ICA2018

11th International Congress on Aerobiology

3-7 September 2018, Parma, Italy

FIRST INTERNATIONAL RAGWEED WORKSHOP

FROM KNOWLEDGE TO MANAGEMENT

Parma (Italy), 3 September 2018

Booklet produced by Heinz Müller-Schärer and Carine Beuchat (CH)

International Association for Aerobiology

International Ragweed Society

Congress Centre of the Chamber of Commerce of Parma
DU TILLOT Room; 9h00-13h00

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International Ragweed Society

Introduction of the course

Dear participants, I'm happy to introduce the First International Ragweed Course "FROM KNOWLEDGE TO MANAGEMENT", organized by the IRS.

This is an opportunity to widen your knowledge on ragweed, starting from the importance of its impact on health, deeping the aspects of different species, airborne pollen, widening the management and the biocontrol.

Hoping this is the first of many other courses, because there is no good management without knowledge.

The IRS President
Maira Bonini

My notes

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Allergy to ragweed and allergens involved

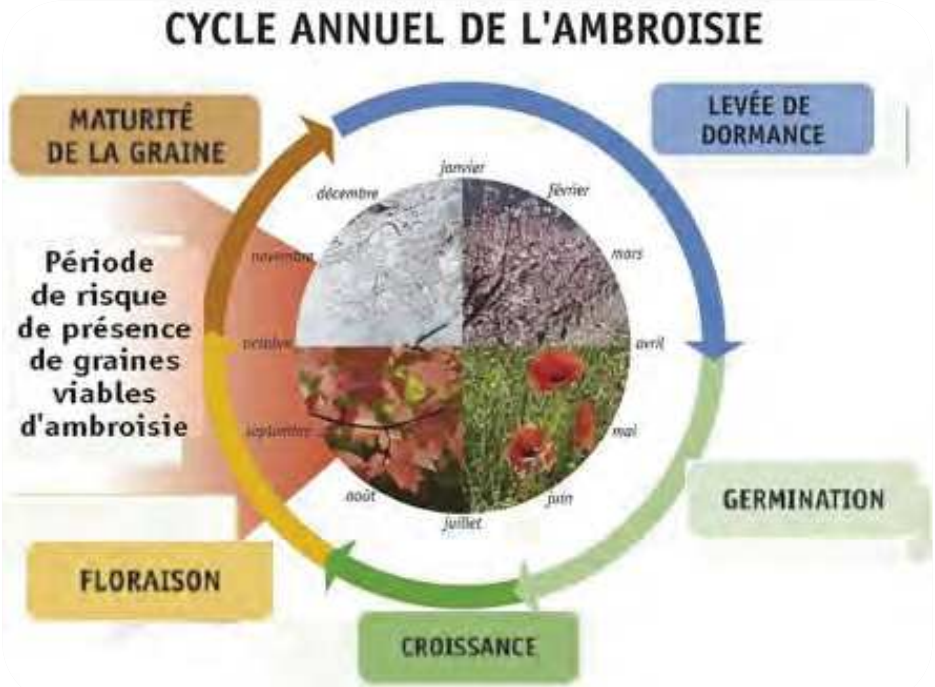
Michel Thibaudon (RNSA – France)

Ambrosia artemisiifolia

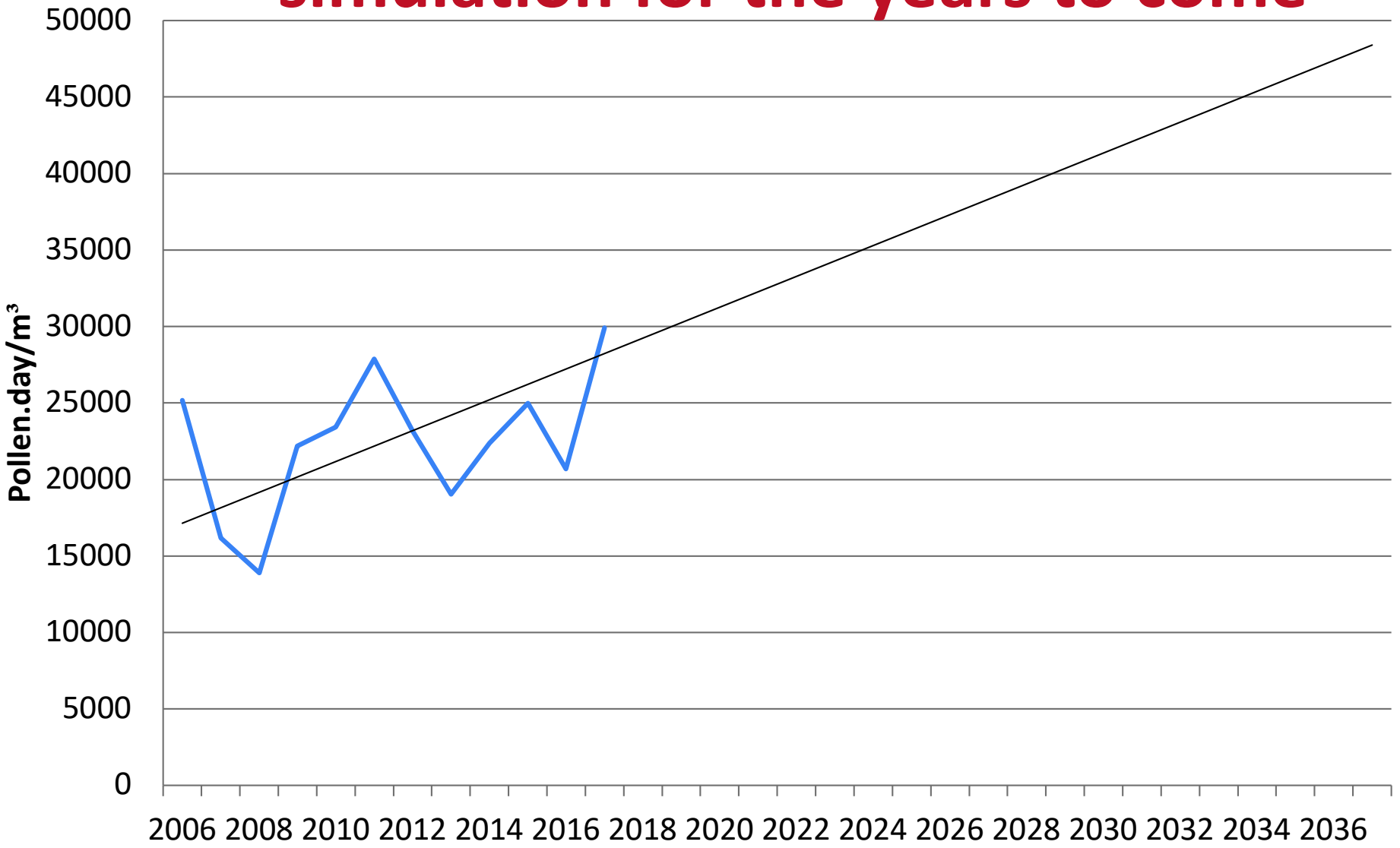
- Species of the **Asteraceae family**
Daisy, Groundsel, Sunflower, wormwood

- Annual species
maintenance of the species in an environment related to its reproductive success

- Invasive Exotic Species
a species native to North America
a species capable of breeding in our latitudes
a large production of mature seeds



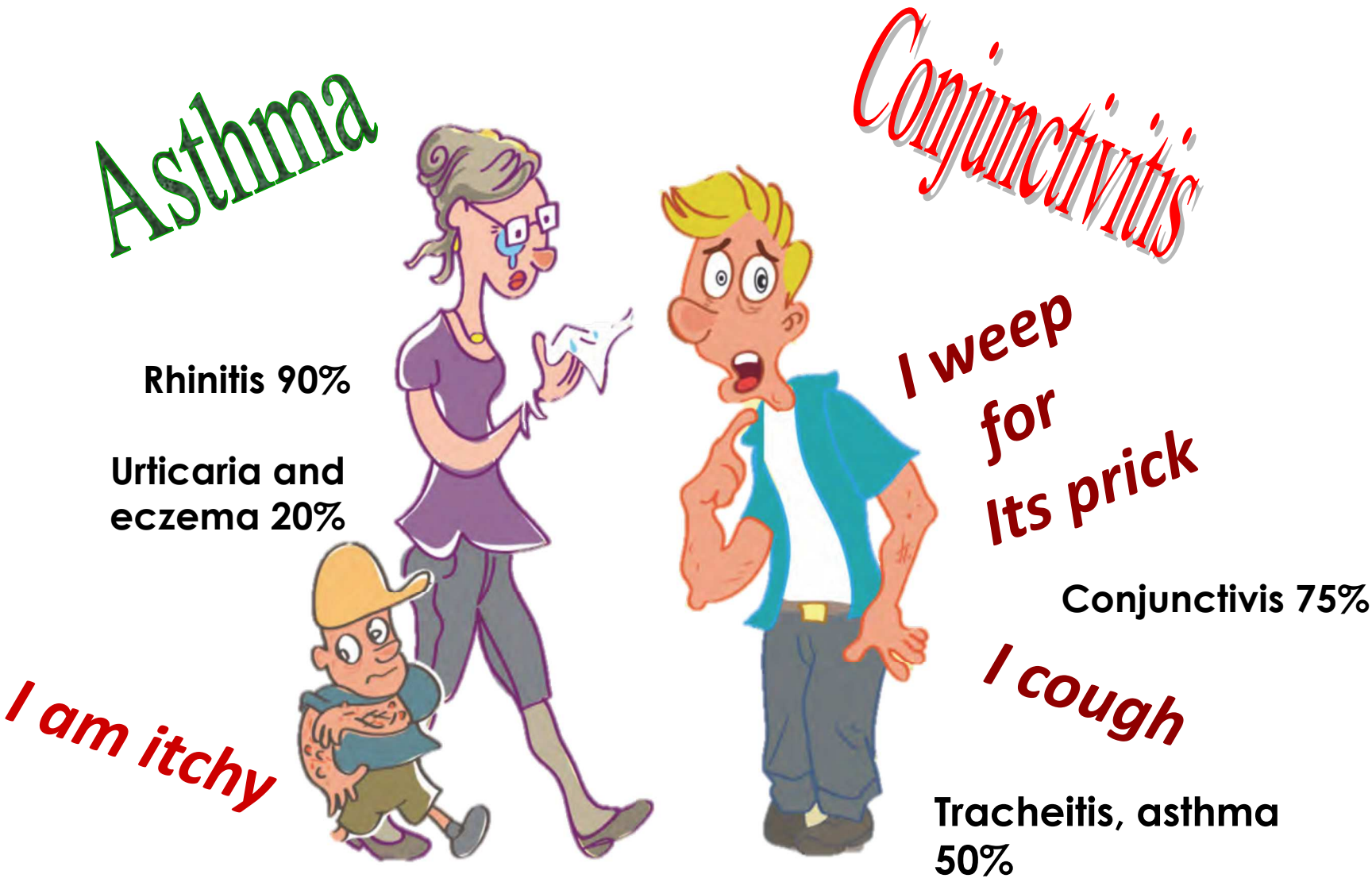
Evolution of ragweed pollen in France and simulation for the years to come



ragweed pollen allergens

Name	Mr	pI théoric	Fonction	Glycosylation	Prevalence		Remarks
					Allerdata	IUIS	
Amb a 1	38	5,3-6,6	pectate lyase	non glycosylé	>90%	95-97%	12 isoformes
Amb a 2	38	5,8-6	pectate lyase	non glycosylé	50-90%		= Amb a 1.05
Amb a 3	11	6,11	plastocyanine	glycosylé	30-50%	51-65%	
Amb a 4	30		défensine	O-glycosylation	environ 30%		Art v 1-like (nucléotides)
Amb a 5	5	8,19			10-20%	5-17%	2 isoformes
Amb a 6	10	8,93	LTP		30%	21-25%	
Amb a 7	12		plastocyanine	glycosylé	15-20%		
Amb a 8	14	4,8	profiline		15-40%		nombreuses isoformes
Amb a 9	10	4,2	polcalcine		10-20%		plusieurs isoformes
Amb a 10	18	4,25	4-EF Ca binding protein		10-20%		initialement Cytochrome C
Amb a 11	37/43	6,43	Cystéine protease	non glycosylé	ND	54%	3 ponts disulfures
Amb a 12	46,6	5,13	Enolase 1	non glycosylé	ND	65,80%	2 isoformes
Amb a CPI	10,5	5,2	Cystatin proteinase inhibitor				Allergome, Act d 4-like
Mr: apparent molecular mass			apparent molecular mass				
pI: isoélectric point			isoelectric point				
ND: not done							

