



Introduction

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Invasive alien species

The movement of animals and plants goes far back into the history of humankind. For centuries, we have transported useful species between countries and continents, which, as a result of their origin, are called **alien species**. Many of these species are still important food resources. However, during recent decades we have become increasingly aware of a downside to the movement of species. Some alien species have managed to establish themselves in natural environments and thrive without any human assistance. Having no natural enemies and diseases, they are able to spread and cause damage to the environment and to the economy. These species are termed **invasive alien species**.

For many years, invasive alien species did not receive much attention. Data on their distribution were not systematically collected and they were recorded more or less sporadically as interesting findings. In many countries the spread of invasive alien species continued unnoticed and no measures were taken to prevent their spread.

However, in recent years our attitude towards alien species has evolved rapidly. We have become aware of their presence and of their impacts on the environment and the economy (figure 1). At the same time, it has become clear that, for the effective management of alien species, we should pay more attention on preventing their arrival and spread. Various legal instruments are now in place to prevent introductions, for example a ban on the import and possession of some invasive alien species. There is also complex plant and animal health legislation, imposing checks of consignments at borders with the aim of preventing the unintentional introduction of alien species with goods. There are a growing number of awareness-raising campaigns on

invasive alien species. A variety of target groups is being informed of the negative environmental impacts of invasive alien species and are encouraged to handle them responsibly in order to prevent their spread into the environment.

Unfortunately, data show that the preventive measures are insufficient and the number of alien species continues to grow. Within Europe alone, they annually cause several billions of euros of costs. Massive levels of international trade remain a continuous source of new introductions.

Once alien species are established and start spreading, eradication is often not feasible. To mitigate their impacts, an **early warning and rapid response (EWRR)** system should be set in place. This increases the likelihood that new alien species are detected at the early stages of invasion and that measures can be taken to prevent that these species form permanent or expanding populations, which may cause damage.

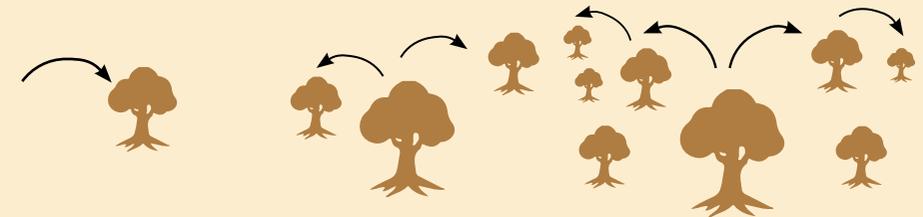
KEY TERMS

Alien species: any living organism which has been deliberately or unintentionally introduced to an area outside of its native range which it could not reach without the help of humans.

Invasive alien species: an alien species that threatens ecosystems, habitats and species. Many also have negative impacts on the economy and human health.

Native species: a species living within its (past or current) native range, even if it is present there only sporadically.

THE INVASION PROCESS - FROM INTRODUCTION TO INVASIVENESS



Phase 1: an introduction of a new species which is deliberately or unintentionally introduced to an area outside of its native range.

Phase 2: the species is established in the new environment, it is reproducing and forming permanent populations - it is **established**.

Phase 3: the species is spreading quickly and causing damage to native species and ecosystems, sometimes also to the economy - the species is **invasive**.



Figure 1. Invasive alien species have various impacts on forests: **a)** tree-of-heaven (*Ailanthus altissima*) overgrows forest margins, **b)** the fungal disease ash dieback (*Hymenoscyphus fraxineus*) causes dieback of ash trees, **c)** Asian longhorn beetle (*Anoplophora glabripennis*) bores tunnels in wood, **d)** bark stripped by grey squirrel (*Sciurus carolinensis*).

Early warning and rapid response

An "early warning and rapid response" (EWRR) system consists of several activities:

1. Early warning can include active searching for new alien species. This is challenging, because it may not be possible to predict which new species appear, and where. In initial stages, there are sometimes only few individuals present. This makes them difficult to detect. It is therefore imperative to set priorities. We should pay extra attention to invasive species which are already spreading and which are likely to increase their distribution. Species such as these may be placed on alert lists.

In the framework of the LIFE ARTEMIS project, we compiled an alert list for alien species in forests, which also served as a basis for this guide. For this English edition, we have added several species which are relevant for European temperate forests. Because this guide is meant as a tool for early detection, many widespread invasive alien species are not included.

Priority areas to search for invasive alien species may be places where invasive alien species are likely to appear (see the box on the right), areas with suitable conditions for certain species, and protected areas where we aim to safeguard biodiversity. These activities may be carried out by experts carrying out phytosanitary measures, or who are in charge of biodiversity monitoring and forest management.

In addition to this, for effective EWRR it is very important to have a broad network of observers, who can provide random observations from a wide area. Anyone interested can keep an eye on their surroundings and learn to recognise alien species. With the rise of new technologies, it is now easy to report data over mobile applications. This has given rise to many citizen-science initiatives. For an overview see pages 6–8.

TIPS ON EARLY DETECTION

Alien species can appear anywhere, but because of their pathways and ecological characteristics, we should especially pay attention:

- in areas, where primary vegetation has been removed and soil is partially exposed (industrial areas, construction sites, field margins);
- in forest clearings, especially where the soil has been damaged by forestry machinery;
- along roadsides and railroad embankments;
- in the surroundings of airports and harbours;
- in the vicinity of tree nurseries, botanical gardens, cemeteries and in city parks,
- on wasteland, disused quarries and in their surroundings,
- along rivers and streams, especially where banks are not entirely vegetated.

We may suspect that an observed species is alien to an area when we:

- suddenly see large numbers (clumps of plants, groups of animals) that we did not notice before,
- find a species in the garden which we did not plant;
- see a plant in nature, which we know as an ornamental plant and is not native to the country;
- notice the dieback of trees (dying of leaves, necrosis, dieback of branches, cracks on the trunk and branches, thickened calluses on bark); one tree species or several may be affected;
- observe mammals (especially squirrels) which are tame and do not run away.

2. Identification of alien species is sometimes not straightforward because they may be new and unknown to the observer. They are often not described in local identification guides. This field guide was developed to specifically enable identification of alien species. These are compared with the most similar other alien and/or native species.

