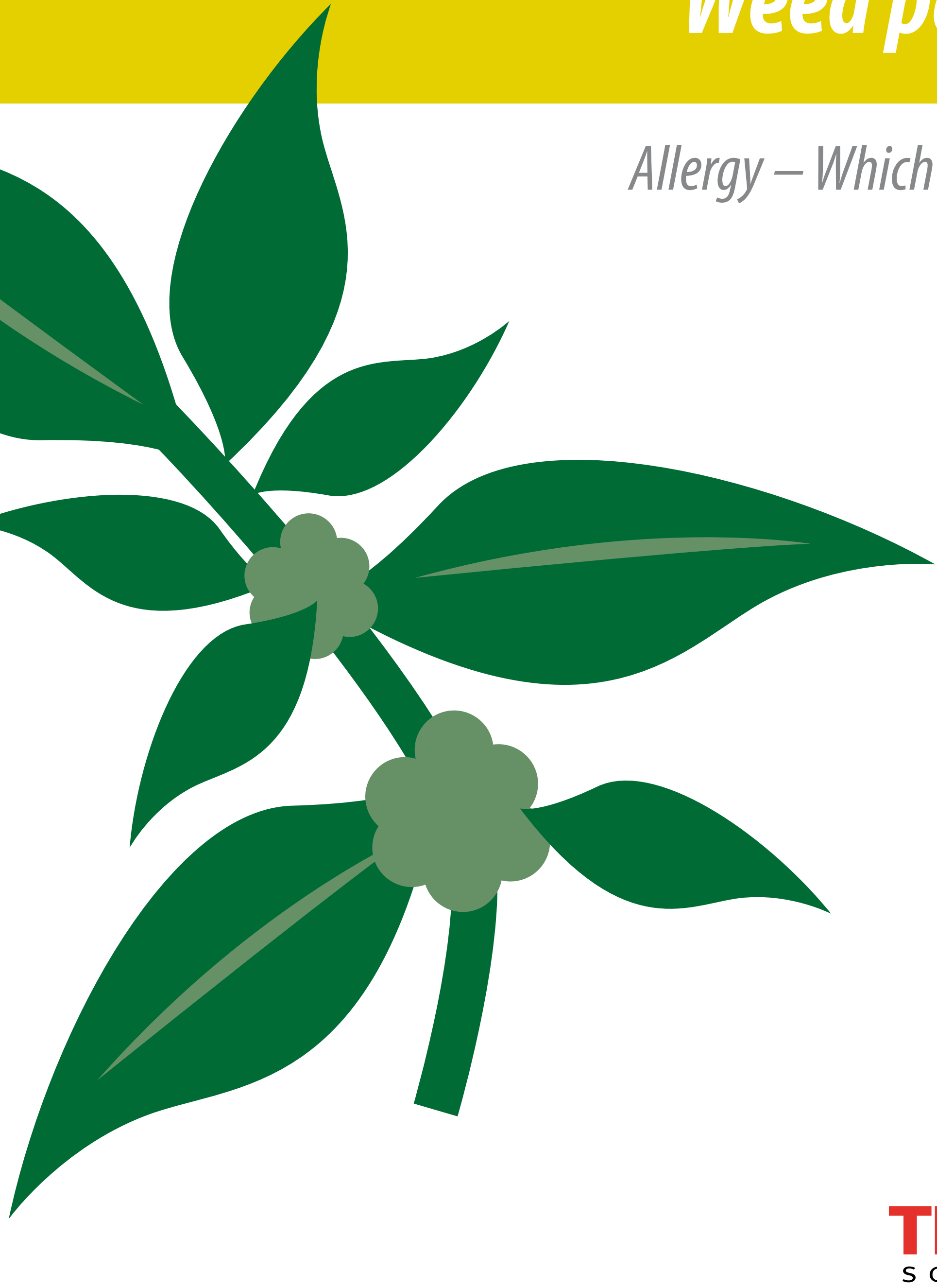
ImmunoCAP®
Is it allergy?

Weed pollens

Allergy – Which allergens?



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Contents

Weed Pollen Allergens

Although the number of weed species is enormous, the role of weeds in pollen allergy is quite narrow – yet at the same time very important. Most weeds are not wind-pollinated and so do not produce the small, light, un-waxy, easily airborne pollens associated with allergy. Moreover, weeds are major victims of human control of the environment. Having not made major contributions to human culture or material welfare, they are traditionally eradicated whenever possible, especially in agriculture, and the use of some as ornamentals (for example, the Marguerite or Daisy, Wall pellitory and the Sunflower) or food plants (Camomile, Beet, Sunflower and Rape) provides only a partial counterbalance. They persist on wasteland and some grazing land, and they play an important role as "succession" plants in natural reforestation, but many species fight a largely losing battle with human civilisation.

However, all of these considerations are placed in the shadow by the major role a few weeds play in hay fever, the seasonal syndrome of red, swollen, itchy, and/or watery eyes (conjunctivitis), sneezing, congestion, runny nose, and/or nasal itching (rhinitis), and asthma. Among the culprits, the Ragweeds and Mugwort are most familiar to clinicians. These can produce up to a million pollen grains a day, and the pollen can be highly mobile, depending on atmospheric conditions. As daunting as such factors may seem, a careful and systematic approach should be made to each case. Though hay fever is not among the more "serious" allergic conditions in that it is seldom in itself life-threatening, it should not be treated dismissively, either by total neglect, or by the prescription of symptom-masking medication before any attempt is made to identify and avoid the allergen(s) in question. Weed pollen allergy is striking among the pollen allergies for the debilitating effects it can have, with numerous lost school and work days and the accompanying high social and economic costs. Also, the role weed pollens commonly play in allergic asthma, and their importance in cross-reactivity, should ensure proper attention. The "allergy season" for weeds is later than for grasses and trees: it is typically midsummer to late fall.

There may exist among weed plants a relatively strong tendency for occupational allergy to those plants with commercial uses which are traditionally classed among the weeds. Occupational allergy has been reported to Rape (1), Beet (2), Sunflower (3-4) and cut flowers (5); no such broad pattern appears among the grasses with commercial uses, but it is unclear whether this is because of the actual nature of the allergens or because of the focus of clinical studies. Tree pollen and/or wood, in contrast to grasses, is the cause of significant occupational allergy.

Cross-reactivity

Cross-reactivity can be expected to roughly follow taxonomy. The closest relationships are shown on next page (but are not universally agreed on).

The importance of these relationships is widely borne out by a number of clinical trials and laboratory studies, especially within (and sometimes between) the *Asteraceae* and *Amaranthaceae*. Among the allergens most persistently emerging in the complex cross-reactivity shown in major studies are Common and Giant ragweed, Goosefoot, Common pigweed, Goldenrod, and Mugwort (6-8).

Broader cross-reactivity encompasses tree and grass pollens and plant-derived foods and other substances from distantly related species, one of the most important connections being between Mugwort and Celery. Mugwort, Wall pellitory, Plantain and Ragweed are prominent in studies of cross-reactivity with, most conspicuously, Olive tree, Birch, Timothy, Rye, and Cocksfoot among the trees and grasses; among foods and other substances, Apple, Celery, Melon, Carrot, Kiwi and Latex stand out in the same connection (9-19). Oral Allergy Syndrome may be involved (19). The above is naturally merely a brief overview of weed cross-reactivity.