Pollen allergy

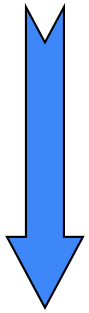


Other complications

- ***Sinusitis***
- ***Otitis***
- ***Viral and microbial infections***
- ***Sleep disorders***
- ***Loss of reflex***
- ***Scholar and professional absenteeism***

Allergy potency

(exposure)



Allergy risk

(health impact)

Difference between allergy potency and allergy risk

The allergy potency is specific to a pollen grain whatever the location while **the allergy risk** is a measure of health impact and depends on several factors such as the amount of pollen, the weather, the phenology, the symptoms observed by doctors…

Allergy potency of plants

The allergy potency of a plant species is the ability of its pollen to cause an allergy to a significant part of the population

The allergy potency can be:

- **Low or negligible** :This means that a very large amount of pollen is needed to trigger an allergy and this applies only to the most sensitive people
- **Moderate** :These species may be present locally to bring diversity into plantations, but they should not represent the majority of planted species
- **High** : A few number of pollen is enough to cause an allergic reaction

Allergy potency of herbs

SPONTANEOUS GRASSES		
Species	**Family**	**Allergy potency**
chenopod*	Chenopodiaceae	Moderate
Burned soda *(prickly saltwort)*		Moderate
ragweed*	Asteraceae	High
mugwort*		High
daisy*		Low or negligible
dandelion*		Low or negligible
mercury*	Euphorbiaceae	Moderate
plantain*	Plantaginaceae	Moderate
grasses*	Poaceae	High
sorrel* (*Rumex*)	Polygonaceae	Moderate
neettle*	Urticaceae	Low or negligible
pellitory*		High

*several species

ORNAMENTAL GRASSES		
Species	**Family**	**Allergy potency**
reed canary-grass	Poaceae	High
reed grass		Moderate
tufted hairgrass		High
sand ryegrass		Moderate
fescue*		High
oatgrass		High
hare's-tail		Moderate
giant feather grass		Moderate

*many species

Grasses

Ragweed

LIFE13 ENV/IT/001107

Pollen allergy

- The **World Health Organization (WHO)** classifies allergic diseases as the **fourth** largest **disease** in the world and considers them to be **"a major public health problem in terms of quality of life, lost working days or teaching , drug costs, even mortality. "**
- Since the 2000s, pollen allergies affect **10 to 15%** of the world's population. According to a WHO estimate, they could reach **50%** of the world's population in less than ten years.
- It is admitted today that **30% of French people** are allergic to pollen. All age groups are affected, but there is a predominance among adolescents and young adults.
- In the **Rhône-Alpes region 13 to 21%** of the exposed population is allergic to ragweed (Rhône-Alpes ORS study)

Study of the prevalence of ragweed allergy in Rhône-Alpes
Report of December 2014

Agence Régionale de Santé Rhône-Alpes

The study consists of a **telephone survey** based on a questionnaire, conducted in mid - September 2014 by IPSOS on a sample of 2502 households, with 7024 persons.

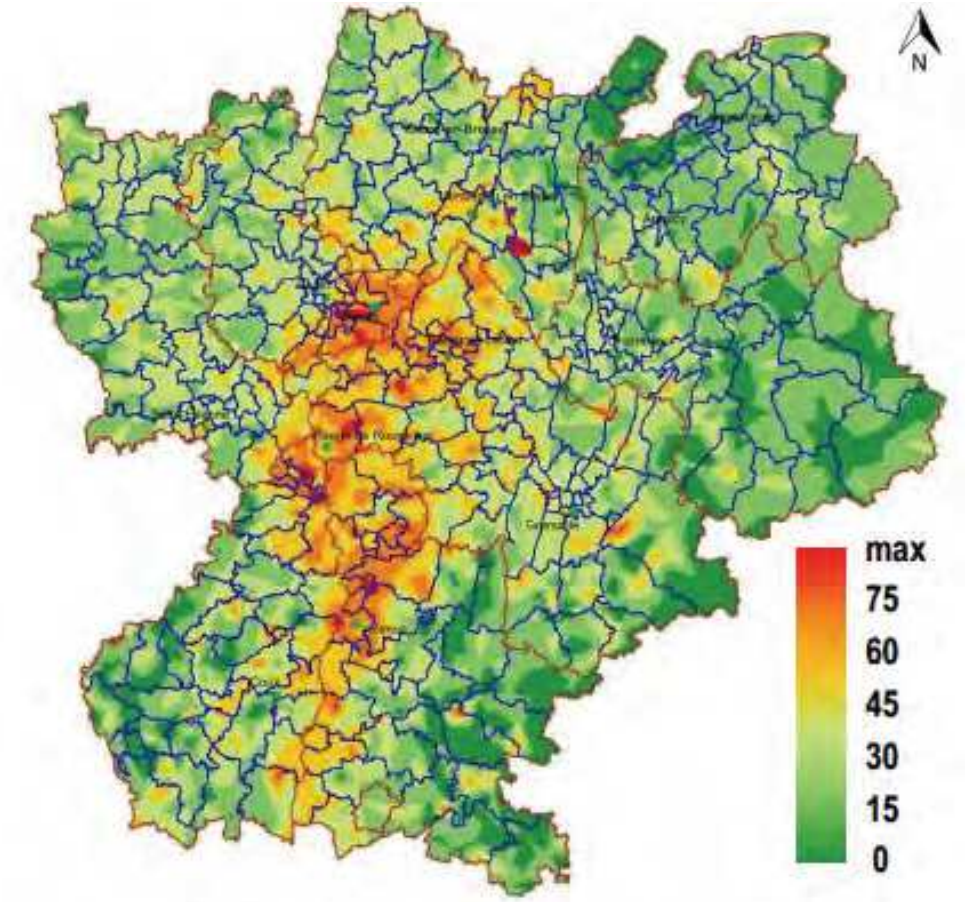
In all zones, a quarter of households include at least one case of allergy, a significantly higher proportion in highly exposed areas.

Since 2004, the rate of households with at least one case of allergy has significantly increased. Similarly, the individual prevalence of ragweed allergy was **13% in 2014** (compared with **9.2% in 2004**) and reached **21% in the highly exposed area.**

A total of **284 604** Rhônalpins people are potentially affected by ragweed allergy in the three study areas, including 161 697 in high-exposure areas, 88 436 in medium-exposure areas, and 34 613 in non-exposed areas.

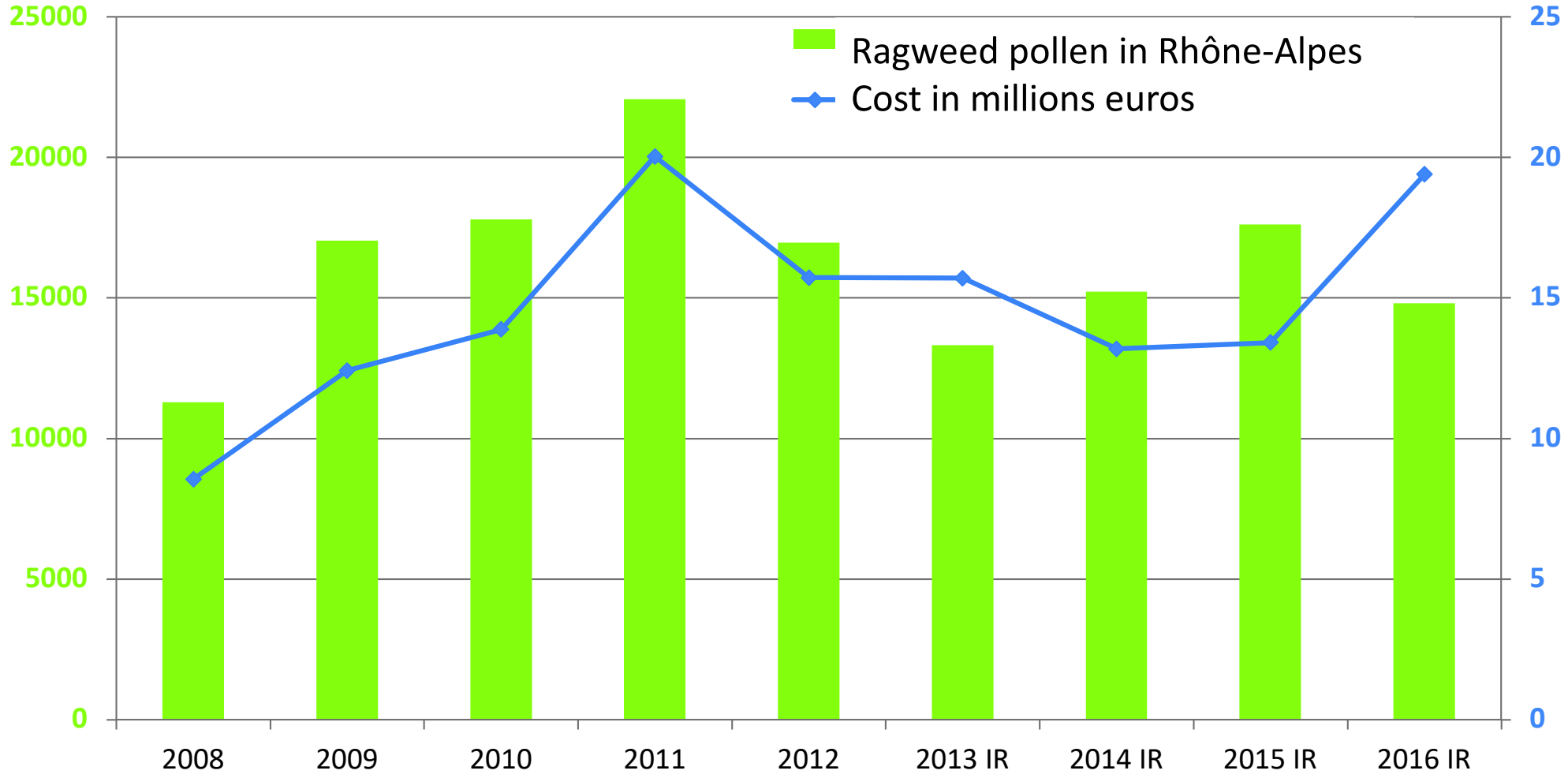
A high cost that must be reduced

In Rhône-Alpes in 2014, it is estimated that the allergy to ragweed has affected 284 604 people for a total cost of more than 20 million euros.



Number of allergy sufferers for 1000 habitants in Rhône-Alpes

Evolution 2008-2016 on the Rhône-Alpes region
Cost of Health / Ragweed Pollens



RNSA

In the greater Auvergne-Rhône-Alpes region the cost even reach 22 million euros in 2016