3. Reporting of data: EWRR systems should enable fast and efficient reporting of data which are then collected in a central system. This is usually done via web and mobile based applications. In some of these applications, data are verified by experts. This greatly improves the reliability of data.

4. Risk assessment: After the discovery of a new alien species, experts should perform a risk assessment, based on the available scientific literature and consultation with experts from other countries. In this process, it is assessed how likely a species is to become invasive in an area and which negative impacts it may have.

5. Rapid response: When a species is discovered in the early stages of invasion and the results of the risk assessment provide evidence that the species poses serious threat to the environment or the economy, eradication measures are set out. If the species is already established and eradication is no longer feasible, measures to control the species and prevent further spread should be determined. When determining these measures, it is important that they are accepted by the public, and are ethical and economically and politically acceptable. This requires efficient communication with landowners and key target groups as well as informing the public.

A DIAGRAM OF THE EARLY WARNING AND RAPID RESPONSE SYSTEM



SELECTED TOOLS FOR RECORDING ALIEN SPECIES

In recent years, many projects have emerged in Europe which use a citizen science approach towards collecting data on invasive alien species (IAS). Many online portals and smartphone applications now exist to report observations, at different geographical scales and with various taxonomic scopes. Observers have to carefully choose the tools they use to submit records, in order to maximize usefulness of their data for invasion research or management.

The list below presents a selection of citizen science portals, mobile applications and projects related to the invasive species and forest pests mentioned in this field guide. This selection only refers to live systems which allow the submission of records. The list was compiled by the AlienCSI COST action, see: <https://alien-csi.eu/> As this overview is probably not exhaustive, additional relevant recording portals can be reported to alienCSIWG1@gmail.com.

INTERNATIONAL

iNaturalist: www.inaturalist.org (all species)

e-Bird: www.ebird.org (all bird species)

Observation.org: observation.org (all species)

EUROPE

Invasive alien species Europe: <https://easin.jrc.ec.europa.eu/easin/NewsAndEvents/DetailNews/391a026f-d9f5-4fce-8789-2028ea73f86d> (species from the IAS Regulation)

iNaturalist – Invasive Alien Species of Union Concern: <https://www.inaturalist.org/projects/invasive-alien-species-of-union-concern>

WeObserve: www.weobserve.eu (all species, environmental monitoring)

Ornitho.eus: www.ornitho.eus (birds)

European Ladybirds: european-ladybirds.brc.ac.uk (invasive harlequin ladybird)

REGIONAL

DanubeForestHealth: danubeforesthealth.eu (Forest pests and pathogens; Countries: Austria, Croatia, Hungary, Serbia, Slovenia)

BELGIUM

Waarnemingen.be/exoten: waarnemingen.be/invasive_alert_view.php (a selection of (potential) IAS)

Vespawatch: www.vespawatch.be (Asian hornet)

That's Invasive: www.rinse-europe.eu/resources/smartphone-apps/ (selection of IAS)

Portail Biodiversité Wallonie Espèces Invasives: biodiversite.wallonie.be/fr/invasives.html?IDC=5632 (selection of IAS)

DEMNA OFFH: observatoire.biodiversite.wallonie.be/encodage/ (all species)

CZECH REPUBLIC

Biolib.cz: www.biolib.cz/en/speciesmappings (all species)

Plant Medicine Portal: eagri.cz/public/app/srs_pub/fytoportal/public/?k=0#r|p|met:domu|kap1:start|kap:start (Monitoring of Pests including invasive species)

ESTONIA

Nature observations database (Loodusvaatluste andmebaas, LVA):

lva.keskkonnainfo.ee (all species)

FINLAND

Finnish Biodiversity Information Facility: laji.fi/en (all species)

Finvasive LIFE-project: laji.fi/vihko/MHL.53 (selection of IAS)

Natural Resources Institute Finland: lomakkeet.luke.fi/vieraslaji (invasive mammals)

FRANCE

Faune France: www.faune-france.org (all species)

EEE-EIF: eee.mnhn.fr (selection of IAS)

Les écureuils en France: ecureuils.mnhn.fr/enquete-nationale (alien squirrels)

INPN frelon asiatique: frelonasiatique.mnhn.fr (Asian hornet)

AGIIR: ephytia.inra.fr/fr/P/128/Agiir (pest insects)

Observatoire de la Coccinelle asiatique en France: vinc.ternois.pagesperso-orange.fr/cote_nature/Harmonia_axyridis/ (harlequin ladybird)

GERMANY

KORINA: www.korina.info (alien plants)

Ambrosia Scout: lfu.brandenburg.de/info/ambrosia_scout (common ragweed)

Berliner Aktionsprogramm gegen Ambrosia: ambrosia.met.fu-berlin.de/ambrosia/index.php (common ragweed)

DDA Bird Monitoring: www.ornitho.de (birds)

Naturgucker: www.naturgucker.de (all species)

Artenfinder: artenfinder.rlp.de (all species)

Deutschlandflora: deutschlandflora.de/dflor (plants)

Flora Incognita: floraincognita.com (plants)

ICELAND

Reykjavik Bioblitz: www.reykjavikbioblitz.is (all species)

IRELAND

National Biodiversity Data Centre: www.biodiversityireland.ie (all species)

iSpot share nature: www.ispotnature.org (all species)

Report Invasive Plants in Limerick: invasivespecies.limerick.ie (selected invasive plants)

ITALY

LIFE STOPVESPA: www.vespavelutina.eu/en-us/what-can-you-do/Report-your-observation (Asian hornet)

LIFE EC-SQUARE: www.rossoscoiattolo.eu/en/what-can-i-do-project (alien squirrels)

LIFE U-Savereds: usavereds.eu/it_IT/cosa-puoi-fare-per-il-progetto/ (native and alien squirrels)

Life Csmon: www.csmon-life.eu/pagina/segnala/all (all species)

LIFE ASAP: lifeasap.eu/index.php/it/component/content/article/2-uncategorised/201-segnalazioni (selected alien species)

Bugmap: meteo.fmach.it/meteo/bugMap.php (brown marmorated stink bug)