Weeds

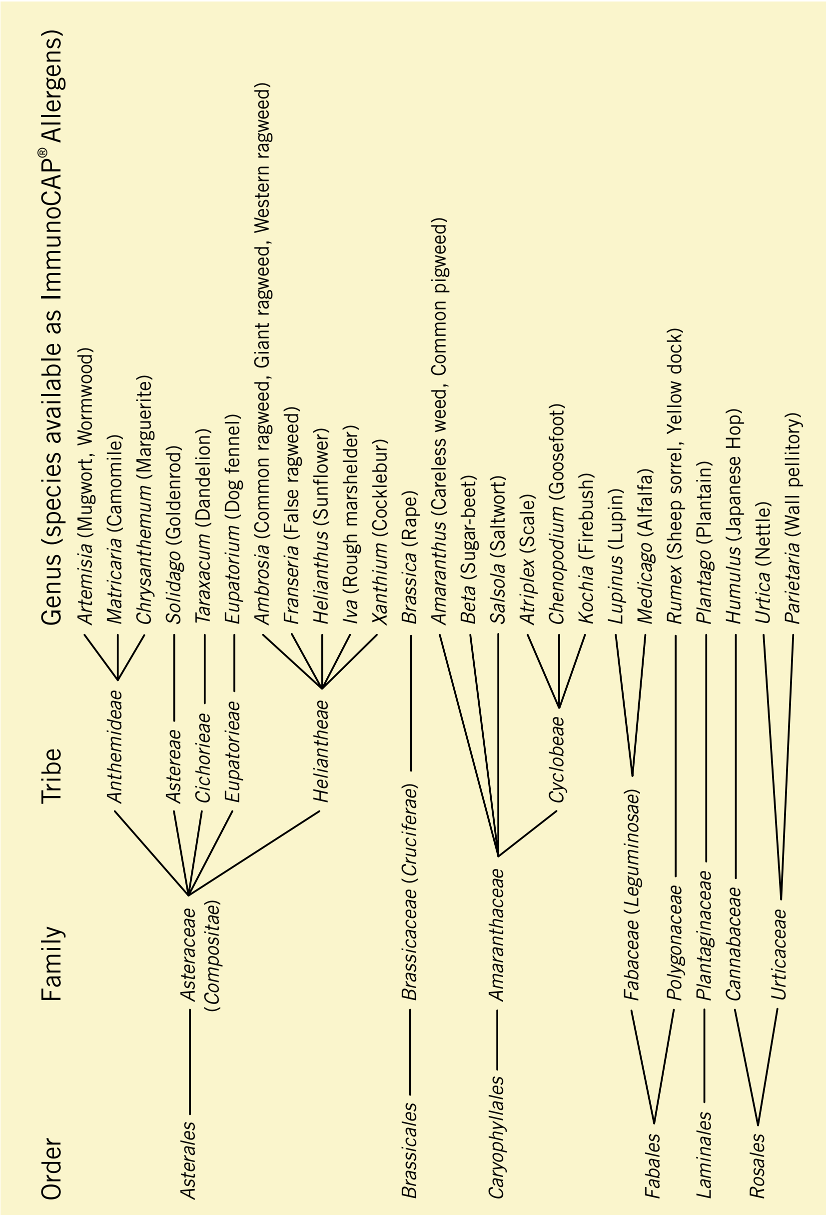

Figure 1. Weeds and their botanical relations, adapted from L Yman (7).

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Weed ImmunoCAP® Allergens available for IgE antibody testing

w45	Alfalfa (*Medicago sativa*)
w206	Camomile (*Matricaria chamomilla*)
w82	Careless weed (*Amaranthus palmeri*)
w13	Cocklebur (*Xanthium commune*)
w14	Common pigweed (*Amaranthus retroflexus*)
w1	Common ragweed (*Ambrosia elatior*)
w8	Dandelion (*Taraxacum vulgare*)
w46	Dog fennel (*Eupatorium capillifolium*)
w4	False ragweed (*Franseria acanthicarpa*)
w17	Firebush (Kochia) (*Kochia scoparia*)
w3	Giant ragweed (*Ambrosia trifida*)
w12	Goldenrod (*Solidago virgaurea*)
w10	Goosefoot, Lamb's quarters (*Chenopodium album*)
w22	Japanese Hop (*Humulus scandens*)
w207	Lupin (*Lupinus spp.*)
w7	Marguerite, Ox-eye daisy (*Chrysanthemum leucanthemum*)
w6	Mugwort (*Artemisia vulgaris*)
w20	Nettle (*Urtica dioica*)
w9	Plantain (English), Ribwort (*Plantago lanceolata*)
w203	Rape (*Brassica napus*)
w16	Rough marshelder (*Iva ciliata*)
w11	Saltwort (prickly), Russian thistle (*Salsola kali*)
w15	Scale, Lenscale (*Atriplex lentiformis*)
w18	Sheep sorrel (*Rumex acetosella*)
w210	Sugar-beet (*Beta vulgaris*)
w204	Sunflower (*Helianthus annuus*)
w21	Wall pellitory (*Parietaria judaica*)
w19	Wall pellitory (*Parietaria officinalis*)
w2	Western ragweed (*Ambrosia psilostachya*)
w5	Wormwood (*Artemisia absinthium*)
w23	Yellow dock (*Rumex crispus*)
Mixes:	**wx1, wx2, wx3, wx5, wx6, wx7**
	wx209

Allergen components – Recombinant/ purified native

w230	nAmb a 1 Ragweed
w231	nArt v 1 Mugwort
w211	rPar j 2 LTP, Wall pellitory

Information regarding available allergen components can be found in "Allergy – Which allergens?, Native & recombinant allergen components".

Medicago sativa

Family: *Fabaceae* (*Leguminosae*)

Common names: Alfalfa, Lucerne, Lucerne grass, Medick

Source material: Pollen

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Allergen Exposure

Geographical distribution

Fabaceae (*Leguminosae*), a family of 630 genera with about 18,000 species, consists of 3 subfamilies: *Mimosoideae*, which includes Acacia, Mimosa, and Mesquite; *Caesalpinioideae*, which includes Honey locust; and *Faboideae*, which includes Peanut, Soybean, and Alfalfa.

Alfalfa is a perennial legume native to Europe, and now introduced as a forage plant to many other parts of the world. It is best suited to temperate and warm-temperate regions and thrives in semi-arid areas under irrigation. It is a common weed of roadsides, fence-lines, and waste areas. It can become a weed in cultivated crops in areas previously used for forage (1).

Alfalfa is one of the most valuable forage plants. Alfalfa is the type species of the medicks. Other introduced medicks are annuals and include spotted medick (*M. Arabica*), California bur-clover (*M. hispida*), and black medick (*M. lupulina*) (1).

Alfalfa is a curled or twisted small leguminous plant. The plant grows to a height of up to 1 metre and has a deep root system. It has ascending stems up to a meter long, with stems arising from a thick woody crown. The leaves are alternate and compound, comprised of three hairy ovate leaflets that are 10-35 mm long. The terminal leaflet has a short stalk, while the lateral leaflets do not (1).

Alfalfa flowers are blue to purple, 5-11 mm long, and borne in globe-shaped terminal clusters or in leaf axils. The fruit is a spirally-coiled brown pod, 5-8 mm long, with several seeds. In the northern hemisphere, flowering is from May to October. Alfalfa is entirely entemophilous. It is suggested that since Alfalfa is cut while in bloom, pollen dispersal may be facilitated by drying (1).

Environment

Alfalfa is widely grown throughout the world as forage for cattle, and is most often harvested as hay, but can also be made into silage, grazed, or fed as greenchop (2). It is also a commercial source of chlorophyll. Alfalfa seeds are small and kidney shaped, and usually used in sprout form for cooking.

Unexpected exposure

Natural flavourant, for cola, liquor, and maple-flavoured beverages and cordials. A commercial source of chlorophyll. Alfalfa and alfalfa extracts are used as herbal medicines.

w45 Alfalfa

Allergens

No allergens have been characterised.

A pathogenesis-related (PR) class 10 protein isolated from Astragalus mongholicus had a 73.3% identity with the PR-10 protein PR10.2 from Alfalfa (3). Bet v 1 homologues, which are panallergens, are PR-10 proteins. The clinical relevance of the Alfalfa PR10.2 has not yet been determined.

The minor Pear allergen, Pyr c 5, an isoflavone reductase (IFR), has an 80% amino acid sequence identity with Bet v 6, a minor Birch tree pollen allergen, and 59% with the IFR from Alfalfa (4). The clinical relevance of the Alfalfa IFR has not yet been determined.

