69–70, {489}
 Trinidad, mycorrhizal fungi 333–4
 tropical pine habitats 22–5, 211,
 312–13
 Tunisia 22, 153, 155, 165, 444
 Turkey 26, 266–7, 410, 412
 afforestation 156–7, 444
 Anatolia 153, 155–6, 162–3
 Taurus Mountains 155–6, 161
- Uganda 457
 species/provenance trials 420
 Ukraine 74, 265, 267
 fossil pines 76
 United Kingdom 107, 113, 387, 408, 413,
 415, 419, 421, 444–5
 Ural Mountains 107
 Uruguay
 pines as invaders 457–8

- plantations, mycorrhizal fungi 334
 USA 142, 346, 348, 354–75, 394, 415,
 418–19, **426–7**
 eastern 24, 225, 228, 230, 232, 238, 312,
 417
 Midwest 392
 northern 138, 394
 northeastern 70, 73, 138, 263, 312,
 344–5, 346, 388, 392
 northwestern 17
 plantation area 421
 southern 36, 347, 373, 419
 southeastern 5–7, 22, 28–32, 49, 55, 82,
 132, 140, 142, 196, 200–2, 223,
 225, 233, 267, 312, 314, 342–3,
 346, 348, 387–9, 391, 394, 398,
 412, 417, 419, 421
 afforestation 31, 443
 southwestern 12, 21, 83, 198–200, 307,
 341, 388, 408–9, 416–17
 western 16, 84, 132, 172, 227, 231, 233,
 305, 310, 342, 346, 366, 385, 388,
 393, 443–4, 447
 USDA Forest Service 38, 438
 US Endangered Species Act (1973) 272
 USSR (former) 14, 418–19, 421
 Utah (USA) 27, **128**, 173–5, 177, 179, 265,
 283–4
 Abajo Mountains
 Paunsaugunt Plateau 28
 range expansion of pines (20th century)
 451
 range management **179**
 Uinta Mountains/Basin 175
 Wasatch Range 177
 Zion National Park 4, 21–2, **175**
- Venezuela 212, 335, 421, 444
 Vermont (USA) 74, 232, 266
 Vietnam 5–7, 13, 24–5
 range expansions (20th century) 451
 Viggartal
 Virginia (USA) 30, 267, 413
 afforestation 31
 volcanic soils 159, **160–1**, 444, 459
 volcanoes 74, 81, 83–4, 86, 139, 451
- Wales
 afforestation 416
 see also **United Kingdom**
- wars – impacts on pine forests 154, 163,
 413–15, 417
- Washington (USA) 17, 28, 75, 84, 130–1,
 266
 Cascade Mountains 129, 198–9, 227
 Columbia Basin 129–30
 fossil pines 75–6, 79, 81, 84, 122
 Puget Trough **128–30**
 Olympic Peninsula 79, **128–9**
 Wenatchee National Forest 199
- water relations
 cavitation 304–5, {476}
 embolism, vulnerability to 305–6
 hydraulic conductance 302, 304–6, 309,
 {481}
 hydraulic resistance 304–5, {481}
 rooting behaviour 303–4, 306–7
 tree hydraulics 304
 water storage in sapwood 304
 water-use efficiency 302–3, 306–7,
 310–11, {489}
 wood permeability 305
 xylem anatomy 305
- White Mountains – see **California**
- wind
 as stress factor 16, 221, 309–10
 role in disease 202, 385, 388, 390–2
 role in fire 194, 205, 210, 212, 235
 seed dispersal 232, 238, 240, 288–9,
 292–3, 463
 -throw **23**, 227, 232, 241
- Wisconsin (USA) 28, 266, **301**
 Pine Barrens 29
 range expansion of pines (20th century)
 451
 Wisconsin glacial **140**, 171, **173–8**
 witches' broom 382–3, 384
 wood anatomy 9, 56–7
 Wyoming (USA) **128**, 285
 fossil pines 75
 Yellowstone National Park **128**, 130–1,
 204
 range expansion of pines (20th century)
 451
 Rendezvous Mountain 285
 Squaw Basin 285
- Yellowstone National Park – see
Wyoming
- Younger Dryas 113, {489}
 Yosemite Valley – see **California**
 Yugoslavia (former) 26–7, 82, 158–9
- Zambia
 plantations, mycorrhizal fungi 333
 species/provenance trials 420
- Zimbabwe 417, 443, 457
 species/provenance trials 420
- Zion National Park – see **Utah**