LIFE SAMFIX: www.lifesamfix.eu/it/progetto/ (black coffee borer, *Xylosandrus compactus*)

Fitodetective App Regione Lombardia: play.google.com/store/apps/details?id=net.studiocm.android.ersafAlieni&hl=it&rdid=net.studiocm.android.ersafAlieni (selected alien plant pests)

LUXEMBURG

Musée national d'histoire naturelle Luxembourg: data.mnhn.lu/en/enter-single-record (election of IAS)

iNaturalist - neobiota project: www.inaturalist.org/projects/neobiota-luxembourg (selection of IAS)

NETHERLANDS

Waarneming.nl: waarneming.nl (reporting portal, all species)

Telmeel.nl: www.telmeel.nl (reporting portal, all species)

FLORON: www.floron.nl/meedoen/nova (plants, fungi and lichens)
snApp de exoot: snappdeexoot.nl (selection of invasive species)

NORWAY

Norwegian Biodiversity Information Centre: artsdatabanken.no (all species)
Artsobservasjoner: www.artsobservasjoner.no (all species)
Artsjakten: www.sabima.no/kartleggingsapp (selection of common species)

POLAND

Ornitho.pl: www.ornitho.pl (birds)
Birdwatching.pl: www.birdwatching.pl (birds)
Barszcz.edu.pl: barszcz.edu.pl (Sosnowsky's hogweed)

PORTUGAL

Plantas Invasoras: invasoras.pt (invasive plants)

SLOVENIA

Invazivke: www.invazivke.si (selected IAS)
Bioportal: www.bioportal.si/moj_bp.php (all species)

SPAIN AND CATALONIA

Natusfera: natusfera.gbif.es (all species)
Observado: spain.observation.org/index_map.php
IASTracker: play.google.com/store/apps/details?id=com.ic5team.iastracker&gl=ES (selection of IAS)
Vespapp: vespapp.uib.es (Asian hornet)
Alerta Forestal: www.alertaforestal.com (selected IAS)
Exoticas Murcia: play.google.com/store/apps/details?id=es.carm.medioambiente.exoticasmurcia&hl=en (selected IAS)
Ornitho.cat: www.ornitho.cat (birds)

SWEDEN

Naturforskaren: dina-web.net/naturalist (all species)
Artportalen: www.artportalen.se (all species)
Skoskada: www.slu.se/centrumbildningar-och-projekt/skogsskada (insects and fungi)

SWITZERLAND

Centre Suisse de Cartographie de la Faune (CSCF): www.cscf.ch (all animal species)
Info Flora: www.infoflora.ch/fr/neophytes.html (alien plants)

UNITED KINGDOM

iRecord: www.brc.ac.uk/irecord (all species)
iSpot: www.ispotnature.org (all species)
Recording Invasive Species Counts (RISC): www.nonnativespecies.org/recording (selected IAS)
Asian Hornet Watch: play.google.com/store/apps/details?id=uk.ac.ceh.hornets&hl=en_GB (Asian hornet)
That's Invasive! www.rinse-europe.eu/smartphone-apps (selected IAS)
Plant Tracker: planttracker.naturelocator.org (plants)
iRecord Ladybirds: www.ladybird-survey.org/recording.aspx (harlequin ladybird)
AshTag: livingashproject.org.uk (ash dieback tolerant trees)
Tree Alert: www.forestresearch.gov.uk/tools-and-resources/tree-alert (selected pests)
Report squirrels: www.northernredsquirrels.org.uk/report-sightings (squirrels)
Plant Alert: plantalert.org (invasive plants in gardens)

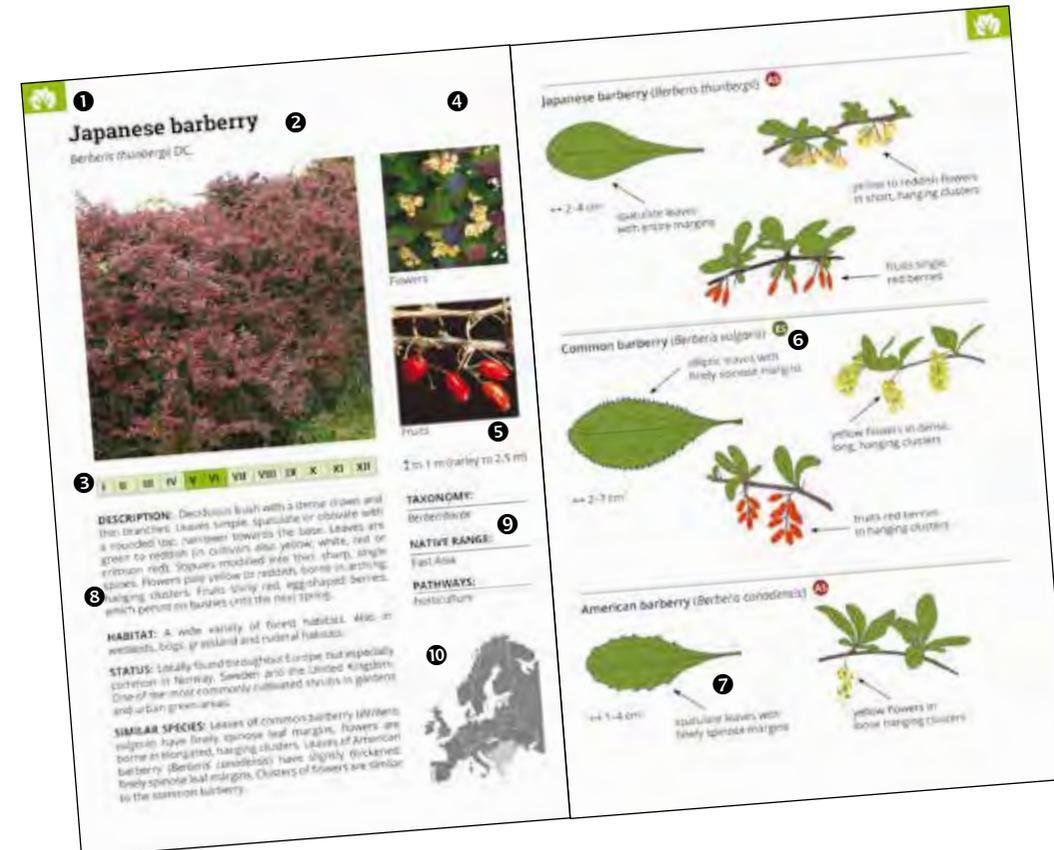
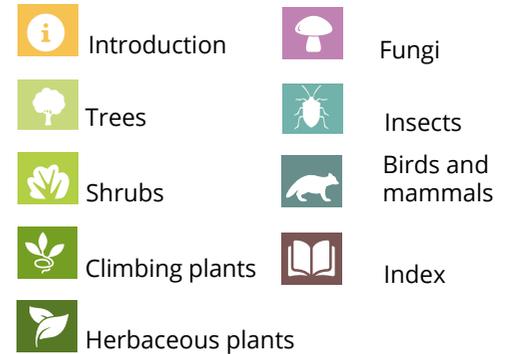
How to use this guide