Potential cross-reactivity

Cross-reactivity could be expected between species of the genus *Medicago*.

Clinical Experience

IgE-mediated reactions

Alfalfa is entirely entemophilous naturally, yet sensitisation does occur, with markedly positive skin test, resulting in asthma, hayfever and allergic conjunctivitis in susceptible individuals, primarily among farm workers (1,5- 7).

In 327 adult patients with respiratory, dermatologic and ophthalmologic diseases of suspected allergic origin attending a hospital in the United Arab Emirates, 22.9% were skin prick test positive to Alfalfa (8).

In a study in Saudi Arabia 1,159 patients (806 Saudi Arabs and 241 Western expatriates (mainly North Americans)) attending an allergy clinic were skin prick test positive to one or more inhalants. Alfalfa was one of the 10 most frequent positive skin test positive allergens affecting 36% of Saudi Arab patients and 24% of North American expatriates. Other common allergens in the Saudi Arab patients were: Goosefoot (*Chenopodium album*) 53%, Kochia 51%, Mesquite tree 46%, Cottonwood tree 38%, dust mite-Dermatophagoides farinae 36%, Cockroach 35%, House dust 31%, Bermuda grass 29%, and Acacia tree 29%. For North American expatriates living in the area, the 9 other allergens were: Dust mite (*Dermatophagoides farinae*) 43%, House dust 41%, *Alternaria* 36%, grass mix 34%, Bermuda grass 33%, Mesquite 32%, Cat 31%, Kochia 28%, and Goosefoot 24% (9).

An examination of the pollen content of the atmosphere of Montpellier, southern France, and compared with pollinosis of patients born and living in and around Montpellier, found that some patients had positive skin tests to Alfalfa pollen though these pollens were almost absent from pollen counts. The authors suggested that in a few cases local sources of these pollens could account for the positive skin tests but this could be attributed to cross-reactive mechanisms (10).

In a survey of Ohio cash grain farmers, wheezing was associated with Alfalfa hay. Whether this was as a result of the production of hay, Alfalfa pollination, irritants or allergens, was not clarified (11).

Other reactions

Farmer's lung as a result of exposure to mouldy organic dust from Alfalfa hay has been described (12-13).

Rhinitis, asthma, and urticaria from alfalfa plants or milled powder in farmers, millers, or store workers have been described (6).

Alfalfa sprouts has been associated with drug-induced lupus erythematosus, a lupus-like illness (14).

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w206 Camomile

Matricaria chamomilla

Family: *Asteraceae* (*Compositae*)

Common names: Chamomile, Wild camomile, German camomile, Scented mayweed

Synonyms: *M. recutita, Chamomilla recutita*

Source material: Pollen

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Allergen Exposure

Geographical distribution

German Camomile is native to Europe and western Asia and naturalised in North America. It is cultivated in Germany, Hungary, Russia, and several other European countries.

German Camomile is a many-branched, erect annual, growing to a height of about 0.3 to 0.6 m. The plant produces many terminal flower heads in a comb-like formation from June to July. The disk-like flowers are yellow and surrounded by ten to twenty petal-like white ray flowers. The scented flowers are hermaphrodite (have both male and female organs) and are pollinated by insects. The seeds ripen from July to August.

Environment

Camomile grows in the wild, but also may be grown in cultivated beds and escape into the surrounding area.

This plant is used as a condiment, and for Camomile tea, perfume, and medicine. The young sprigs serve as a seasoning. Essential oil distilled from the flower heads is added to shampoos to impart the odour of Camomile.

Unexpected exposure

Camomile contains sesquiterpene lactones, an important cause of dermatitis.

Allergens

Allergens of 23-50 kDa have been detected, all heat-stable (1).

A homologue of the major Birch pollen allergen Bet v 1 has been detected in two Camomile blots (from the plant, not the pollen). Deglycosylation experiments proved the presence of carbohydrate determinants in Camomile, which were, however, not responsible for IgE-binding. Profilins (Bet v 2) were not detected in the Camomile extracts (1).

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Asteraceae* (*Compositae*) (2).

One study shows a high degree of *in vivo* cross-reactivity between *Artemisia vulgaris* and *Matricaria chamomilla*, and the authors suggest that sensitisation to *A. vulgaris* may thus result in allergic reactions to Camomile infusions (3-4).

In laboratory studies, binding to Camomile proteins was inhibited in variable degrees by extracts from Celery roots, Anise seeds and pollen from Mugwort, Birch and Timothy grass (1).

In a group of flower sellers investigated for occupational allergy, extensive cross-sensitisation was seen to pollen of several members of the *Asteraceae* (*Compositae*) family (*e.g.*, *Matricaria*, *Chrysanthemum*, *Solidago*) and to pollen of the *Amaryllidaceae* family (*Alstroemeria* and *Narcissus*) (5).

Cross-reactivity among Camomile tea extract and the pollens of *Matricaria chamomilla*, *Ambrosia trifida* (Giant Ragweed), and *Artemisia vulgaris* (Mugwort), was demonstrated by an ELISA-inhibition study (6).

Clinical Experience

IgE mediated reactions

Camomile pollen can induce asthma, allergic rhinitis and allergic conjunctivitis (3).

In a study of patients allergic to Camomile, 10 of 14 had a clinical history of immediate reactions to Camomile, in some cases life-threatening. Eleven subjects were also shown by specific IgE tests to be sensitised to Mugwort, and eight to Birch tree pollen (1).

One study reports that Mugwort (*Artemisia vulgaris*) hay fever can be associated with the *Asteraceae* (*Compositae*) family of foods, including Camomile, but that it is not normally associated with other foods. The inference is that individuals allergic to Camomile pollen may be allergic to other parts of the plant or infusions made from the plant (4,7).

Nine patients with hay fever, with or without asthma, experienced systemic allergic reactions after ingestion of natural honeys and/or Camomile tea. This study suggests that pollen of *Asteraceae* (*Compositae*) may be responsible for allergic reactions to certain natural foods and that the reactions are mediated by an IgE-related mechanism (8).

Allergy and anaphylaxis have been described to Camomile (6,9-10), as well as anaphylaxis to a Camomile tea enema (11-12).

Camomile has been suggested to cause Oral Allergy Syndrome (13).

Other reactions

A 43-year-old male tea-packing plant worker developed occupational asthma and rhinitis caused by inhalation exposure to chamomile dust (14).

Camomile flowers, leaves and stems contain sesquiterpene lactone, which causes contact dermatitis (15). Camomile is one of the commonest causes of contact dermatitis, and cross-reactivity between this plant and other members of the *Compositae*, *e.g.*, *Chrysanthemum*, Feverfew and Tansy, are common (16-18).

In this study, allergen-specific immunoglobulin E antibodies to black or Camomile tea were found in 5.6% of employees of a tea packing factory, but there was little evidence of specific allergic sensitisation to the tea varieties tested. The excess of work-related respiratory and nasal symptoms probably represented non-specific irritation (19-20).

Contact urticaria and allergic contact dermatitis have been reported to the plant and tea (21-27).

Camomile tea eye washing has been shown to induce allergic conjunctivitis.(4). A 20-year-old woman with a proven allergy to camomile suffered from short-lasting rhinitis when using a camomile-scented toilet paper (28).

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Amaranthus palmeri

Family: *Amaranthaceae*

Common names: Careless weed, Carelessweed, Palmer amaranth, Palmer's pigweed

Source material: Pollen

See also: Common Pigweed (*A. retroflexus*) w14

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Allergen Exposure

Geographical distribution

The amaranth family comprises about 40 genera and 475 species. They are mostly weedy herbs though some genera are low or climbing shrubs. The flowers of all are characterised by extreme simplicity. Some species are wind pollinated whereas others are insect pollinated. The flowers may be monoecious or dioecious, but they are always small, often greenish or yellowish.

Careless weed is a species of flowering plant in the amaranth genus. It is native to most of the southern half of North America, and particularly, throughout the southern United States from southern California to Virginia. It has also been introduced to Europe, Australia, and other areas.