Thank you for your attention

www.pollens.fr

http://www.vegetation-en-ville.org/

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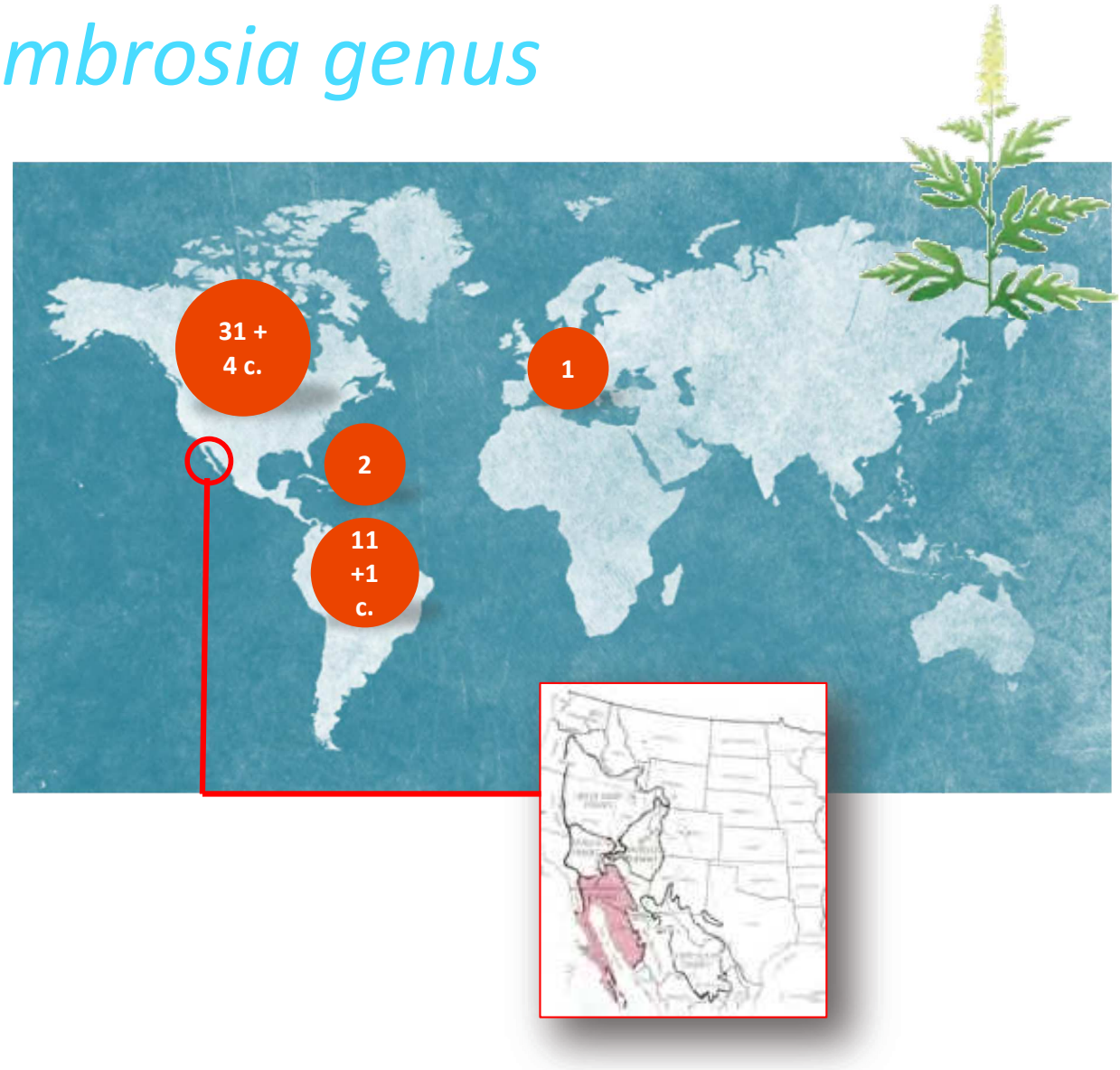
In field and herbarium collections, distinguishing different species may be hard due to partial similarity of some *taxa*, incomplete specimens and lack of reliable keys for identification.

Since the correct identification of ragweeds is the first step to understand how to manage them, the lecture focuses on practical detection of main distinctive morphological traits and related ecological and biological differences of species.

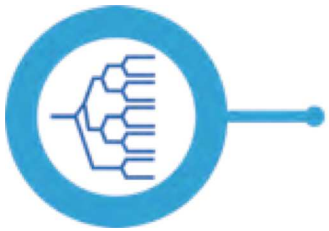
Ambrosia genus

There are over 40 species in the genus *Ambrosia* L. (Asteraceae), most of which are native to the Americas. The putative center of diversity of the genus is the Sonoran Desert. *Ambrosia* genus includes both dioecious shrubs and weeds, annuals and perennials, characterized by different "pioneer behaviour" thus by a different proclivity to become establish beyond their natural borders.



According to literature:

- 31 species are native to North and Central America, occurring only in a area comprising temperate North America and Mexico;
- 2 species occur mostly in the Carribean area;
- 11 species are almost exclusive of South America;
- 1 species is native to the Old World (South Europe, North Africa);
- 5 cosmopolitan species (origin: Americas).



Numbers can change because the taxonomy of *Ambrosia* is a very intricate topic: systematic of ragweed is troubled by confusion and complicated identification due to high morphological variability, polyploidization events and hybridization of *taxa*.

Ragweeds in Europe

The most common American ragweeds in Europe are:
- *A. artemisiifolia* (origin: North America);
- *A. psilostachya* (origin: North America);
- *A. tenuifolia* (origin: South America);
- *A. trifida* (origin: North America).

Then *A. tomentosa* (origin: North America) is a very rare ragweed in Europe, at now recorded as casual only in Spain.
In addition to them *A. confertiflora* is an invasive plant in Israel and could be potentially a future entry in the exotic European flora.

In Southern Europe, the only European native ragweed, *A. maritima* occurs in very few sites.

The present work deals with identification of *A. artemisiifolia, A. psilostachya, A. tenuifolia, A. trifida* and *A. maritima.*

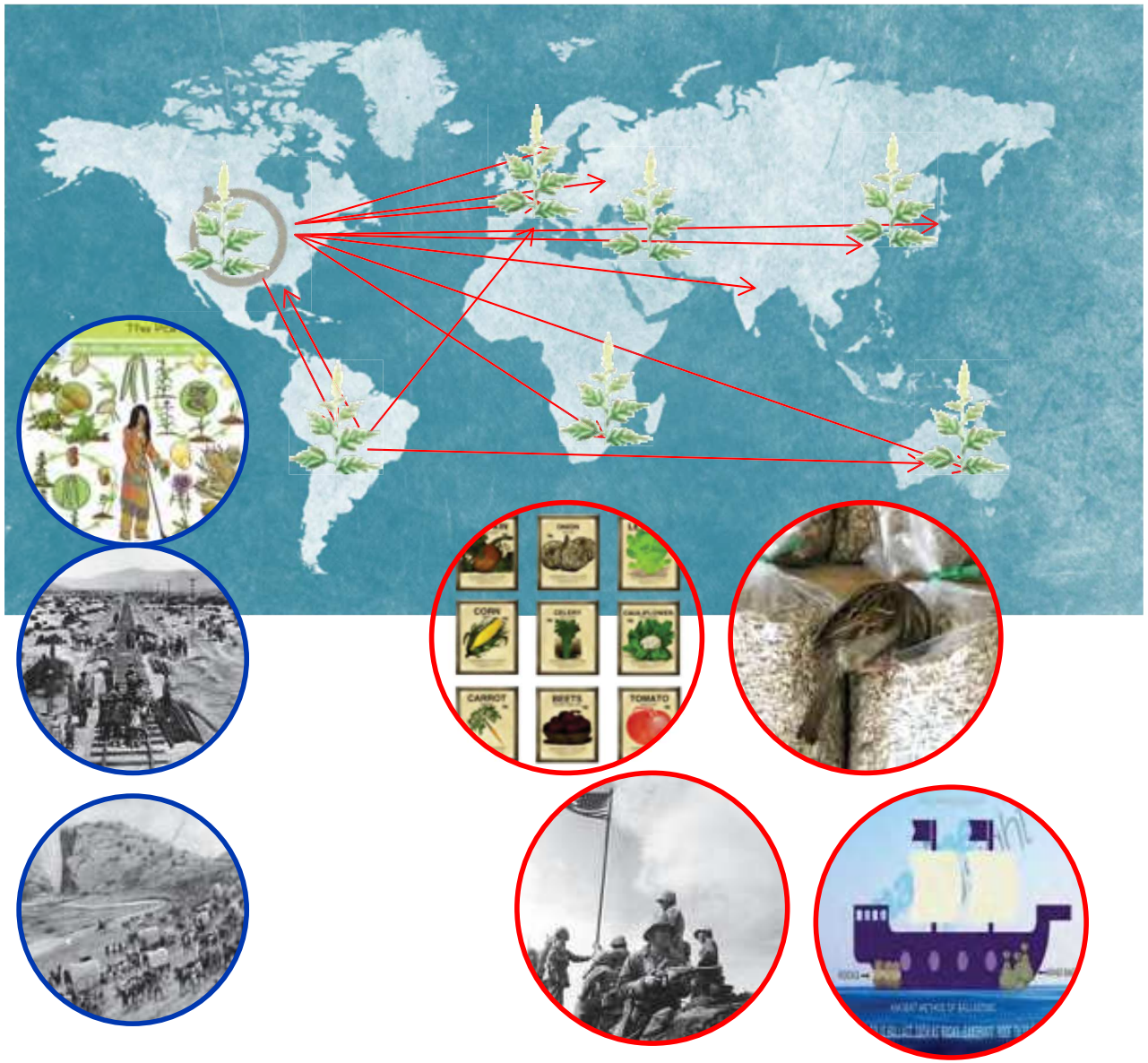
How ragweeds became cosmopolitan

Since ancient times *A.artemisiifolia, A. psilostachya, A. tenufolia* and *A. trifida* have been used in traditional medicine in the Americas (e.g., native Americans).

However, even several species were cultivated in European botanical gardens, the scientific or ethnobotanical interest was not the main way of introduction for these species, as the amounts of seeds or plants moved were probably small.

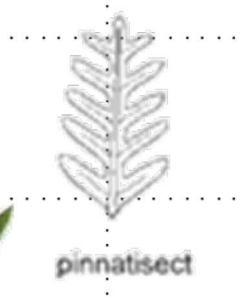
Owing to the frequency and abundance of ragweeds in anthropic environments also in their native range, it is widely accepted that their massive expansion followed involuntary human pathways, mainly human activities along trade routes.

The main pathways of introduction to Europe and other parts of the world are: contaminants of seed lots of grain, vegetables, seed for forage or oil-seeds (e.g. sunflower) and also seed found in bird food, military movements and some other secondary vectors (e.g. *A. tenuifolia* as ballast-plant).

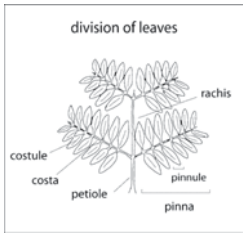


Identification of ragweed: technical terms

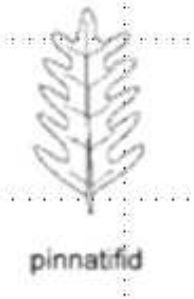
Pinnatisect leaf = Pinnately dissected to the midrib but having the segments confluent with it.



(bi-pinnatisect)



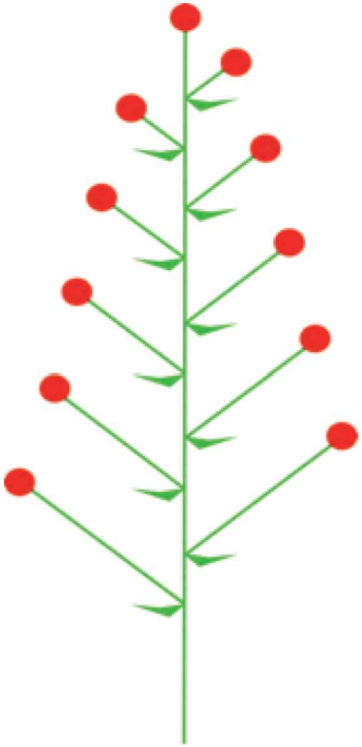
Pinnatifid leaf = leaf cut deeply into lobes, but by far not to the midrib

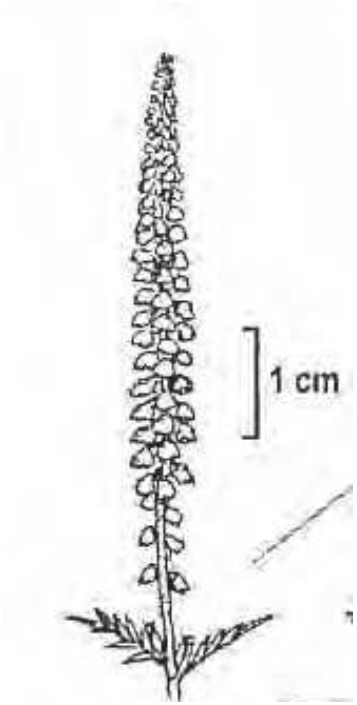


Simple leaf (with lobes)

Petiole or stalk
(no or very short stalk = sessile leaf)

Identification of ragweed: technical terms





Raceme = an indeterminate inflorescence with a simple, elongated axis and pedicellate flowers.

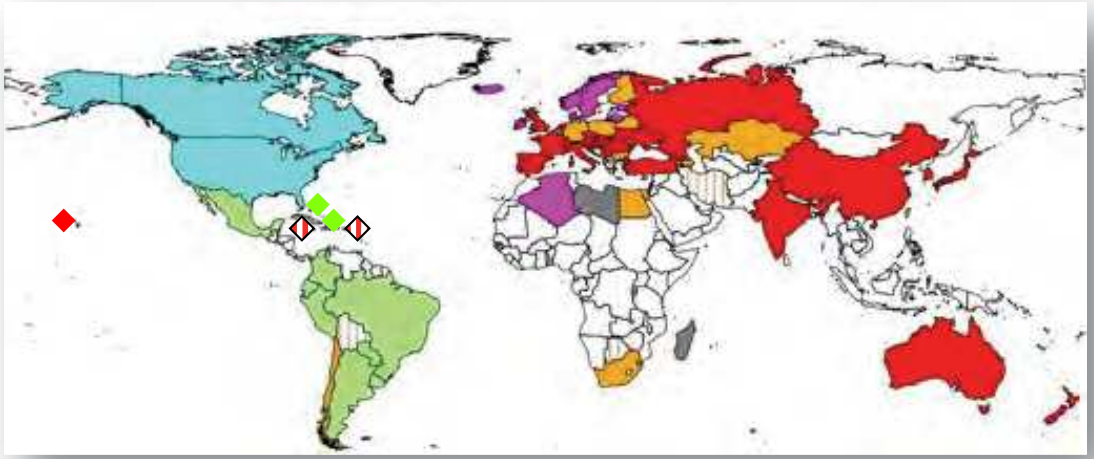
In ragweeds, apical racemes carry male capitula, while female capitula are at the leaf axils.