In this guide, we describe selected alien plants, fungi, insects, birds and mammals. Plant species are subdivided into trees, shrubs, climbing plants and herbaceous plants. Within these broad categories, species follow the taxonomic order of plant families. Fungi are divided to subgroups on basis of the damage which they cause: the diseases of roots and trunk, diseases of bark, cankers, wilt, diseases of shoots and branches, and diseases of leaves and needles. Insects, birds and mammals are arranged in the taxonomic order of families.

Each species is presented on a page with one to three photographs, which show their most distinguishing characters. For some species, drawings on the facing pages depict characters which aid in distinguishing them from the most

similar alien and/or native species. Several symbols are used throughout the guide, which are explained below and on the following pages.

1 Chapter labels:



2 English name and scientific name of the species and the authorship of the scientific name.

3 Identification throughout the year: In the most intensely-coloured months the species is easily detectable (e.g. due to flowering of plants or flying of insects). Months are coloured more pale when the species is less obvious, but still detectable. In uncoloured months, the species cannot be detected.

4 Species listed in the EU legislation and by the EPPO: Some of the species in the guide are included in legal or advisory documents of the European Plant Protection Organisation (EPPO). Symbols used at the species descriptions and in tables 1–4 have the following meaning:

BIO invasive alien species of Union concern, listed on the European Commission's implementing regulations. Rules of the EU Regulation 1143/2014 apply.

PH species covered by the EU Plant Health legislation.

A1 A2 EPPO List of pests recommended for regulation as quarantine pests (A1 pests are absent from the EPPO region, A2 pests are locally present in the EPPO region).

ALERT EPPO Alert List.

IAP EPPO List of invasive alien plants.

OBS EPPO Observation List of invasive alien plants.

5 Size: the height of entire plants is marked with the symbol ↑ on the left pages. The leaf size is indicated after the symbol ↔ on the right pages.

6 On the right pages, after the names of species, there is a symbol **AS** for the **species which are alien to Europe** and symbol **ES** for the **species which are native to Europe**. Species which are marked with both symbols are native in parts of Europe but alien in others.

7 Arrows on the drawings: the most important identification characters are marked with arrows. Full-lined arrows → point to characters which are depicted on the drawings, while arrows with dotted line ----> point to characters which are only visible on the underside. Drawings are approximately in ratio between the species on the same page, but vary between pages.

8 Description: a brief description of the species with key identification characters is provided. In descriptions of insects and fungi also characteristic damage they cause is described. There is a short description of **habitat** or host plants. The **status** of the species provides a brief summary of the status of the species in temperate European forests. Under the title **similar species** we describe the most similar native or alien species with which the alien species in question could be confused.

9 Brief facts: down the side of the species descriptions, we provide the taxonomic group to which the species belongs, its native range and the main pathways of introduction.

10 Maps of currently known distribution of species are provided in each species account. The countries where the species has already been recorded are coloured dark grey. Maps were compiled on the basis of several European databases: EASIN, CABI, DAISIE, EPPO, Invazivke.si, iNaturalist, Observation.org. In some cases the Flora Croatica Database, Artdatabanken.se and the Online Atlas of the British and Irish flora were checked. In these databases it is not possible to distinguish between planted plants now established, or self-sustaining populations. Some data may refer to plants in gardens and parks and not always to escaped populations. This distinction is not relevant for invertebrates. In the case of mammals, only records in the wild are considered and maps show only the countries where the species has not yet been eradicated.

Alien species in this guide

This guide has primarily been developed as a tool within a system of early warning and rapid response (EWRR) for Slovenian forests. Most species which we present have been included in the alert list of potentially invasive alien species in Slovenian forest¹. The guide also includes some alien species which in Slovenia are invasive and widespread and at the

same time commonly found in forests or along forest edges. In the guide's English edition, additional species are included, which are beginning to spread within European temperate forests. However, many widespread invasive alien species are not included, because we did not want to lose focus on the species from the Alert List.

Table 1: Overview of alien plants described in the guide. See page 10 for an explanation of the used symbols.

English name	Scientific name	EU law	EPPO	Pages in the guide
Trees				
Northern red oak	<i>Quercus rubra</i>			24–25
Hackberry	<i>Celtis occidentalis</i>			26–27
Paper mulberry	<i>Broussonetia papyrifera</i>		OBS	28–29
Black cherry	<i>Prunus serotina</i>		IAP	30–31
Staghorn sumac	<i>Rhus typhina</i>			32–33
Tree-of-heaven	<i>Ailanthus altissima</i>	BIO	IAP	34–35
Boxelder	<i>Acer negundo</i>			36–37
Golden rain tree	<i>Koelreuteria paniculata</i>			38–39
White ash	<i>Fraxinus americana</i>			40–41
Royal paulownia	<i>Paulownia tomentosa</i>			42–43

¹ de Groot, M., L. Kutnar, D. Jurc, N. Ogris, A. Kavčič, A. Marinšek, J. Kus Veenvliet, A. Verlič. 2017. *Opozorilni seznam potencialno invazivnih tujerodnih vrst v slovenskih gozdovih in možne poti vnosa teh vrst*. [The alert list of potentially invasive alien species in Slovenian forests and possible pathways of their introduction]. *Novice iz varstva gozdov* št. 10: 8–15.