Careless weed closely resembles many other pigweed species. It is an erect summer annual that may reach 1.5-2 m in height. It has one central stem from which several lateral branches arise. The leaves are alternate, glabrous (without hairs), and lance- or egg-shaped in outline. Leaf sizes are from 5 cm to 20 cm in length and 1 to 6 cm wide with prominent white veins on the under-surface. Leaves occur on relatively long petioles (1).

The flowers are small, light-green, and inconspicuous produced in dense, compact, terminal panicles that are from 15 cm to 45 cm in length. Smaller lateral inflorescences also occur between the stem and the leaf petioles (leaf axils). Male and female flowers occur on separate plants. Each terminal panicle contains many densely packed branched spikes that have bracts that are 3 to 6 mm long. The plant blooms from June - November in the northern hemisphere (1).

A small, dry, one seeded fruit is produced consisting of a single seeded utricle about 2 mm in size, which splits to show a glossy black to dark brown seed that is 1 to 1.2 mm long. The utricle is wrinkled when dry (1).

Careless weed is often confused with other similar pigweed species, but differs in that no other pigweed species have terminal panicles that reach 45 cm in length, and that the terminal spike of is much smoother and narrower and less spike-like than either Common Pigweed (Redroot Pigweed) (*A. retroflexus*) or smooth pigweed (*A. hybridus*). The leaves of Careless weed are also without hairs and have prominent white veins on the under-surface unlike those of Common Pigweed (1).

Unexpected exposure

In Mexico, a candy is produced by drying the seeds, mixing with honey and baking.

w82 Careless weed

Allergens

No allergens have been characterised.

Potential cross-reactivity

Cross-reactivity could be expected between species of the family *Amaranthaceae*, and in particular the genus *Amaranthus*.

Although no specific information on cross-reactivity of this plant with others exists, a high degree of cross reactivity has been reported to occur between Goosefoot (*Chenopodium album*) and Saltwort (*Salsola kali*), and other species taxonomically less related members of the *Amaranthaceae* family like *Amaranthus retroflexus*. Common allergenic determinants are present in these plants (2).

In a study using a fluorescent allergosorbent test, similar antigenic determinants were found between Short Ragweed and Giant Ragweed, Cocklebur, Lamb's Quarters, Rough Pigweed, Marsh Elder, and Goldenrod. Cocklebur and Giant Ragweed were highly potent in competitively binding to short ragweed IgE. The other pollens demonstrated lower potency of cross-reacting antigens (3).

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Careless weed; however, few specific studies have been reported to date (4-8).

Sensitisation to Careless weed has been documented in Tucson, Arizona (2) and in Mexico (4-6). In a Mexican study of allergic patients, sensitisation to Careless weed was demonstrated in 43.8% (3).

In a study examining aeroallergen sensitisation rates in military children in Texas undergoing skin testing for rhinitis, of 209 patients, 27% were sensitised to Common Pigweed or Careless weed (7).

In a study in the Midwestern USA, evaluating the frequency of sensitisation to cannabis pollen, found that 61% were skin prick positive for cannabis and all subjects were also skin test positive to weeds pollinating during the same period: Ragweed, Pigweed, Cocklebur, Russian thistle, Marsh elder, and Kochia (9).

In a study among Thai patients with vernal keratoconjunctivitis (VKC), positive results of skin prick testing to Acacia, Careless weed, mould, Johnson grass and Cow's milk were significantly more common in patients with palpebral VKC (10).

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Xanthium commune

Family: *Asteraceae* (*Compositae*)

Common names: Cocklebur, Rough cocklebur, Common cocklebur

Source material: Pollen

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Allergen Exposure

Geographical distribution

Cocklebur is native to Europe, Asia, southern Canada, and most of the United States, Mexico and Central America. Cocklebur is now found worldwide. Another species that is less common but widespread across North America is called Spiny Cocklebur (*X. spinosum*).

Cocklebur is an annual, grey-green plant, growing up to 1.5 m. The plant's structure is coarse and bushy with stems that are erect, branched, and rigid, with purple or black spots, and very rough. The leaves are lobed, triangular or heart-shaped, coarsely toothed, borne on long stalks, and rough on both sides. Leaves are 5 cm to 35 cm long, and 2 to 20 cm wide.

Cocklebur flowers from July to October and the seeds ripen from August to October. The flowers are monoecious (individual flowers are either male or female, but both sexes can be found on the same plant) and are pollinated by insects. The plant is self-fertilising. Male flowers are small and green and hidden at the top of the plant in round clusters. Female flowers occur in burs on short stalks at the base where the leaf axils meet the stem. Each bur contains two flowers. The male flowers drop quickly, while female burs persist, with 2 blackish achenes.

The fruit produced is an elliptic to egg-shaped two-chambered bur, 1 to 3.5 cm long, and is covered with about 400 stiff, hooked spines. Two prickles that are longer and wider than the others project from the tip of the bur.

Environment

This weed is commonly found in cultivated fields, waste areas, run-down and abandoned pastures, and road ditches. It is poisonous during the two-leafed stage. The burs often become tangled in the fur of grazing animals, thus aiding distribution of the species. Both seeds and seedlings are toxic to livestock.

The seed may be dried, ground into a powder, and mixed with cereal flours during the making of bread and biscuits.

Allergens

Cocklebur allergens have not yet been fully characterised. Xan Ib and Xan VIa have been isolated from Cocklebur pollen as the important allergenic components. Xan Ib was found to be devoid of carbohydrate and had a molecular weight of 103 kDa. Xan VIa was a glycoprotein of molecular weight 17 kDa. The carbohydrate moiety of Xan VIa was found to be associated with allergenicity (1).

w13 Cocklebur

Potential cross-reactivity

Cocklebur is a member of the *Ambrosiinae* subtribe, tribe *Heliantheae*, in *Asteraceae*, as are ragweeds and marshelders. An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Asteraceae* (2). However, despite this close botanical proximity to ragweeds, it was reported that there is little significant cross-reactivity (3).

However, an earlier study reported that similar antigenic determinants were found between Short Ragweed and Giant Ragweed, Cocklebur, Lamb's Quarters, Rough Pigweed, Marsh Elder, and Goldenrod. Cocklebur and Giant Ragweed were highly potent in their ability to competitively bind to Short Ragweed IgE (4).

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Cocklebur; however, few specific studies have been reported to date (5-7).

In a study in Westchester County in the state of New York of skin prick tests to 48 aeroallergens in 100 patients referred for allergic rhinitis, 65% had a positive SPT to at least 1 aeroallergen. Skin prick test for Cocklebur was positive in 3% (5).

In a study in the Midwestern USA, evaluating the frequency of sensitisation to cannabis pollen, found that 61% were skin prick positive for cannabis and all subjects were also skin test positive to weeds pollinating during the same period: Ragweed, Pigweed, Cocklebur, Russian thistle, Marsh elder, and Kochia (8).

The incidence of positive intradermal tests after a negative skin prick test for 24 inhalant antigens was conducted on 133 patients in a study in Michigan, USA. Allergens with positive intradermal wheals after negative prick testing included Cocklebur, Rough marshelder, and Ragweed, all with incidences of 16% to 19% (7).

Common Cocklebur is an important cause of inhalant allergies in Turkey (4) and India (9).

Other reactions

Cocklebur is a common cause of contact dermatitis (10-13).

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w14 Common pigweed

Amaranthus retroflexus

Family: *Amaranthaceae*

Common names: Common pigweed, Redroot pigweed

Source material: Pollen

See also: Careless weed (*A. palmeri*) w82

Note: Lamb's quarters (*Chenopodium album*) is occasionally also called Pigweed or Smooth pigweed but does not belong to the *Amaranthaceae* family. There is a particular resemblance in the cotyledon stage, but Lamb's quarters cotyledons often have a mealy grey cast and the first true leaves are alternate, unlike those of any of the Pigweed species

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Allergen Exposure

Geographical distribution

The Amaranth family comprises about 40 genera and 475 species. They are mostly weedy herbs though some genera are low or climbing shrubs. The flowers of all are characterised by extreme simplicity. Some species are wind pollinated whereas others are insect pollinated. The flowers may be monoecious or dioecious, but they are always small, often greenish or yellowish (1).