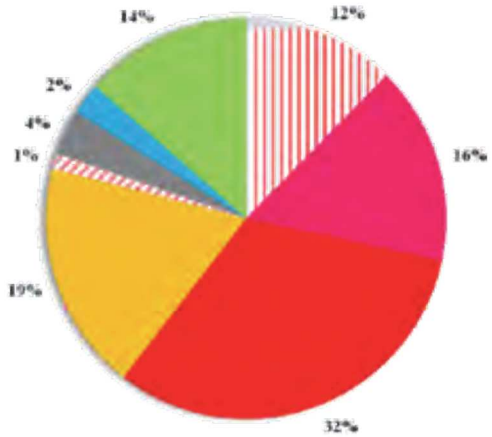
Capitulum (pl. –a) = an inflorescence with a dense cluster of sessile flowers borne on a flattened or vaulted receptacle typical, for example, of Asteraceae.

Photos: Essl et al., 2015

A. artemisiifolia – common ragweed

A. artemisiifolia occurs in every continent and it is a invasive alien plant in about one third of its global distribution.





Alien Invasive | Alien Naturalized | Alien Casual | Alien Invasive? | Alien Naturalized? | Alien Casual? | Alien status unkown | Species occurring | Native | Doubtful occurrence

Photos: https://keyserver.lucidcentral.org; Maps and graphics: Montagnani et al., 2017

Due to its weediness *A. artemisiifolia* can colonize a wide range of habitats. Its life strategies allows being a very hard competitor in perturbed sites, where it can successfully persist until vegetation cannot evolve to mature stages.

Species	*Ambrosia artemisiifolia* L.
Native habitat	Disturbed open habitat
	Semi-natural grasslands
	Croplands
	Along transportation corridors
	Wastelands
	Riparian habitat
	Dunes
	Non dense wood
Habitat in invasive range	Disturbed open habitat
	Semi-natural grasslands
	Croplands
	Along transportation corridors
	Wastelands
	Riparian habitat
	Dunes
	Non dense wood
Climate	Warm temperate climate (with exceptions)
	Drought tolerant
	Freeze tolerant
Soil	Alkaline
	Acid
	Silty
	Sandy
	Well drained/dry
	Moist/wet
	Saline
	Metal
Light	Heliophylous
	Shady-tolerant

Species	*Ambrosia artemisiifolia* L.
Resistance	Morphologic structures
	Chemical defence against stress and predators
	Allelopathy
	Mychorrhiza
	Reallocation biomass
Resilience	Resprouting
	Rhizome
	Secondary dormancy
	Soil seed bank
	Long-lasting soil seed bank
Competition	Advantages from vegetation gaps
	Weak competitor in more evolved vegetation stages
	Persistence in more evolved vegetation stages

A. artemisiifolia: identification

A.artemisiifolia shows a high morphological variability. Anyway there are several distinctive traits listed in the following table.

Species	*A. artemisiifolia* L.
Life form	Annual
Plant size (cm)	10 to 250
Belowground	**Taproot**
Stem	+/- intensively branched, branches with wide angles
Leaves	**Pinnatifid to bipinnate, rarely entire; leaf segments broadened and separated, rarely narrow, with lobes and undivided part 1-5 mm wide; lower leaves with distinct narrow petiole**; upper leaves alternate; long and short hairs mixed
Inflorescence	Numerous racemes terminal and lateral for each stem (8-15 cm**); 2-4 grouped female capitula**
Diaspore (mm)	2-4; 1-seeded
Diaspore coat	Few hairs and glands; 2-5 short lateral spines with sharpened tips; dark brown
Reproductive mode	Sexual (seeds)

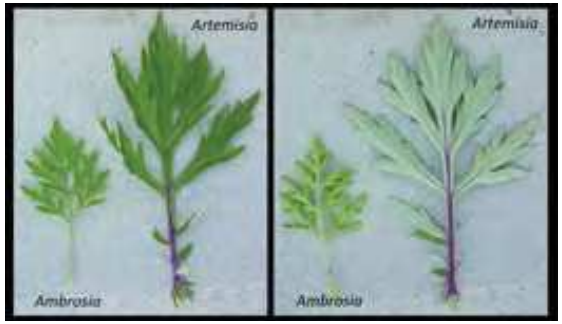
Photos: www.missouriplants.com, Ustyuzhanin et al., 2017; gobotany/newenglandwild.org; www.inspection.gc.ca; www.minnesotawildflowers.info

A. artemisiifolia and Artemisia vulgaris

A.artemisiifolia can be confused with several species.
Main misidentifications are between *A. artemisiifolia* and *A. vulgaris*.
They can be discriminated mainly thanks to:
- Shape of leaf lobes, color of leaf lower surface
- Capitula and racemes that have different shape and habit and in A. vulgaris capitula are hermaphrodite

A. artemisiifolia

A. vulgaris



A. artemisiifolia

A. vulgaris

Photos: Ustyuzhanin et al., 2017; keyserver.lucidcentral.org; naturelab.it; www.pollnet.it; www.biodiversita.lombardia.it

A. artemisiifolia, Artemisia annua and A. verlotiorum

Confusion can be made also with *A. annua* and *A. verlotiorum*. *A. verlotiorum* is very similar to *A. vulgaris* and distinctive traits are the same. *A. annua* is different from *A. artemisiifolia* due to:

-3-pinnately lobed leaves, with tiny lobes;

- racemes with nodding capitula in open, (diffusely branched, leafy) arrays

A. annua

A. velotiorum

Photos: Scott Bauer, www.minnesotawildflowers.info; http://www.actaplantarum.org; dryades.units.it

A. artemisiifolia.. and possible oversights

A inexpert observer can determinate as *A. artemisiifolia* very different species, such as those of *Achillea* and *Fumaria* genus.

Fumaria (Papaveraceae): plant have different habit and flowers; confusion can be made mainly when *Fumaria* is at a seedling stage.

Achillea (Asteraceae): confusion can be made when the plants are not flowering, due to “similar” bipinnate leaves.

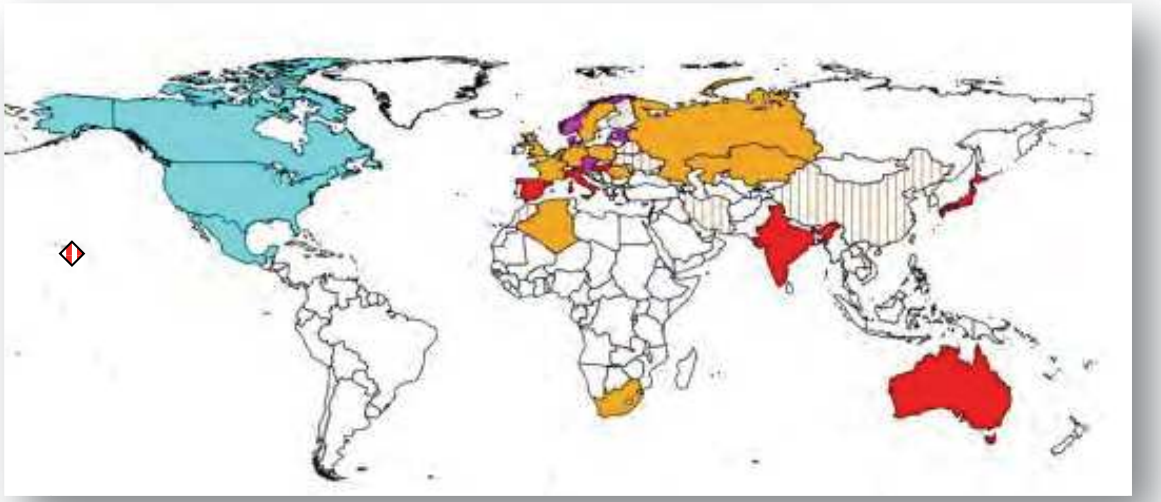
Fumaria spp.
(*F. officinalis*)

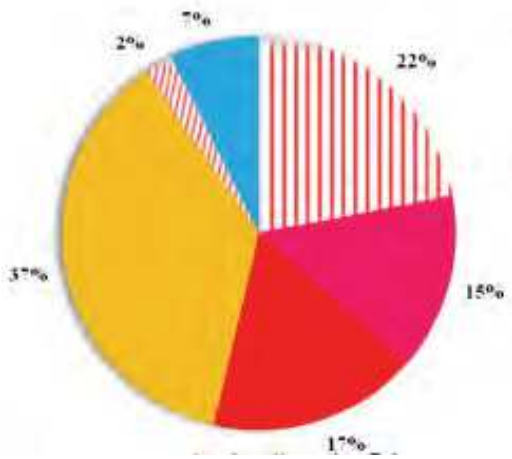
Achillea spp.
(*A. ligustica*)

Photos: www.minnesotawildflowers.info; www.meditflora.com; pestid.msu.edu; plantevaernonline.dlbr.dk

A. psilostachya – Western or perennial ragweed

A. psilostachya is a perennial ragweed, with a strong proclivity to naturalization thanks to its vigorous rhizome. It is naturalized and often invasive in almost all colonized European countries.





Alien Invasive | Alien Naturalized | Alien Casual | Alien Invasive? | Alien Naturalized? | Alien Casual? | Alien status unkown | Species occurring | Native | Doubtful occurrence

Photos: Chiara Montagnani; ; Maps and graphics: Montagnani et al., 2017

A. psilostachya shares the ruderal behaviour of *A. artemisiifolia*, but differently to common ragweed, it is very invasive on sandy soil, often showing its weediness in coastal dunes systems; thanks mainly to its rhizome, it can persist in very harsh environment. It can stand also in more evolved and shady vegetation stages.

Species	*Ambrosia psilostachya* DC.
Resistance	Morphologic structures
	Chemical defence against stress and predators
	Allelopathy
	Mychorrhiza
	Reallocation biomass
Resilience	Resprouting
	Rhizome
	Secondary dormancy
	Soil seed bank
	Long-lasting soil seed bank
Competition	Advantages from vegetation gaps
	Weak competitor in more evolved vegetation stages
	Persistence in more evolved vegetation stages

Species	*Ambrosia psilostachya* DC.
Native habitat	Disturbed open habitat
	Semi-natural grasslands
	Croplands
	Along transportation corridors
	Wastelands
	Riparian habitat
	Dunes
	Non dense wood
Habitat in invasive range	Disturbed open habitat
	Semi-natural grasslands
	Croplands
	Along transportation corridors
	Wastelands
	Riparian habitat
	Dunes
	Non dense wood
Climate	Warm temperate climate (with exceptions)
	Drought tolerant
	Freeze tolerant
Soil	Alkaline
	Acid
	Silty
	Sandy
	Well drained/Dry
	Moist/Wet
	Saline
	Metal
Light	Heliophylous
	Shady-tolerant

Photos: Chiara Montagnani

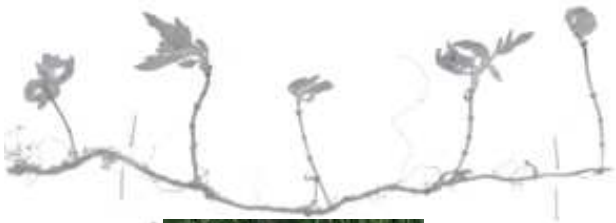
A. psilostachya: identification

To identify *A.psilostachya,* there are several distinctive traits listed in the following table.