English name	Scientific name	EU law	EPPO	Pages in the guide
Bushes				
Japanese barberry	<i>Berberis thunbergii</i>			46–47
Oregon grape	<i>Berberis aquifolium</i>			48–49
Golden currant	<i>Ribes aureum</i>			50–51
Cherry laurel	<i>Prunus laurocerasus</i>			52–53
Wine raspberry	<i>Rubus phoenicolasius</i>			54–55
Japanese spiraea	<i>Spiraea japonica</i>			56–57
Common ninebark	<i>Physocarpus opulifolius</i>			58–59
Multiflora rose	<i>Rosa multiflora</i>			60–61
Juneberry	<i>Amelanchier lamarckii</i>			62–63
Purple chokeberry	<i>Aronia x prunifolia</i>			64–65
Wall cotoneaster	<i>Cotoneaster horizontalis</i>			66–67
False indigo	<i>Amorpha fruticosa</i>		IAP	68–69
Thorny olive	<i>Elaeagnus angustifolia</i>			70–71
Red osier dogwood	<i>Cornus sericea</i>		IAP	72–73
Fuzzy deutzia	<i>Deutzia scabra</i>			74–75
Amur honeysuckle	<i>Lonicera maackii</i>			76–77
Snowberry	<i>Symphoricarpos albus</i>			78–79
Chinese privet	<i>Ligustrum lucidum</i>			80–81
Wolfberry, goji beery	<i>Lycium barbarum</i>			82–83
Butterfly bush	<i>Buddleja davidii</i>		IAP	84–85
Running bamboos	<i>Phyllostachys</i> spp.			86–87
Climbing plants				
Five-leaf akebia	<i>Akebia quinata</i>		OBS	90–91

English name	Scientific name	EU law	EPPO	Pages in the guide
Russian vine	<i>Fallopia baldschuanica</i>		IAP	92–93
Japanese hop	<i>Humulus scandens</i>	BIO	A2	94–95
Kudzu	<i>Pueraria montana</i> var. <i>lobata</i>	BIO	A2	96–97
Chinese wisteria	<i>Wisteria sinensis</i>			98–99
Frost vine	<i>Vitis vulpina</i>			100–101
Bur cucumber	<i>Sicyos angulatus</i>		IAP	102–103
Japanese honeysuckle	<i>Lonicera japonica</i>			104–105
Cape ivy	<i>Delairea odorata</i>		IAP	106–107
Cruel plant	<i>Araujia sericifera</i>		OBS	108
Herbaceous plants				
Asiatic dayflower	<i>Commelina communis</i>			110–111
American skunk cabbage	<i>Lysichiton americanus</i>	BIO	OBS	112–113
American pokeweed	<i>Phytolacca americana</i>			114–115
Himalayan knotweed	<i>Persicaria wallichii</i>			116–117
Giant knotweed	<i>Fallopia sachalinensis</i>		IAP	118–119
Garden lupine	<i>Lupinus polyphyllus</i>		OBS	120–121
Himalayan balsam	<i>Impatiens glandulifera</i>	BIO	IAP	122–123
Small balsam	<i>Impatiens parviflora</i>			124–125
North American asters	<i>Symphotrichum</i> spp.			126–127
Annual fleabane	<i>Erigeron annuus</i>			128–129
Candelabra thistle	<i>Cirsium candelabrum</i>			130–131
Giant hogweed	<i>Heracleum mantegazzianum</i>	BIO	IAP	132–134

Table 2: Overview of alien fungi and bacteria described in the guide

English name	Scientific name	EU law	EPPO	Pages in the guide
Phytophthoras	<i>Phytophthora</i> spp.	PH	A2	136
Heterobasidion root disease	<i>Heterobasidion irregulare</i>	PH	A2	137
Chestnut blight	<i>Cryphonectria parasitica</i>	PH	A2	138
Charcoal disease of oak	<i>Biscogniauxia mediterranea</i>			139
Thousand cankers disease	<i>Geosmithia morbida</i>	PH	A2	140
Sooty bark disease	<i>Cryptostroma corticale</i>			141
Eutypella canker of maple	<i>Eutypella parasitica</i>			142–143
Pitch canker of pine	<i>Fusarium circinatum</i>	PH	A2	144
Atropellis canker	<i>Atropellis pinicola</i>	PH	A1	145
White pine blister rust	<i>Cronartium ribicola</i>			146
Dutch elm disease	<i>Ophiostoma novo-ulmi</i>			147
Canker stain of plane	<i>Ceratocystis platani</i>	PH	A2	148–149
Ash dieback	<i>Hymenoscyphus fraxineus</i>			150–151
Canker of balsam fir	<i>Neonectria neomacrospora</i>		ALERT	152
Sirococcus shoot blight	<i>Sirococcus tsugae</i>			153
Plane-tree powdery mildew	<i>Erysiphe platani</i>			154
Dothiostoma blight	<i>Dothiostroma septosporum</i>	PH		155
Brown-spot needle blight	<i>Lecanosticta acicola</i>	PH	A2	156
Alder rust	<i>Melampsorium hiratsukanum</i>			157
Blueberry leaf rust	<i>Thekopsora minima</i>	PH	A2	158
Pierce's disease of grapevines	<i>Xylella fastidiosa</i>	PH	A2	159