The *Amaranthus* genus is annual herbs. The genus comprises about 50 species of which about 35 are native to North America (1). The genus includes Common pigweed, Powell amaranth, Prostrate pigweed, and Tumble pigweed, the most common of these being Common pigweed. Pigweeds are annual plants that germinate from seeds from late winter through summer.

Common pigweed is a common weed found throughout the world, in particular in Europe, the USA, Brazil, Korea, Spain, Mozambique, Mexico, Hungary, Germany, and Afghanistan.

Common pigweed is an erect summer annual that may reach 2 m in height. The stems are stout, erect, and branched, usually with short hairs, especially near the upper portions of the plant. The plant has a shallow taproot that is often reddish in colour.

The leaves are grey-green and oval-spearhead-shaped, and covered with dense, coarse hair. Red or light-green stripes run the length of the tall main stem. Seeds are in bushy spikes at the top of the plant and in the axils of the leaves. Although Pigweed is primarily an upright grower, it will lie near the ground with constant mowing.

The flowers are greenish-grey and inconspicuous, and are produced in dense, compact, terminal panicles that are approximately 2 cm wide and from 5 to 20 cm in length. They are mixed with bristle-like bracts. Smaller inflorescences also occur between the stem and the leaf axils. Male and female flowers occur on the same plant (*i.e.*, the structure is monoecious). Common pigweed flowers in high summer and fall, very shortly after germination, and deposits thousands of seeds during a single season, producing over 100,000 seeds per plant. The seeds are small, shiny, and black.

w14 Common pigweed

Careless weed (*Palmer Amaranth*) (*Amaranthus palmeri*) also resembles Common and Smooth pigweed, but the terminal panicles of this species are much longer and narrower. Common pigweed is also often confused with other Pigweed species.

Environment

The Common pigweed is found in horticultural, nursery, and agronomic crops, wild landscapes, roadsides, and also in pastures and forages.

Unexpected exposure

North American Indians used *A. retroflexus* for flour and warm drinks.

Pigweed contains a nephrotoxin that causes kidney failure. It also contains soluble oxalates and is capable of accumulating nitrates. Toxicity can be due to a combination of these causes.

Allergens

A 14 kDa and a 35 kDa allergen have been identified, but the allergens have not yet been fully characterised (2-3).

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Amaranthaceae* (4) and *Chenopodiaceae* (2). *Atriplex latifolia*, *Beta vulgaris*, *Salsola kali* and *Amaranthus retroflexus* were compared with an extract from *Chenopodium album* by both *in vivo* and *in vitro* methods. The study's results suggest that common allergenic determinants are present (2).

In a study using a fluorescent allergosorbent test, similar antigenic determinants were found between Short ragweed and Giant ragweed, Cocklebur, Lamb's quarters, Rough pigweed, Marsh elder, and Goldenrod. Cocklebur and Giant ragweed were highly potent in competitively binding to short ragweed IgE. The other pollens demonstrated lower potency of cross-reacting antigens (5).

Clinical Experience

IgE-mediated reactions

Common pigweed pollen commonly induces asthma, allergic rhinitis and allergic conjunctivitis (6-9).

Pigweed pollen has been shown to be a common aeroallergen in the Midwestern USA (10), the Tampa Bay area, Florida (11), St. Louis, Missouri (12), and in Lincoln, Nebraska, USA (13). In a study examining aeroallergen sensitisation rates in military children in Texas undergoing skin testing for rhinitis, of 209 patients, 27% were sensitised to Common pigweed or the closely related Careless weed (*A. palmeri*) (9).

Pigweed pollen is also an important aeroallergen in Salamanca, Spain (14). In the central region of Coahuila, Spain, 5.4% of allergic individuals were sensitised to this pollen (6). Common pigweed pollen has been reported in Burgos, Spain (15).

In Mexico (16), Israel (17) and North China (7), Pigweed is a major contributor to the aeroallergen load. In Thailand, 16% of patients with allergic rhinitis were Pigweed-sensitised (5). In an assessment of allergic diseases and sensitisation in people aged 65 and over in Mexico, 3.6% were sensitised to Common pigweed (18).

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w1 Common ragweed

©University of South Carolina Herbarium. Photo: Linda Lee

Ambrosia elatior

Family:	*Asteraceae* (*Compositae*)
Common names:	Common ragweed, Annual ragweed, Short ragweed, Roman wormwood, American wormwood
Synonym:	*A. artemisifolia*
Source material:	Pollen
See also:	Giant ragweed (*A. trifida*) w3, Western ragweed (*A. psilostachya*) w2

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Allergen Exposure

Geographical distribution

Common (Short) ragweed is native to North America, but can also be found in Canada, Japan, Australia and Europe. It is a prime cause of allergy in the US, and now in Europe, in particular in the upper Rhône valley, the Balkan states and the Krasnodar district of the Russia.

Common (Short) ragweed is an erect summer annual herbaceous plant growing to 0.9 m. The leaves are soft, green and opposite or alternate. Each leaf is divided into narrow segments, which are in turn irregularly lobed. It closely resembles False ragweed. Short ragweed produces burs similar to those of Giant ragweed, but the former are considerably smaller (2 to 4 mm long).

Short (Common) ragweed flowers from August to October. It is wind-pollinated, releasing millions of pollen grains into the air. However, the presence of the pollen in honey indicates some insect pollination.

Male and female flowers are in separate heads on the same plant (a monoecious structure). The tiny, nodding, greenish staminate (male) flowers, usually drooping, are in slender racemes near the top of the plant, while the pistillate (female) flowers tend to cluster at the bases of the racemes.

The Ragweed pollination period extends from the beginning of August to mid-October with a peak from mid-August to the end of September. Ragweed pollen release begins at sunrise and continues during the morning, reaching its highest count around midday. Pollen release is maximal in sunny and dry weather, and when night temperature is above 10° C. The pollen of *A. artemisiifolia* is produced in enormous amounts compared to other grasses, and a single plant alone may produce millions of pollen grains. Since the pollen grains are small (18–22 µm), they are often transported long distances. Ragweed pollen is very allergenic, and very low concentrations such as 5–10 pollen by cubic meter of air are sufficient to trigger allergic reactions in sensitive patients (1).

Environment

Short Ragweed is found in woodland and waste places. It occurs on dry fields and pastures, along roadsides, and especially in disturbed soil sites. It can become a pernicious weed in cultivated soils.

Unexpected exposure

The leaves of the plant are used in herbal medications. A tea made from the roots is used as a herbal remedy. The pollen is harvested commercially and manufactured into homeopathic preparations for the treatment of allergies to the plant.

Allergens

Ragweed contains numerous allergens. Among these allergens, 22 are already well known and 6 are considered major. Several ragweed pollen allergens have been characterised at the molecular level. Amb a 1 is the most important allergen, since 95% of Ragweed-sensitive individuals react to the protein in skin tests and show high serum IgE antibody titers (1-4).

The following allergens have been characterised:

Amb a 1, a 38 kDa protein, a pectate lyase, also known as Antigen E, AgE, a24, a789 and previously as Amb a I, Amb e 1 (3,5-15).

Amb a 2, a 38 kDa protein, a pectate lyase, also known as Antigen K, AgK, and previously as Amb a II, Amb e 2 (3,7,10-11,14,16-17).

Amb a 3, a 9 kDa protein also known as Ra3, and previously as Amb a III, Amb e 3 (7,18-22).

Amb a 5, a 5 kDa protein, also known as Ra5, Ra5S, and previously as Amb a V, Amb e 5 (9,21,23-29).

Amb a 6, a 10 kDa protein, a lipid transfer protein, also known as Ra6 and previously as Amb a VI (2,7,21,30-33).