Species	***A. psilostachya* DC.**
Life form	Perennial
Plant size (cm)	10 to 90
Belowground	Root sprouter
Stem	Few branches, with narrow angles
Leaves	**Pinnatifid**, **rarely entire, with 3-7 mm wide leaf segments; +/- sessile**; upper leaves alternate; dense short hairs on upper and lower leaf surface, which is slightly brighter then the upper one.
Inflorescence	1 terminal x stem, usually lateral raceme reduced to glomerules
Diaspore (mm)	2-3; 1-seeded
Diaspore coat	Few glands and short hairs; blunt, short lateral spines few or none; dark brown
Reproductive mode	Mostly vegetative, rarely by seeds








Photos: Chiara Montagnani, www.inspection.gc.ca, dryades.units.it

A. psilostachya and *A. artemisiifolia*

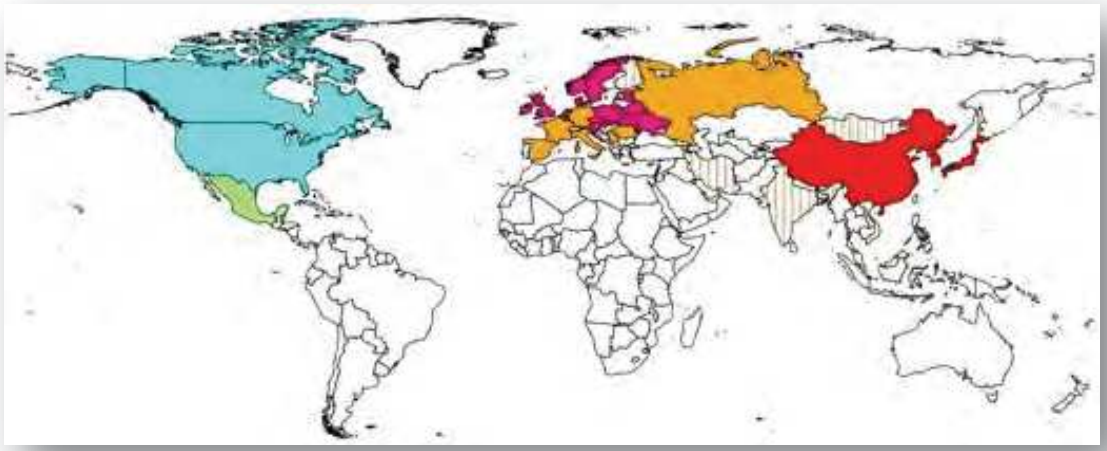
A.psilostachya and *A. artemisiifolia* are often confused.
Easily identifiable traits are:

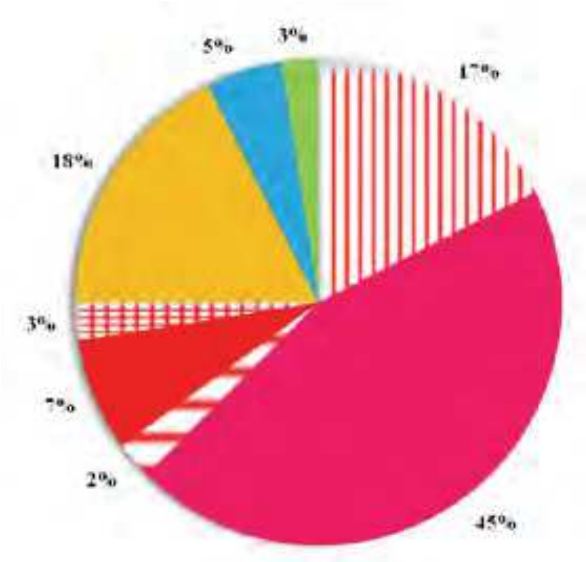
A. psilostachya	**A. artemisiifolia**
Ipogeous part	
rhizome	taproot
Leaves	
pinnate leaves with lobes 3-7 mm wide	Pinnatifid to bipinnate leaves with lobes and undivided part 1-5 mm wide
No or short petiole	Petiole (at least basal leaves)
Tomentose	Variably hairy
Raceme	
1 terminal x stem, usually lateral raceme reduced to glomerules	Numerous racemes terminal and lateral x stem

Photos: Chiara Montagnani, www.uwgb.edu, www.minnesotawildflowers.info

A. Trifida – giant ragweed

A. trifida is an annual, very tall, ragweed. Its distribution is more fragmented in Europe than previous ragweed. It often persists locally in stable dense populations, but it does not reach the weediness of the other congeners.





Alien Invasive | Alien Naturalized | Alien Casual | Alien Invasive? | Alien Naturalized? | Alien Casual? | Alien status unkown | Species occurring | Native | Doubtful occurrence

Photos: Chiara Montagnani; Maps and graphics: Montagnani et al., 2017

A. trifida shares the ruderal behaviour of *A. artemisiifolia*, with a more marked tendency to colonize river banks in perturbed sites. It is a high light specialist or light-loving species. The early emergence, development of seedlings and the great growth of plants would indicate that the life cycle of *A.trifida* is strongly shaped around light exploitation.

Species	*Ambrosia trifida* L.
Resistance	Morphologic structures
	Chemical defence against stress and predators
	Allelopathy
	Mychorrhiza
	Reallocation biomass
Resilience	Resprouting
	Rhizome
	Secondary dormancy
	Soil seed bank
	Long-lasting soil seed bank
Competition	Advantages from vegetation gaps
	Weak competitor in more evolved vegetation stages
	Persistence in more evolved vegetation stages

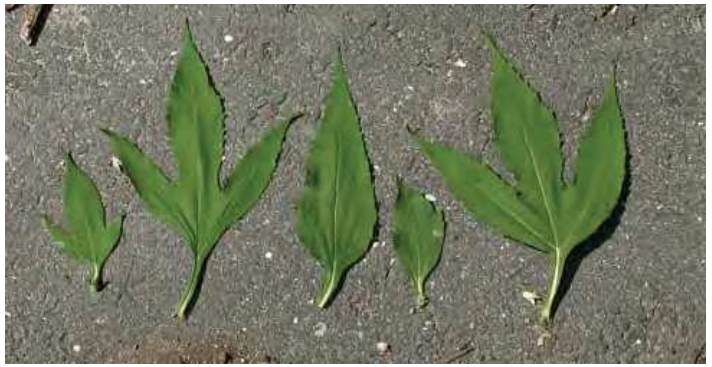
Species	*Ambrosia trifida* L.
Native habitat	Disturbed open habitat
	Semi-natural grasslands
	Croplands
	Along transportation corridors
	Wastelands
	Riparian habitat
	Dunes
	Non dense wood
Habitat in invasive range	Disturbed open habitat
	Semi-natural grasslands
	Croplands
	Along transportation corridors
	Wastelands
	Riparian habitat
	Dunes
	Non dense wood
Climate	Warm temperate climate
	Drought tolerant
	Freeze tolerant
Soil	Alkaline?
	Acid
	Silty
	Sandy
	Well drained/dry
	Moist/wet
	Saline
	Metal
Light	Heliophylous
	Shady-tolerant

Photos: Chiara Montagnani, www.no-tillfarmer.com

A. trifida: identification

The identification of *A. trifida* is very easy, due to its peculiar traits, listed in the following table. Beyond its height (up to 4 m), its leaves are very easily identifiable in spite of a certain morphological variability (palmate sometimes entire leaves).

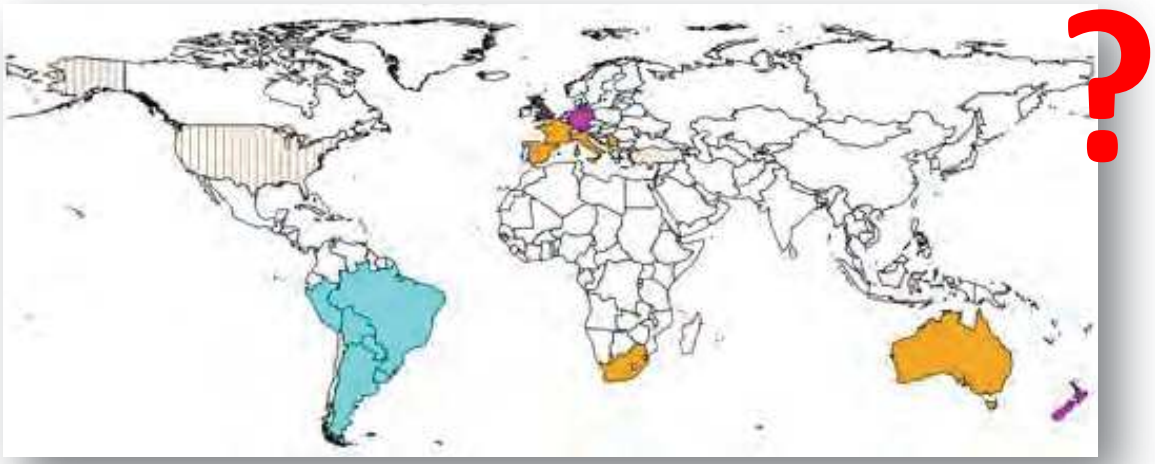
Species	*A. trifida* L.
Life form	Annual
Plant size (cm)	**40 to 400**
Belowground	Taproot
Stem	+/- intensively branched
Leaves	**Entire or divided in 3(-5) lobes**; glabrous or few short hairs; all leaves opposite
Inflorescence	Terminal raceme with 1mm male capitula; 4 mm female capitula
Diaspore (mm)	>6; 1-seeded
Diaspore coat	Glabrous or few hairs; 2-4 indistinct lateral spines; dark brown to black
Reproductive mode	Sexual (seeds)

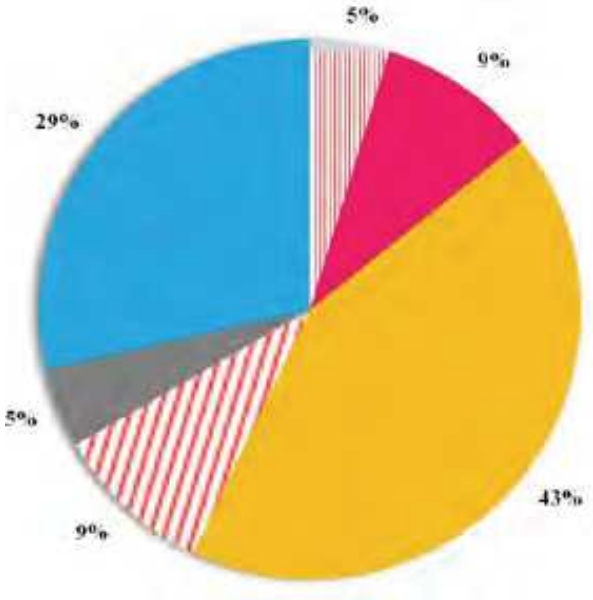


Photos: Chiara Montagnani, www.inspection.gc.ca; wikimedia

A. Tenuifolia – slimleaf bur ragweed

A. tenuifolia is less widespread than previous ragweeds. Its distribution is under debate, due to taxonomical criticisms. For example, in Europe, *A. tenuifolia* could be limited to France and Spain, while in Italy small-leaved ragweed could be hybrids of *A. artemisiifolia* x *A. psilost*achya (*A. intergradiens*; *G. Karrer personal communication*)





Alien Invasive | Alien Naturalized | Alien Casual | Alien Invasive? | Alien Naturalized? | Alien Casual? | Alien status unkown | Species occurring | Native | Doubtful occurrence

Photos: dryades.units.it; Maps and graphics: Montagnani et al., 2017

Habitat colonized by *A. tenuifolia* are very similar to ones where *A. psilostachya* can be found. Beyond ruderal enviroments that are common to all cited ragweeds, *A. tenuifolia* can colonize sandy soil, coastal dunes and river banks.

It is a perennial, as *A. psilostachya*, resistant to seasonal flooding. If seed production is scarce for *A. psilostachya*, on the other hand *A. tenuifolia* potentially can match a vigorous rhizome with a conspicuous seed bank.

Species	*Ambrosia tenuifolia* Spreng.
Resistance	Morphologic structures
	Chemical defence against stress and predators
	Allelopathy
	Mychorrhiza
	Reallocation biomass
Resilience	Resprouting
	Rhizome
	Secondary dormancy
	Soil seed bank
	Long-lasting soil seed bank
Competition	Advantages from vegetation gaps
	Weak competitor in more evolved vegetation stages
	Persistence in more evolved vegetation stages

Species	*Ambrosia tenuifolia* Spreng.
Native habitat	Disturbed open habitat
	Semi-natural grasslands
	Croplands
	Along transportation corridors
	Wastelands
	Riparian habitat
	Dunes
	Non dense wood
Habitat in invasive range	Disturbed open habitat
	Semi-natural grasslands
	Croplands
	Along transportation corridors (?)
	Wastelands
	Riparian habitat (?)
	Dunes
	Non dense wood
Climate	Warm temperate climate
	Drought tolerant
	Freeze tolerant
Soil	Alkaline?
	Acid
	Silty
	Sandy
	Well drained/Dry
	Moist/Wet
	Saline
	Metal
Light	Heliophylous
	Shady-tolerant

Photos: Chiara Montagnani, Gerhard Karrer

A. tenuifolia: identification

To identify *A. tenuifolia*, there are several distinctive traits listed in the following table.