Table 3: Overview of alien insects described in the guide

English name	Scientific name	EU law	EPPO	Pages in the guide
Asian ambrosia beetle	<i>Xylosandrus crassiusculus</i>		ALERT	162
Asian longhorn beetle	<i>Anoplophora glabripennis</i>	PH	A1	163
Citrus longhorn beetle	<i>Anoplophora chinensis</i>	PH	A2	164–165
Red-necked longicorn	<i>Aromia bungii</i>	PH	A1	166–167
Japanese cedar longhorn beetle	<i>Callidiellum rufipenne</i>			168
Two-lined chestnut borer	<i>Agrilus bilineatus</i>		ALERT	169
Emerald ash borer	<i>Agrilus planipennis</i>	PH	A2	170–171
Japanese beetle	<i>Popillia japonica</i>	PH	A2	172–173
Western conifer seedbug	<i>Leptoglossus occidentalis</i>			174–175
Brown marmorated stinkbug	<i>Halyomorpha halys</i>			176–177
Citrus flatid leafhopper	<i>Metcalfa pruinosa</i>			178
Silver fir woolly adelgid	<i>Dreyfusia nordmannianae</i>			179
Sycamore lace bug	<i>Corythucha ciliata</i>			180
Oak lace bug	<i>Corythucha arcuata</i>			181
Oriental chestnut gall wasp	<i>Dryocosmus kuriphilus</i>		A2	182
Zigzag elm sawfly	<i>Aproceros leucopoda</i>			183
Asian hornet	<i>Vespa velutina</i>	BIO		184–185
Horse-chestnut leafminer	<i>Cameraria ohridella</i>			186
Lime leafminer	<i>Phyllonorycter issikii</i>			187
Japanese silkworm	<i>Antheraea yamamai</i>			188–189
Box tree moth	<i>Cydalima perspectalis</i>			190

Table 4: Overview of alien birds and mammals described in the guide

English name	Scientific name	EU law	EPPO	Pages in the guide
Birds				
Red-billed leiothrix	<i>Leiothrix lutea</i>			192–193
Vinous-throated parrotbill	<i>Sinosuthora webbiana</i>			194–195
Mammals				
Siberian chipmunk	<i>Eutamias sibiricus</i>	BIO		196–197
Grey squirrel	<i>Sciurus carolinensis</i>	BIO		198
American red squirrel	<i>Tamiasciurus hudsonicus</i>			199
Pallas's squirrel	<i>Callosciurus erythraeus</i>	BIO		200
Ring-tailed coati	<i>Nasua nasua</i>	BIO		201
Raccoon	<i>Procyon lotor</i>	BIO		202
Raccoon dog	<i>Nyctereutes procyonoides</i>	BIO		203
Reeves's muntjac	<i>Muntiacus reevesi</i>	BIO		204–205

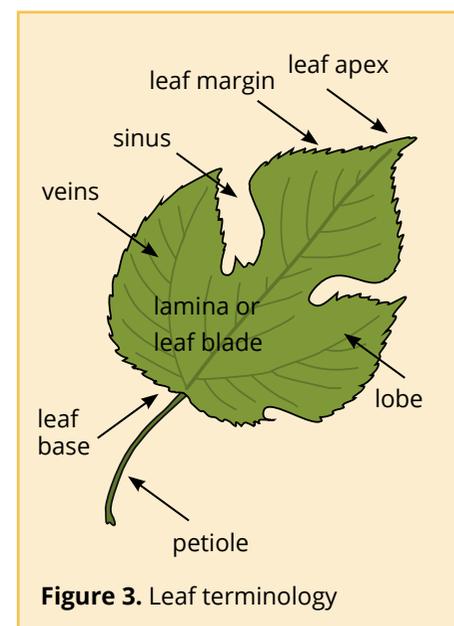
Terminology used in the guide

1. Botanical terms

In the descriptions of plants, some botanical terms are used which need to be understood in order to properly interpret identification characters. Identification is most often carried out on the basis of leaves (complexity, shape, arrangement), flowers, clusters of flowers and fruits.

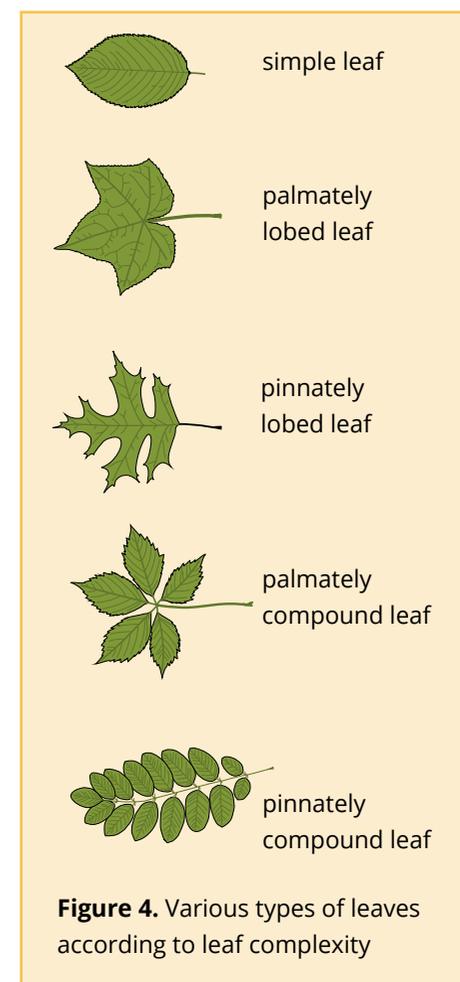
compound when leaflets radiate from the top of the petiole with no apparent rachis. Leaves are pinnately compound leaflets are attached laterally along a rachis (figure 4). Pinnately compound leaves which end in a single top-leaflet are called odd-pinnate; when they end without a top-leaf or with a tendril, they are called paripinnate.

1.1 Basic leaf terminology



1.2 Leaf complexity

Leaves may be simple or compound. Simple leaves have one leaf blade which can be entire or it can be divided into lobes. Such a single leaf blade is shed as an entire unit in autumn. Compound leaves consist of leaflets, which can sometimes be shed separately in autumn. Leaves are palmately



1.3 Leaf shapes

Leaves (or leaflets in compound leaves) can have various leaf-blade shapes. Some of the main types which appear in this guide are shown in figure 5. Leaves may have intermediate shapes, for example then may be lanceolate-ovate. Leaves on the same plant may vary in shape and therefore several leaves should be checked when making an identification.