Amb a 7, a 12 kDa protein, also known as Ra7 (7,34.)

Amb a 8, a 14 kDa protein, a profilin (7,35-38).

Amb a 9, a 10kDa protein, a calcium-binding protein (7,36).

Amb a 10, a 10kDa protein, a calcium-binding protein (7,36,39-40).

Amb a Cystatin Prot Inhibitor (41).

Isoforms of Amb a 1 have been identified: Amb a 1.1, Amb a 1.2, Amb a 1.3, Amb a 1.3, and Amb a 1.4 (10).

Amb a 1 and Amb a 2 have been shown to display immunological cross-reactivity in ELISA studies (9).

Potential cross-reactivity

With the use of a serum pool from patients sensitive to Short ragweed, the cross-reactivity of IgE antibodies to six Ragweeds was studied through the radioallergosorbent test. Extracts were analysed for their inhibitory activities, with solid-phase allergens prepared from all of the Ragweed pollens. Also, samples of serum were absorbed with the various solid-phase allergens and the reactivity of the remaining IgE antibodies was determined. Two patterns of reactivity were observed. Short, Giant, Western, and False ragweeds displayed comparable reactivity in both inhibition and absorption experiments. Slender and Southern ragweed were considerably less active, indicating that they lacked allergenic groupings possessed by the other species. These same patterns of cross-reactivity were found using Ragweed pollens from four commercial sources (42).

Further cross-reactivity among the various Ragweeds can be inferred due to the high cross-reactivity among various other members of the genus *Ambrosia* and of the family *Asteraceae*. For example, cross-reactivity among Chamomile tea extract, pollen of *Matricaria chamomilla*, *Artemisia vulgaris* (Mugwort), and *Ambrosia trifida* (Giant ragweed) was demonstrated by an ELISA-inhibition study (43). Further evidence confirming cross-reactivity among members of the Ragweed genus was obtained in a study using a fluorescent allergosorbent test, in which similar antigenic determinants were found among Short and Giant ragweed, Cocklebur, Lamb's quarters, Rough pigweed, Marshelder, and Goldenrod. Cocklebur and Giant ragweed were highly potent in their ability to competitively bind to Short ragweed IgE. The other pollens demonstrated lower potency of cross-reacting antigens (44). Also, a water-insoluble material, extracted from

Short ragweed and False ragweed pollen, contained at least five proteins. Two (RFA2 and RFB2) were isolated and shown to possess antigenicity as well as allergenicity. Immunodiffusion tests of RFB2, isolated from False ragweed and Short ragweed, showed immunological identity (45).

However and surprisingly, Common ragweed and Giant ragweed are not allergenically equivalent because of allergenic differences involving both the major allergens Amb a 1-2 and Amb t 1-2 (all members of the pectate lyase family) and some minor allergens (46). This is illustrated by the example from an area north of Milan (a zone widely invaded only by Short ragweed), where about 50% of patients treated with specific immunotherapy (SIT) with Giant ragweed who showed little or no clinical response to SIT, but showed an excellent outcome if they were shifted to SIT with Short ragweed. These authors suggested that in patients allergic to Ragweed, both diagnosis *in vivo* and immunotherapy should always be performed by using the ragweed species present in that specific geographic area (49).

Sensitisation to Amb a 1, a pectate lyase, results in cross-reactivity only with other pectate lysase containing plants where a high degree of homology occurs. Not all proteins in this family are allergens. The allergens in this family include: Amb a 1, Amb a 2, Cha o 1 (Japanese Cypress tree), Cup a 1 (Arizona Cypress tree), Cry j 1 (Japanese Cedar tree), Jun a 1 (Mountain Cedar tree) (47).

Furthermore, Mugwort, Ragweed, and Timothy grass pollen share IgE epitopes with Latex glycoprotein allergens. The presence of common epitopes might in part explain clinical symptoms on contact with Latex in patients allergic to pollen. In this study, any previously known panallergen was not detected (48).

An association between Ragweed pollinosis and hypersensitivity to *Cucurbitaceae* vegetables (*e.g.*, Watermelon, Cantaloupe, Honeydew Melon, Zucchini, and Cucumber) and Banana has been reported. Up to now three allergens have been identified as candidates for causing this cross-reactivity: profilin, Bet v 1, and a 60-69 kd allergen (49). Further evidence for cross-reactivity between *Cucurbitaceae* and Ragweed was found in a study that reported that of the sera of 192 allergic patients, 63% contained anti-Ragweed IgE, and among these patients, 28% to 50% had sera containing IgE specific for any single gourd family member. The extracts of Watermelon and Ragweed inhibited each other in a dose-dependent manner (50).

Ragweed profilin can be expected to result in cross-reactivity between this plant and other plants containing profilin. This has been demonstrated between Ragweed and Persimmon (44). In a second study, 35 of 36 patients' sera containing IgE to Ragweed profilin reacted with profilin from Latex, indicating structural homologies between profilin from Latex and Ragweed. Because profilin is also present in Banana extract, it is likely to be involved in cross-sensitivity between Banana and Latex (43).

In addition to profilin, Mugwort and Ragweed pollen contain a number of other cross-reactive allergens, among them the major Mugwort allergen Art v 1. These cross-reactive IgE antibodies could result in clinically significant allergic reactions (34). Evidence of further cross-reactivity between Mugwort and other members of the *Asteraceae* family (of which Ragweed is a member) consists in the high degree of *in vivo* cross-reactivity between *Matricaria chamomilla* (Camomile) and Mugwort (51).

Cross-reactivity between Sunflower and other *Asteraceae* pollens (Mugwort, Marguerite, Dandelion, Goldenrod, and Short ragweed) has also been demonstrated by RAST and immunoblotting inhibition experiments. Mugwort pollen exhibited the greatest degree of cross-reactivity with Sunflower pollen, whereas at the other end of the spectrum, Short ragweed showed fewer cross-reactive epitopes (52).

Celery cross-reacting to Ragweed has also been reported, but a panallergen was not identified in these studies (53-54).

Binding to IgE from Ginkgo pollen proteins (*Ginkgo biloba L.*) was shown to be almost completely inhibited by Oak, Ryegrass, Mugwort and Ragweed, but only partially by Japanese Hop and rBet v 2 (55). A panallergen may be indicated but was not isolated.

Sera from subjects allergic to White Cypress Pine, Italian cypress, Ryegrass or Birch pollen were shown to have IgE antibodies that reacted with pollens from these four species and from Cocksfoot, Couch grass, Lamb's quarters, Wall pellitory, Olive, Plantain and Ragweed. The authors concluded that the presence of pollen-reactive IgE antibodies may not necessarily be a true reflection of sensitising pollen species (56).

The Japanese cypress tree pollen allergen, Cha o 1, has a 46 to 49% similarly to the major allergens of Short ragweed, Amb a 1 and Amb a 2 (57).

A panallergen has been identified in Birch pollen, Ragweed pollen, Timothy grass pollen, Celery, Carrot, Apple, Peanut, Paprika, Anise, Fennel, Coriander and Cumin. EAST inhibition and immunoblot inhibition demonstrated that cross-reactions between Mango fruits, Mugwort pollen, Birch pollen, Celery, and Carrot are based on allergens related to Bet v 1 and Art v 1, the major allergens of Birch and Mugwort pollen, respectively (58).

Pollen of *Artemisia annua* is considered to be one of the most important allergens in autumnal hay fever in China, just as Ragweed is in North America. Extracts of pollen-free *Artemisia annua* components were found to contain similar allergens to those of Ragweed pollen. In 52 subjects sensitive to *Artemisia* pollen, 92.3% were shown on skin prick testing to have allergen-specific IgE to this allergen, 100% gave positive responses in intradermal tests, 66.7% gave positive responses in intranasal challenges, and 59.3% gave positive responses in bronchial provocation tests (59).