Species	***A. tenuifolia* Spreng.**
Life form	Perennial
Plant size (cm)	20-100
Belowground	**Root sprouter**
Stem	Few branches, with narrow angles
Leaves	**Bipinnate to pinnatifid with linear lobes narrow as rachid, connected at the base; lower leaves with distinct narrow short petiole**; upper leaves alternate; dense short hairs
Inflorescence	Few terminal racemes and **solitary female capitula**
Diaspore (mm)	2-3.5; 1-seeded
Diaspore coat	Short hairs and glands, 2-5 lateral short blunt spines; olive to dark brown
Reproductive mode	Vegetatively and by seeds (rarely in Europe)

Photos: Chiara Montagnani, Gerhard Karrer

A. tenuifolia, A. psilostachya and A. artemisiifolia

In order to discriminate *A. tenuifolia*, *A.psilostachya* and *A. artemisiifolia*, easily identifiable traits are:

A. tenuifolia	**A. psilostachya**	**A. artemisiifolia**
Ipogeous part		
rhizome	rhizome	taproot
Leaves		
bipinnate to pinnatifid with linear lobes narrow as rachid, connected at the base	pinnate leaves with lobes 3-7 mm wide	Pinnatifid to bipinnate leaves with lobes and undivided part 1-5 mm wide
inferior leaves with short petiole	None or short petiole	Petiole (at least basal leaves)
Hairy	Tomentose	Variably hairy
Raceme		
Few terminal racemes, solitary female capitula	1 terminal x stem, usually lateral racemes reduced to glomerules	Numerous racemes terminal and lateral x stem, 2-4 grouped female capitula

Photos: Chiara Montagnani, www.minnesotawildflowers.info

A. tenuifolia & A. intergradiens

As previously pointed, the identification of *A. tenuifolia* can be critic often due to confusion with *A. intergradiens* (*A. artemisiifolia* x *A. psilostachya*). Investigation is in progress and discriminative elements will be identified. In the meanwhile, the main morphological trait to pay attention is the leaf and the shape of leaf lobes.

A.tenuifolia
(herbarium speciemen, France)

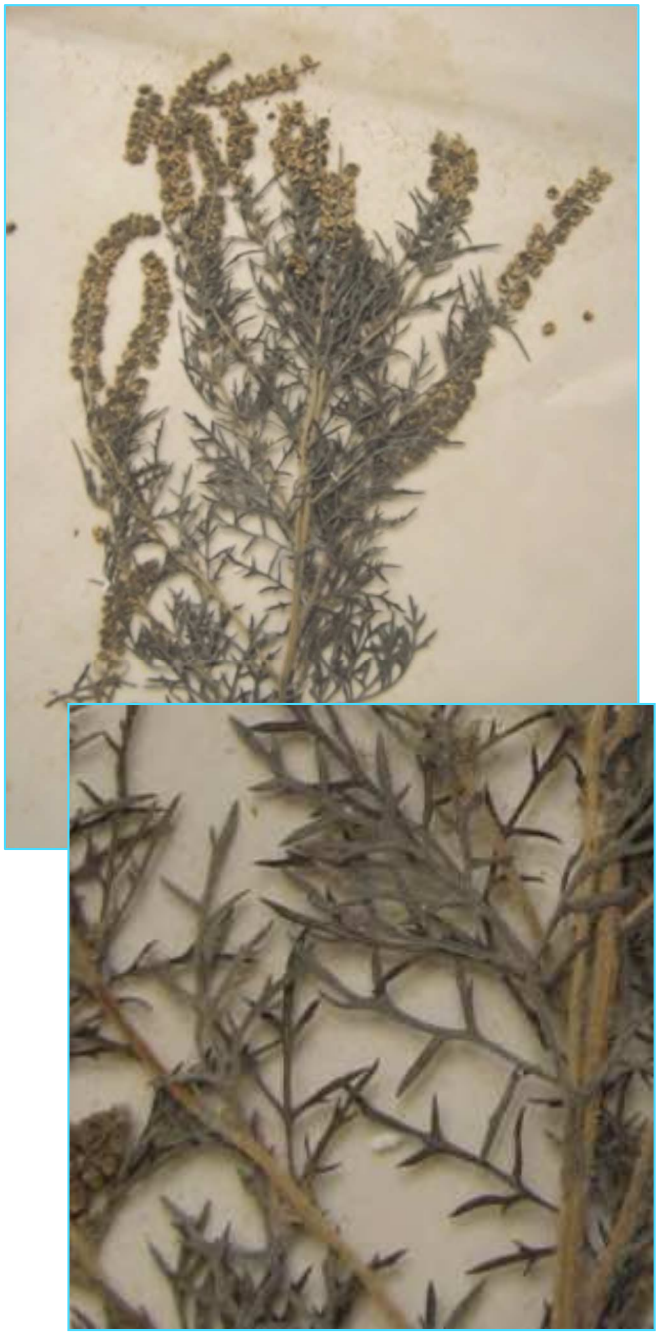
A.intergradiens (?)
(herbarium speciemen, Italy)

Photos: Chiara Montagnani, HERB PAD

A. tenuifolia & Artemisia annua

Confusion can be made between *A. tenuifolia* and *A. annua* . *A. ann*ua is different mainly due to:
-3-pinnately lobed leaves, with tiny lobes;
- racemes with nodding capitula in open, (diffusely branched, leafy) arrays

A. tenuifolia



A. annua

Photos: Chiara Montagnani, Scott Bauer, http://www.actaplantarum.org

A. maritima - Sea Ambrosia

A.maritima is considered the only ragweed native to Old World, even if there are doubts about its nativeness.

Today *A. maritima* is very rare in Europe.

Thanks to recent field investigation, *A. maritima* has been found in Italy (SMARTER Cost Action) and Spain (*G. Karrer personal communication*). Currently, its range is reduced to Italy, Spain, Malta, Greece and Egypt (where it is more widespread and cultivated).

Based on herbarium records and field studies, *A. maritima* is restricted to coastal dunes, even if in Egypt it is also classified as ruderal, occurring also in riparian habitats.

Photos: Chiara Montagnani, Matthias Kropf

A. maritima: identification

To identify *A. maritima*, there are several distinctive traits listed in the following table.

Species	***A. maritima* L.**
Life form	Biennial, perennial
Plant size (cm)	20-80
Belowground	Taproot
Stem	Intensively branched, **stems lignified towards the base**, sprouts from lower aerial stem buds
Leaves	Pinnatifid to bipinnate, **leaf segments rounded; lower leaves with narrow but distinct stalks;** upper leaves alternate; dense hairs all around, **usually ashy - tomentose lower surface, hairy (dark) green upper surface**
Inflorescences	**One terminal raceme for each stem**
Diaspore (mm)	3.5-5; 1-seeded
Diaspore coat	Few hairs, dense glands; 4-6 distinct lateral spines + 1 central lobed spine; olive to dark brown

Photos: Chiara Montagnani, Gerhard Karrer, HERB BO

A. maritima, A. psilostachya and A. artemisiifolia

In order to discriminate A. maritima, A.psilostachya and A. artemisiifolia,
Easily identifiable traits are:

A. maritima	**A. psilostachya**	**A. artemisiifolia**
Ipogeous part		
taproot	rhizome	taproot
Leaves		
Pinnatifid to bipinnate, leaf segments rounded	Pinnate leaves with lobes 3-7 mm wide	Pinnatifid to bipinnate leaves with lobes and undivided part 1-5 mm wide
narrow, distinct petiole	None or short petiole	Petiole (at least basal leaves)
ashy - tomentose lower surface, hairy (dark) green upper surface;	Tomentose	Variably hairy
Raceme		
one terminal raceme for each stem	1 terminal x stem, usually lateral racemes reduced to glomerule	Numerous racemes terminal and lateral x stem

Photos: Chiara Montagnani, www.minnesotawildflowers.info

General recommendations

Correctly identifying ragweeds is essential to effectively manage them, as measures of containment need to be species-specific due to different ecological and biological strategies of species. In order to ensure correct identification, basic recommendation in herborization are required.
During field activities, it is strongly suggested to collect ragweeds or take pictures of plants, paying attention to:

-**Habitus**: collect or take pictures of the entire plant, including roots; in case of pictures, it is suggested to use dimensional landmarks.

- **Leaves**: consider both basal and stem leaves of the same plant and collect/photograph different specimens in the same population, possibly at different life stages ; take detailed pictures of leaves (included petiole) and, if possible, of hairiness.

- **Seeds**: as they are not always available and very rare for some ragweeds (A. psilostachya), previously they are not cited as the easiest trait to consider in identification; anyway, if seeds are present collect some of them from not collected specimens and put in separate envelope or little bag (do not store them hermetically if you need viable seeds), in order to not loose them. Pictures of seeds have to be very precise (visible hair, glands).

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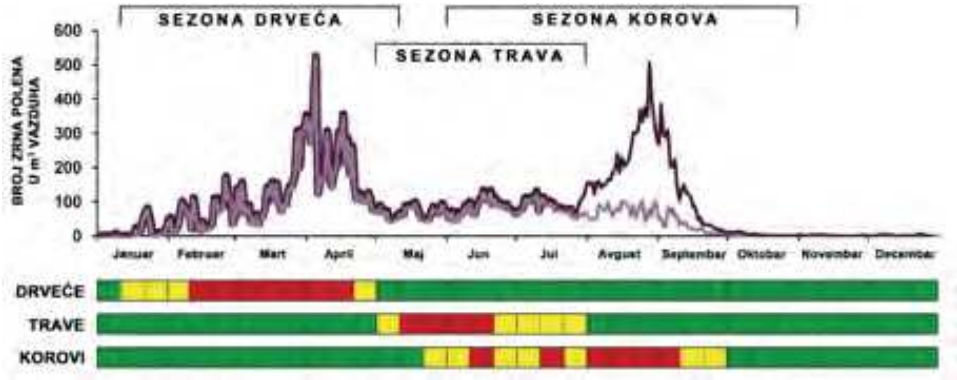
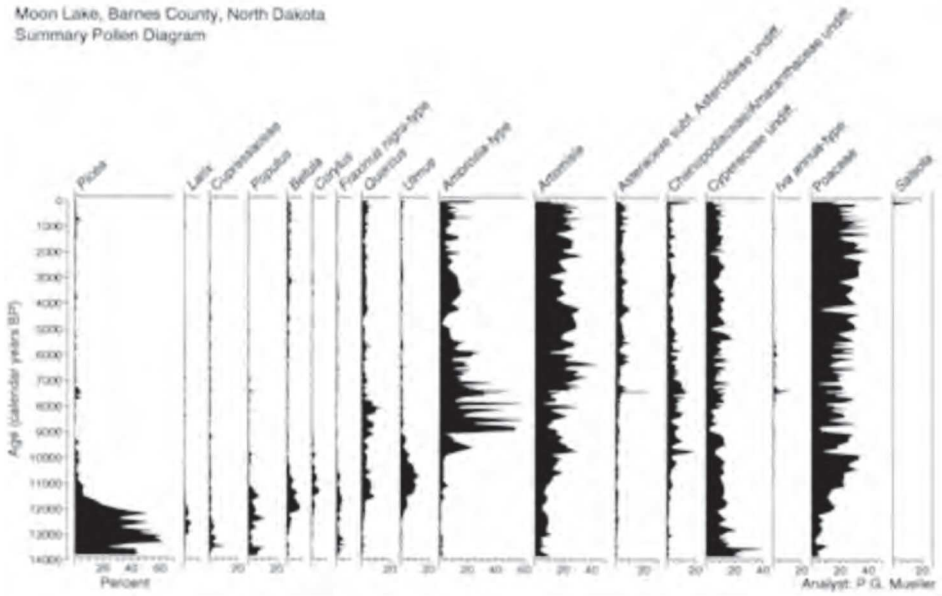
My notes

Maira Bonini (IT)	Introduction of the course
Michel Thibaudon (FR)	Allergy to ragweed and allergens involved
Chiara Montagnani (IT)	How to recognize the different *Ambrosia* species
Branko Sikoparija (SRB)	**How to distinguish *Ambrosia* pollen from other similar pollen**
Rea Maria Hall (CH)	How to manage the *Ambrosia* plants
Heinz Müller Schärer & Carine Beuchat (CH)	*Ophraella communa*: biology, impact, biosafety and recognition

Why is accurate identification important?