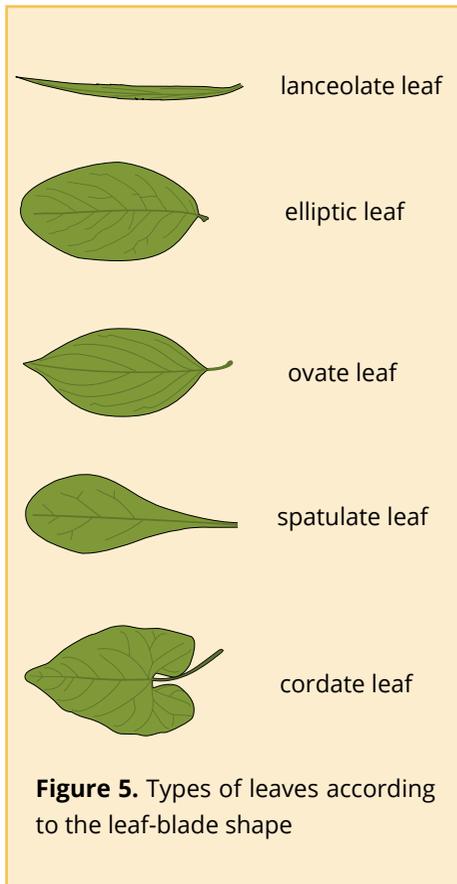


Figure 5. Types of leaves according to the leaf-blade shape

1.4 Leaf-margin shapes

Leaves can have various margin-shapes. In this guide leaves and leaflets are described as having entire, serrulate, serrated, crenate, spinose or wavy margins, see figure 6.

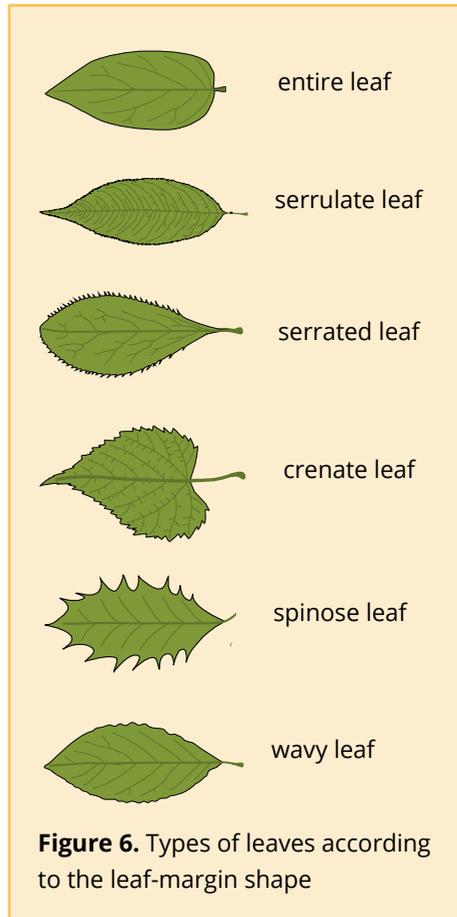


Figure 6. Types of leaves according to the leaf-margin shape

1.5 Leaf arrangement

Leaves are arranged in a particular order along a stem. Leaves are said to be "alternate" when there is a single leaf at each node and the leaves are placed alternating on the left and right side of a branch. "Spiralling" leaves are placed as if they follow an invisible helix around the branch. Leaves are "opposite" when pairs of leaves are attached at each node, opposite to each other. When a pair of leaves is perpendicular to the pair before and after, the arrangement is called "opposite-decussate". The leaf arrangement is "whorled" when there are more than two leaves attached at each node (figure 7).

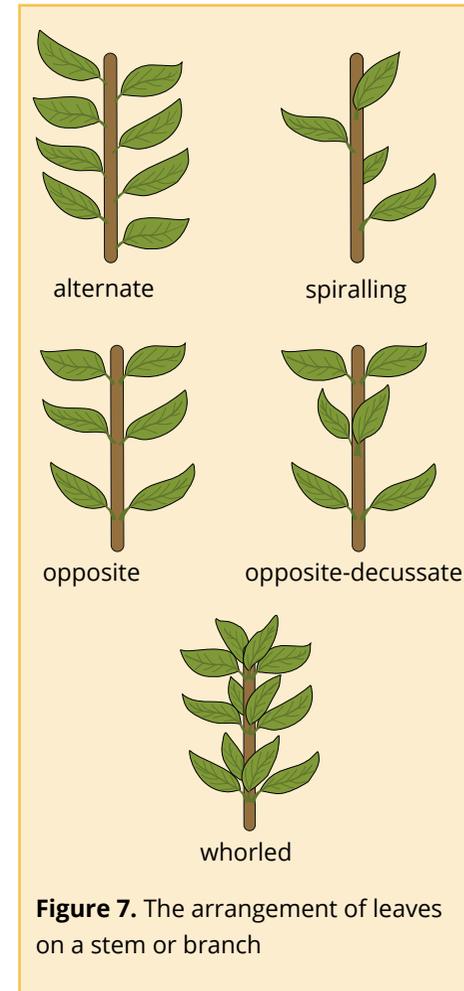


Figure 7. The arrangement of leaves on a stem or branch

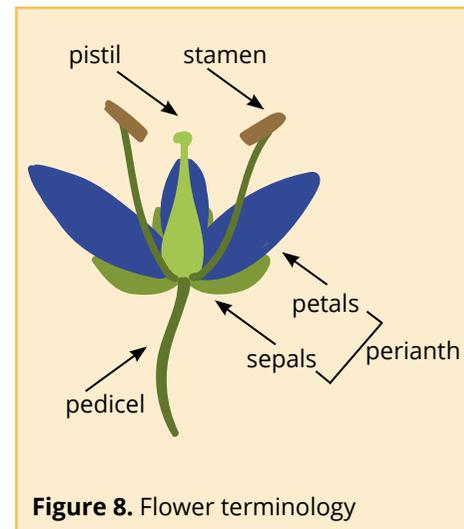


Figure 8. Flower terminology

1.6 Basic flower terminology

The main flower parts are the pedicel and receptacle, perianth, made of petals and sepals, stamens and carpels, which, in angiosperms, is modified into a pistil. The most noticeable part of the flower is the perianth. This consists of sepals, which are often green, but can also have other colours. Their size, shape and placement (spreading or appressed) is often an important identification character. Petals stand out even more as they are often brightly coloured and, compared to the other parts of the flower, rather large. Sepals or petals can be separate from each other or fused to form differently shaped flowers (figure 8).

1.7 Flower arrangement

Plants can have several flowers along a stem. When these are placed on the same floral axis, we call then an inflorescence (figure 9).