Ragweed pollen appears to also be cross-reactive with pollen from Yellow dock (*Rumex crispus*). When monoclonal antibodies with different specificity were applied against the major allergenic components of Ragweed pollen, the monoclonal antibodies reacted with antigens of Yellow dock pollen. In a preliminary study, sera of 2 patients containing IgE antibodies to Ragweed pollen antigens also reacted to the 40K component of Yellow dock pollen. In allergen-specific IgE tests on 109 patients with bronchial asthma, 22 had a positive reaction to a crude extract of Ragweed pollen, and 18 also reacted to a crude extract of Yellow dock pollen (60).

Clinical Experience

IgE-mediated reactions

Ragweed, and in particular Short ragweed (*A. artemisiifolia*), is clinically the most important source of seasonal aeroallergens, as it is responsible for both the majority of cases and the most severe cases of allergic rhinitis (61-66). Ragweed pollen also contributes significantly to exacerbation of asthma and allergic conjunctivitis. Ragweed pollen has also been implicated in eustachian tube dysfunction in patients with allergic rhinitis (67) and contact dermatitis (68).

The efficacy of Ragweed pollen in exacerbating allergic symptoms may be due to the Ragweed pollen endopeptidase, which may be involved in the inactivation of regulatory neuropeptides during pollen-initiated allergic reactions (69). Studies have also shown that complement activation induced by the allergen may enhance the clinical symptoms of Ragweed allergy (70-71).

A genetic susceptibility to Ragweed allergens has been suggested based on HLA studies; Amb a V, Amb t V and Amb p V from Short ragweed, Giant ragweed and Western ragweed respectively are strongly associated with HLA-DR2 and Dw2 (DR2.2) in allergic Caucasoid individuals (72).

The measurement of specific IgE has been shown to be an accurate and useful diagnostic tool in the evaluation of sensitisation to Ragweed pollen (73-76).

w1 Common ragweed

Aerobiological and clinical studies from various cities in the USA have documented the importance of Ragweed pollen as an aeroallergen (77). Ragweed has been shown to contribute to symptoms in studies in Washington, DC (78), Tucson, Arizona (79), and Tulsa, Oklahoma (80).

The prevalence of Ragweed pollinosis in central Pennsylvania was shown to be significantly greater in the rural subjects than in inner-city ones (81). In Boston women, socio-economic differences in sensitisation to Ragweed differed between the highest and lowest poverty areas (49% *vs*. 23%) (82). Ragweed was shown to be a major aeroallergen in the Tampa Bay area, Florida (83).

In Chicago residents with asthma, Ragweed sensitivity occurred in 45%, more than those sensitised to pollen from all other weeds (42%) (84).

In a collaborative study on *Parthenium hysterophorus* pollen compared to an extract of Western Ragweed, a study contributed to by 22 physicians from 18 Gulf Coast cities, 65.6% overall of the sera tested were positive for one or both of the pollen extracts examined. Thirty-five percent of the sera were sensitive to *Parthenium hysterophorus* and 57.6% were sensitive to Ragweed. Thirty percent of the sera were positive to Western Ragweed only, 8% were positive to *Parthenium hysterophorus* only, and 27.9% were positive to both extracts (85-86). These studies support the findings of another study that examined cross-reactivity of allergens from the pollen of *Parthenium hysterophorus* (American Feverfew) and Ragweed in 2 groups of patients with different geographic distributions. *Parthenium*-sensitive Indian patients, who were never exposed to Ragweed, had positive skin reactions to Ragweed pollen extracts. A significant correlation in the RAST scores of *Parthenium*- and Ragweed-specific IgE was observed with the sera of *Parthenium*- and Ragweed-sensitive Indian and US patients, respectively. RAST inhibition experiments demonstrated that in the sera of Ragweed-sensitive patients the binding of IgE antibodies to Short and Giant ragweed allergens could be inhibited by up to 94% by *Parthenium* pollen extracts. Inhibition up to 82% was obtained when the sera of *Parthenium* rhinitis patients were incubated with Ragweed allergen extracts. The high degree of cross-reactivity between *Parthenium* and Ragweed pollen allergens suggests that individuals sensitised to *Parthenium* may develop type-I hypersensitivity reactions to Ragweed even though they never had contact with Ragweed, and vice versa (87).

In Canada, Ragweed pollinosis studies have been conducted in Quebec. Of 3,371 subjects with a clinical diagnosis of symptomatic asthma or rhinitis, Ragweed sensitisation was documented in 44.9% (88). Ragweed pollen was shown to be the principal allergen causing allergic rhinitis (89).

In Europe, the severity of Ragweed pollinosis varies according to geographical region. Expansion of the Ragweed genus is occurring across Europe, in particular in France, northern Italy, Austria, and Hungary (90).

Ragweed pollinosis has become a rapidly emerging problem in Italy (64). In 21 centres across Italy, in 2,934 consecutive outpatients with respiratory pathology of suspected allergic origin, 28.2% were positive to at least one "emerging" pollen: Birch, Hazelnut, Alder, Hornbeam, Cypress, or Ragweed. Ragweed pollen was shown to provoke asthma much more frequently than any of the other pollens (91). Children appear to be less sensitised to Ragweed pollen than adults are; only 5.9% of 507 asthmatic children aged between 1 and 17 years from a central Italian area had IgE antibodies to Ragweed species (92).

Ragweed pollinosis also has been documented in France (93-95). An epidemiological study of Ragweed allergy was conducted on 646 employees of 6 factories located in the Rhône valley south of the city of Lyon. In this study, 5.4% of subjects were symptomatic to Ragweed pollen, whereas 5.9% were shown to have allergen-specific IgE to this pollen (96). The spread of Ragweed in the middle Rhône area over the last ten years has been considerable; this is especially true of the Drome, along the river Rhône, but also of remote, very sheltered localities to the east and southeast of the province. Although Ragweed is said to grow only in the plains, in this area it appears to be extending into the mountains (97).

Ragweed has been found in the central region of Coahuila, Spain (98). In Canton Ticino, in the southern part of Switzerland, 17% of 503 consecutive patients suffering from hay fever were shown to be sensitised to Ragweed (99).

Ragweed pollinosis is very prevalent in Hungary. In the south of Hungary, among patients with hay fever symptoms during the late summer, 63% were sensitised to Ragweed pollen (100). In Budapest, 64.8% of allergic patients were sensitised to weed pollens, and 59% to Ragweed pollen (101). In other areas, Ragweed sensitisation has been shown to affect up to 83% of patients with late-summer seasonal allergic rhinitis (65).

Ragweed pollinosis is also spreading across Asia.

As Ragweed becomes widespread over China, Ragweed pollinosis tends to be more frequent. A survey of the distribution of Ragweed in the Qingdao district recorded that *Ambrosia artemisiifolia* was found to be widespread in many areas. Ragweed pollen was the chief allergen of the district and contributed over 18% of the total air-borne pollen in a year. IgE antibody determination with *Ambrosia* allergen extracts showed a prevalence of 67.7% in 624 pollen-allergic individuals (102).

Ragweed pollinosis is also prominent in Taiwan (103). Of 3,550 asthmatic patients who visited the Taipei Municipal Chung-shing Hospital, 52.3% were shown to be sensitised to Ragweed (104). A high prevalence of sensitisation to Ragweed pollen has been reported in a further study (105).

Ragweed pollinosis has also been documented in Korea (58,106) and Japan (107-108). In 226 children visiting a paediatric allergy clinic in Kyoto, Japan, 17.1% were shown to be sensitised to *Ambrosia artemisiifolia* (109).

Few studies have examined the prevalence of Ragweed sensitisation in South America. In Cartagena, Columbia, in 99 subjects with acute asthma and 100 controls, the prevalence of specific IgE to Short ragweed was shown to be 23% and 12% respectively (110).

Ragweed allergy has also been reported in northern New South Wales, Australia, where 70 of 153 atopic patients were sensitised to Ragweed, as shown by allergen-specific IgE determination (111).

Although Ragweed is not present in most of Africa, it has been shown to be the third most prominent allergen for asthmatics in Egypt (112).