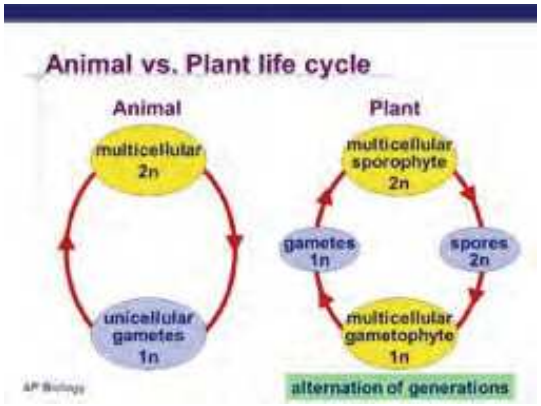




Laird et al. DOI 10.1191/095968398673895438

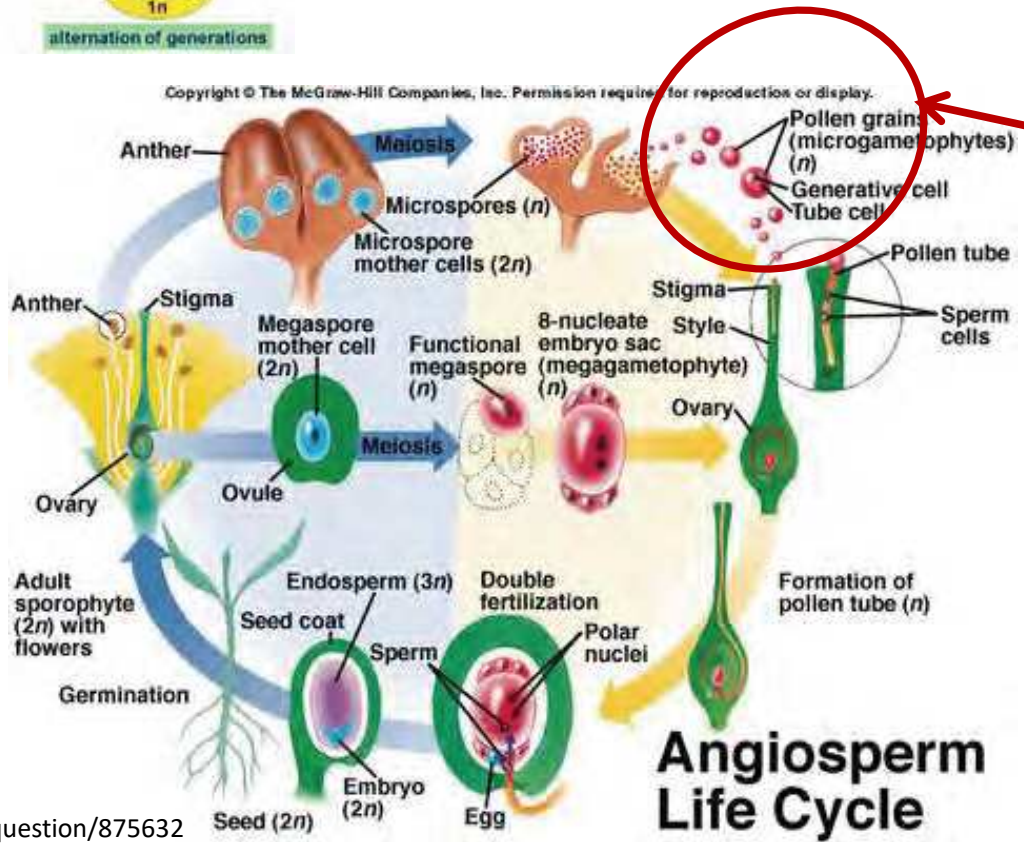
Karrer et al. DOI: 10.1016/j.scitotenv.2015.03.108

What is pollen and what it serves for?



-“structure” in gametophyte (n) generation

-<u>protects</u> genetic material during transfer

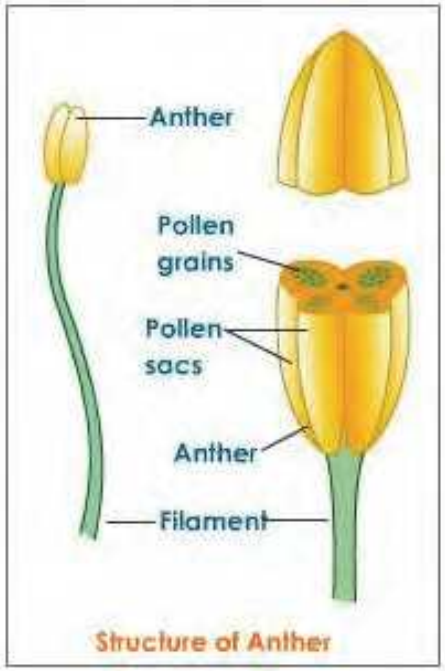


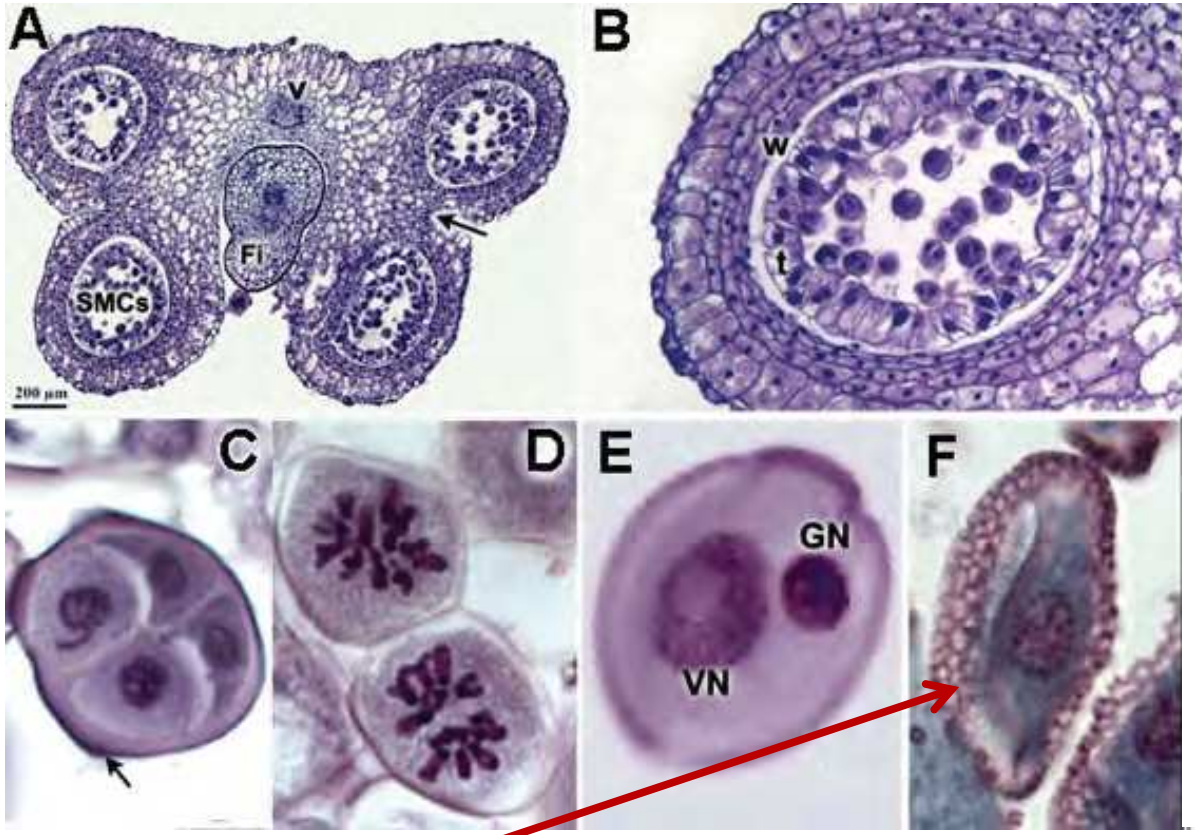
TRANSFER / POLINATION

How?

https://brainly.in/question/875632

Pollen development?

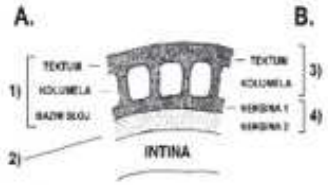




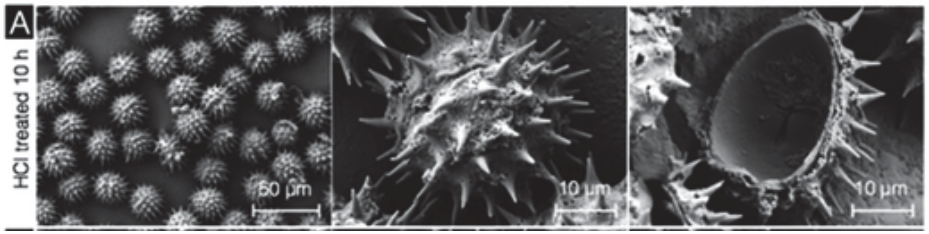
http://www.vcbio.science.ru.nl/en/virtuallessons/pollendevelopment/

Resilience comes from pollen wall:

A multilayered structure made of polymer sporopollenin

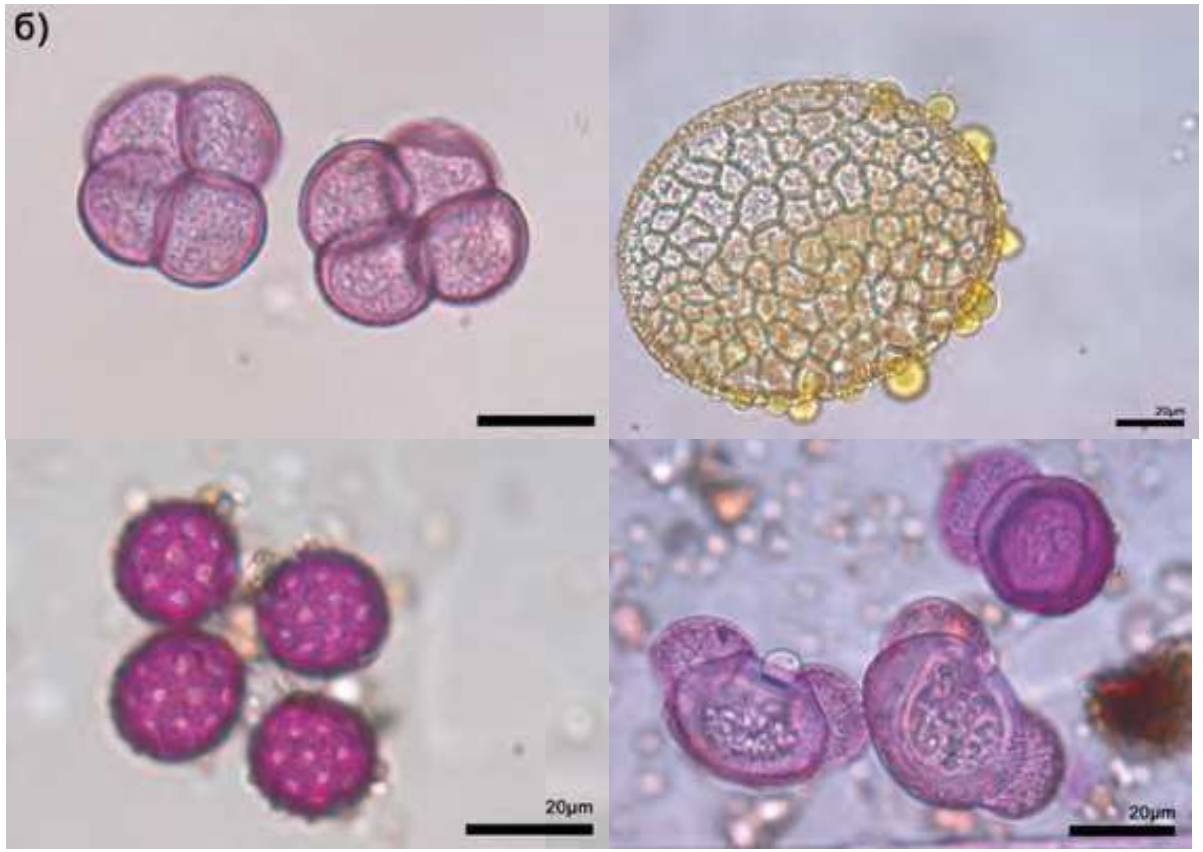


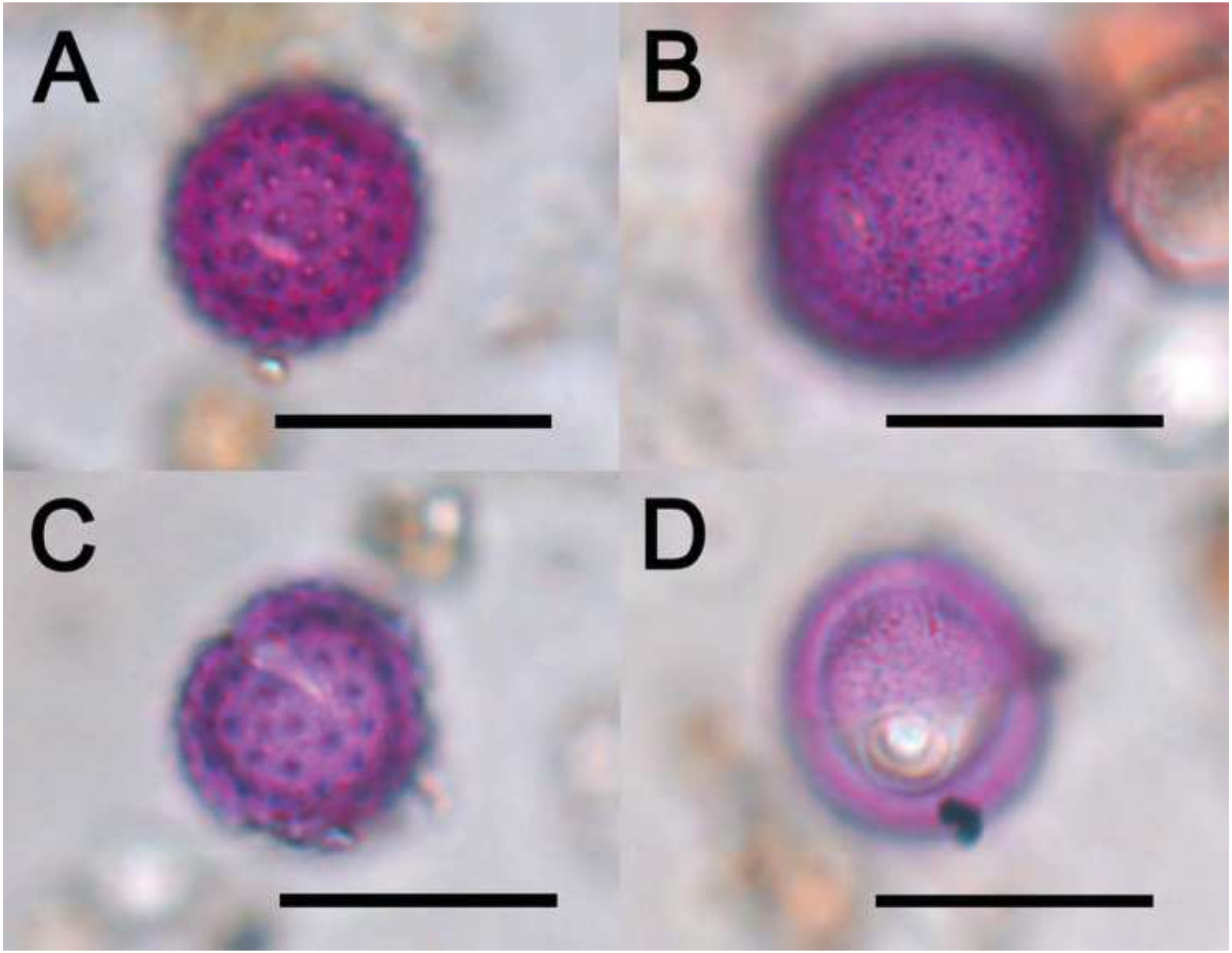
Mundragi et al. DOI: 10.1039/C5RA27207F



Morphology determined by development

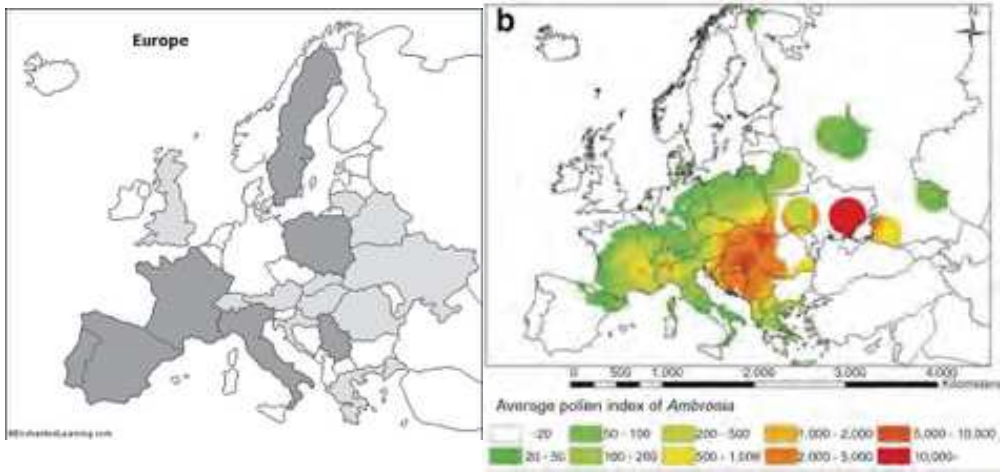
1. Shape
2. Apertures (openings)
3. Surface
4. Size?
5. Peculiarities

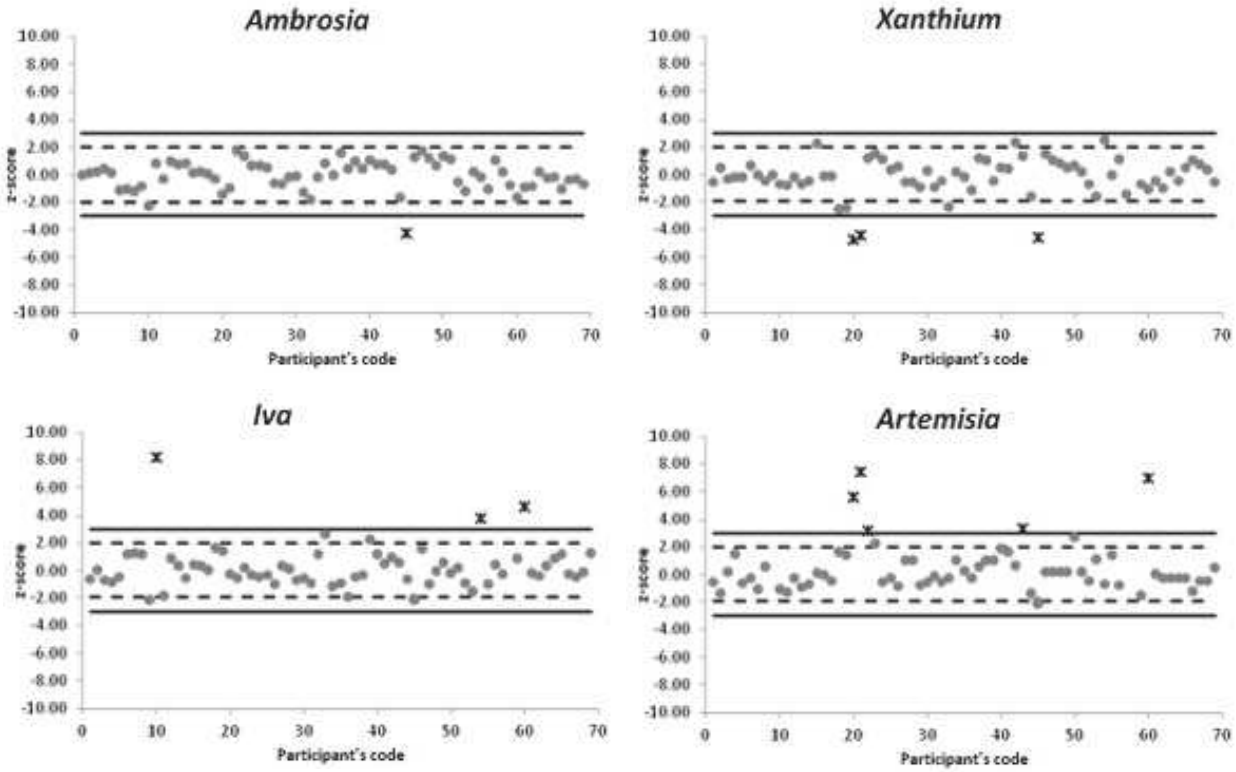




Smith et al. DOI 10.1016/j.envint.2013.08.005

Easy or not?

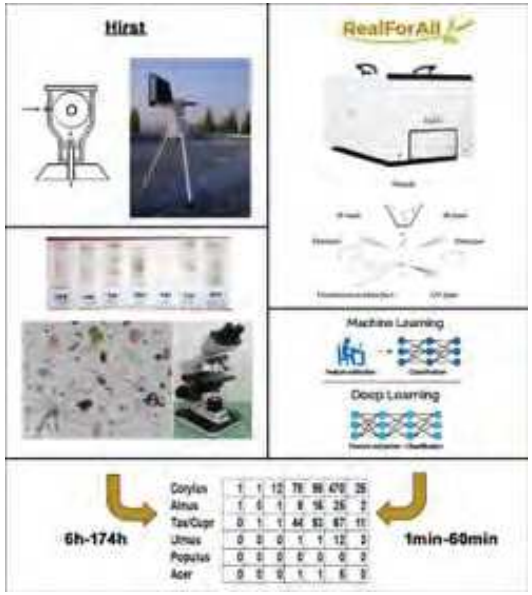


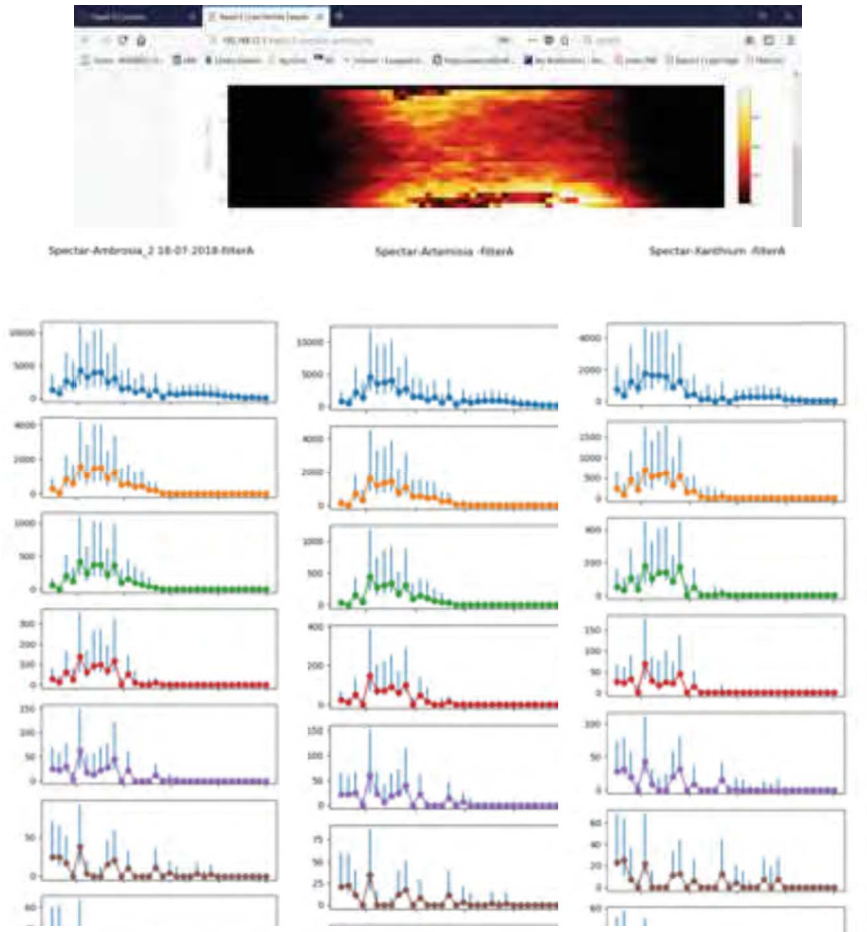


Sikoparija et al. DOI 10.1007/s10453-016-9461-3

Automatic identification?

www.realforall.com





Ongoing activities in Europe:

AutoPollen
EUMETNET
EUROPEAN METEOROLOGICAL SERVICES NETWORK

Electronic Pollen Information, Bavaria (ePIN)

Interreg - IPA CBC
Croatia - Serbia
RealForAll

French real time pollen information France