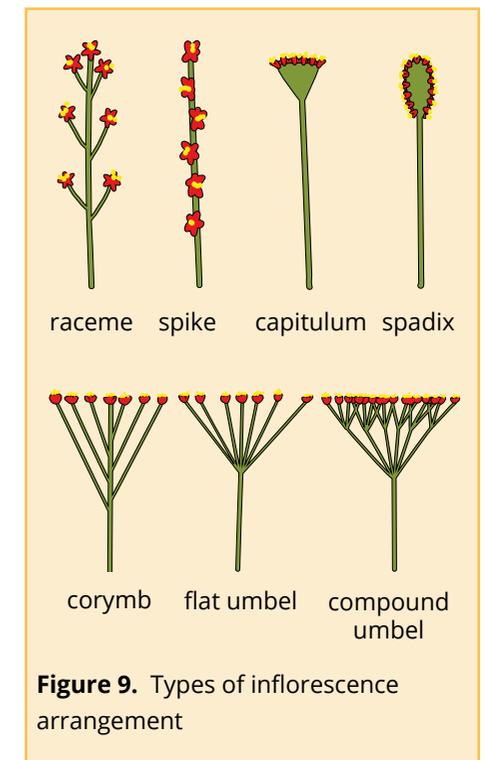


Figure 9. Types of inflorescence arrangement

1.8 Glossary of the most relevant botanical terms

Achene: dry, one-seeded fruit developing from the inferior ovary, which does not open to release the seed. Typical for the aster family.

Capitulum: type of inflorescence made of disc florets, ray florets and **involucral bracts** (modified leaves which cover the outer side of the inflorescence).

Capsule: a dry fruit which develops from a compound ovary, splitting open in sutures or seeds fall out through openings.

Corymb: type of inflorescence with the flowers growing in such a fashion that the outermost are borne on longer pedicels than the inner, bringing all flowers up to a common level. At the first glance corymb may resemble an umbel, however in this type of inflorescence all pedicels spread from a common point.

Cup (or cupule): a cup-shaped capsule, covered with scale leaves or spines, which is formed from the enlarged receptacle and is partially or entirely enclosing one or more fruits.

Habitus: characteristic form in which a given species of plant grows.

Infructescence: an organ of some angiosperms developing after fertilisation of flowers which are borne in clusters and the axis is fused with the fruits into one unit which are at maturity dispersed as a whole.

Leaf rachis: the main axis or stem of a compound leaf.

Lenticel: a porous tissue on the bark where air is entering into the plant.

Nutlet: fruit with one seed, similar to a nut. It is formed from a superior ovary and does not open at maturity.

Ovary: the lower part of the pistil that encloses the ovules.

Pappus: a modified calyx, composed of scales, bristles, or feather-like hairs.

Rhizome: a modified stem which grows underground.

Rosette: vegetative part of shoot with short internodes, giving the appearance that leaves are arranged in whorls. It can be placed at the ground (e.g. in the daisy (*Bellis perennis*)) or higher on a stem (e.g. in the wood spurge (*Euphorbia amygdaloides*)).

Ruderal site: a secondary habitat, created by human activity, e.g. waste places, roadsides, rail-road embankments, abandoned fields.

Runner (or stolon): horizontal stem which grows on at the soil surface (example: strawberry).

Variety: an imprecisely defined taxonomical category ranking below the subspecies but above the form. It is used to denote a group of individuals within sympatric populations of the same species which are differing in certain characteristics from other individuals.

Stipule: differently shaped, usually paired appendage of the petiole at the base of the leaf. It may be present only in the young leaves or permanently, rarely similar to a small leaf or modified into a spine.

Tendrils: a simple or branched thread-like organ, modified from a leaf or a stem, used by climbing plants for support and attachment.

2. Glossary of fungi terminology

Apothecium: a fruiting body of sac fungi (Ascomycota) which is cup or disc shaped, typically with a stalk in which asci and ascospores are formed.

Canker: a dead part of bark which is bent or cracked; dying of parts of the cambium or rhytidome; chronic disease caused by dome fungi or bacteria. The tree attempts to heal the wound by forming a callus, thus creating a typical thickening of the bark. A canker may eventually close, but more often a canker wound stays partly open with a sunken centre and a larger or smaller margin of thickened callus.

Disease: any type of metabolic disturbance and of anatomical or histological structure, which appears due to harmful biotic or abiotic factors and weakens the plant, when the disturbance is negatively affecting the ideal or economic value (use) of the plant.

Endophyte: fungi that live within a plant without causing apparent disease. In certain conditions they can become pathogens and damage the plant's tissue.

Hypertrophy: excessive cell growth of or enlargement and thickening of cells of tissues.

Hypha (pl. hyphae): a filamentous chain of cells, fusing into a mycelium

Hypovirulence: a reduced ability of a pathogen to cause infection.

Infection: the process which lasts from the germination of a disease-causing spore and entry into host plant until the establishment of a parasitic relationship with the host. This is the moment when fungi cease to use their reserves and start absorbing nutrients from the host plant.

Mycelial fan: flattened, fanlike array of fungal hyphae.

Mycelium: a vegetative part of a fungus consisting of hyphae.

Macrosporangium: mushroom, a large reproductive organ of fungi, larger than 2 mm. This term is used for macromycetes. The structure carrying macrosporangium is often made of stipe and pileus.

Microsporangium: a small reproductive organ of fungi, up to 2 mm in size. This term is used for microscopic fungi, for e.g. pycnidium, perithecium, apothecium).

Necrosis: death of cells or living tissue.

Parasite: an organism which develops and feeds on another living organism.

Perithecium: a spherical or flask-shaped sexual fruiting body of sac fungi (Ascomycetes) with a thicker layered wall and an with an apical pore (ostiole).

Saprobe or saprotroph: an organism which feeds on organic matter of dead plants or animals.

Spore: a reproductive cell of a fungus.

Virulence: the ability of a parasite to cause an infection.

Wood decay: the process of degrading and decaying wood which is caused by wood-decay fungi.

Wound: rubbed, removed or thorn outer tissue, so that the inner live tissue is exposed.