Other reactions

The food supplement bee pollen has been previously found to cause anaphylactic reactions. It has been advertised as useful for ”everything from bronchitis to haemorrhoids.” This study describes an atopic patient who experienced a non-life-threatening anaphylactic reaction upon her initial ingestion of bee pollen. The preparation of bee pollen caused 52% inhibition of IgE binding to Short ragweed (113).

w1 Common ragweed

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Taraxacum vulgare

Family:	*Asteraceae* (*Compositae*)
Common names:	Dandelion, Common dandelion
Synonym:	*T. officinale*
Source material:	Pollen

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Allergen Exposure

Geographical distribution

The genus *Taraxacum* is a member of the family *Asteraceae*, subfamily *Cichorioideae*, tribe *Lactuceae*. The *Asteraceae* includes *Chrysanthemum*, Dandelion, and Mugwort.

The Dandelion is a perennial weed that originated in Europe and Asia and is now naturalised throughout the world. It is particularly abundant in most of the northern hemisphere. In many countries such as Australia, Poland, Italy and Turkey it is considered a weed seriously interfering with agriculture.

Dandelion grows to a height of 0.5 m and a width of 0.3 m. Stems are hollow, very short and wholly underground, producing a rosette of leaves at the ground surface. The leaves are deeply toothed and 5 to 40 cm long.

Dandelion flowers in spring and early summer, sometimes with a secondary flowering in autumn. Flowering occurs for the whole year in warmer climates. The 2-3 cm in diameter flower heads are solitary at the end of naked, hollow stalks. Stalks can reach heights up to 60 cm. One head contains from 100 to 300 yellow ray flowers. The flowers have an unpleasant odour, are hermaphrodite (have both male and female organs) and are pollinated by insects. The plant is apomictic (reproduces by seeds formed without sexual fusion) and self-fertilising.

The seeds are brown and connected to white, feathery structures that are easily carried by the wind or by touch. The seeds ripen from May to June. A parachute of bristles aiding in dissemination tops Dandelion seeds. Seeds travel up to several hundred meters.

Environment

The Dandelion is an abundant weed found in lawns, meadows, fields, highways, waste places and the vicinities of railroads. It may also be cultivated.

The small tender leaves can be eaten as salad, the roots can be ground as a substitute for coffee (but are bitter), wine can be fermented from extracts of the flowers, and various parts may be used as medication.

Unexpected exposure

Dandelion pollen may be found in herbal medications (1).

Allergens

A 18 kDa Bet v 1 related-protein has been isolated from the root of the plant (2). Whether a similar protein exists in Dandelion pollen was not determined.

No allergens from this plant have yet been characterised.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Asteraceae* (3).

Many patients found to be sensitive to Dandelion are likely to have been sensitised by other members of the *Asteraceae* (*Compositae*) family, such as the wind-pollinated Mugwort or Ragweed, due to a close botanical relationship. Cross-reactivity has been confirmed between sunflower and other Compositae pollens (Mugwort, Marguerite, Dandelion, Golden rod, and Short ragweed) by RAST and immunoblotting inhibition experiments. Mugwort pollen exhibited the greatest degree of allergenic homology (cross-reactivity) with sunflower pollen, whereas at the other end of the spectrum, Short ragweed showed fewer cross-reactive epitopes (4).

A study investigated the sensitisation and cross-allergenicity of *Chrysanthemum*, Dandelion, and Mugwort by reviewing the records of 6,497 respiratory allergic patients who underwent skin prick tests, and concluded that in individuals with respiratory disease, *Chrysanthemum* and Dandelion were frequently co-sensitised with Mugwort, and that these 2 species also showed extensive cross-allergenicity with Mugwort (5).

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Dandelion; however, few specific studies have been reported to date (5-7).

A Korean study investigated the sensitisation and cross-allergenicity of *Chrysanthemum*, Dandelion, and Mugwort by reviewing the records of 6,497 respiratory allergic patients who had been skin prick tested, and found that sensitisation to Mugwort, *Chrysanthemum*, and Dandelion occurred in 13.4%, 10.0%, and 8.5% of patients, respectively. Co-sensitisation to all three pollens was found in 5.2%. Some patients were monosensitised to 1 species (1.5% to *Chrysanthemum*, 1.4% to Dandelion, and 4.5% to Mugwort). The study concluded that in individuals with respiratory disease, *Chrysanthemum* and Dandelion were frequently co-sensitised with Mugwort, and that these 2 species also showed extensive cross-allergenicity with Mugwort (5).

Seasonal allergic contact dermatitis in a florist has been described (8).

Other reactions

Contact dermatitis due to Dandelion has been described (9-12).

A 32-year-old atopic patient with allergic rhinitis developed a severe anaphylactic reaction following the ingestion of a pollen compound prepared in an herbalist's shop. The patient was found to be sensitised to *Artemisia vulgaris*, *Taraxacum officinalis* or *Salix alba*. All three were components of the pollen compound, in the ratio of 15% *Taraxacum officinalis*, 5% *Artemisia vulgaris*, and 15% *Salix alba*. The allergen responsible for the reaction could not be identified with certainty, but the authors caution that a food-induced systemic reaction due to a pollen compound is possible (1).

Adverse reactions to pollen following ingestion have been documented in other studies. Immediate allergic reactions occurred in 3 patients following the ingestion of a health food known as "bee pollen". The bee pollen contained Dandelion pollen. *In vivo* and *in vitro* studies demonstrated that the patients were sensitive to several *Compositae* family members, rather than to insect-derived antigens (13).

Dandelion pollen in honey may also result in allergic reactions. Other pollen, *e.g.*, from other members of the *Compositae* family, may also result in allergic reactions. However, other possible causes for adverse reactions to honey include bee venom and the presence of bee pharyngeal glands and other bee body components. The authors caution that in individuals allergic to honey, primary sensitisation may be due to the honey itself, to airborne *Compositae* pollen or even to cross-reacting bee venom components (14-15).

Ingestion of other parts of the Dandelion plant has also resulted in adverse reactions, attributed to the presence of sesquiterpene lactonespresent in the leaves and stems (16).

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w46 Dog fennel

Eupatorium capillifolium

Family: *Asteraceae* (*Compositae*)

Common names: Dog fennel, Mayweed

Synonym: *Anthemis cotula*

Source material: Pollen

Some sources regard Dog fennel as *Anthemis cotula*. Other sources refer to stinking chamomile as *Anthemis cotula*

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Allergen Exposure

Geographical distribution

Dog fennel is an aggressive native perennial herbaceous annual member of the *Asteraceae* (*Compositae*) family native to south-eastern North America. The *Asteraceae* are one of the largest families of flowering plants with about 25,000 species. Twelve major tribes are recognised. Dog fennel is a member of the tribe which also contains Yarrow, Chamomile, Sage, Wormwood, *Chrysanthemum* and Tansy (1).

Dog fennel is primarily a weed of landscapes, nursery, and some agronomic crops that is found throughout the United States.

Dog fennel is a winter or summer annual with finely dissected leaves that may reach between 50 cm and 2 meters in height. Stems below the cotyledons are green and become maroon with age. The first true leaves are opposite, but all subsequent leaves are alternate. All true leaves are thick and finely dissected with some short hairs. The stems and base are covered in leaves so dissected that they resemble green hairs coming out of the stem in fractal patterns (2). The leaves are alternate, finely dissected, approximately 2 - 6 cm long and 2.5 cm wide. Leaves emit an unpleasant odour when crushed.

The flowers occur in solitary heads at the ends of branches and are approximately 2 cm to 3 cm in diameter and are white (ray flowers) with yellow centres (disc flowers). The white ray flowers have 3 distinct teeth.

Environment

Dog fennel spreads by both seeds and rootstocks and can grow quite aggressively. It is common in pastures.

Allergens

No allergens have been characterised.

Potential cross-reactivity

Cross-reactivity could be expected between species of the family *Asteraceae*.

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Dog fennel; however, no specific studies have been reported to date.

In Tampa, Florida, the major weed pollen season (May through Dec.) was reported to consist of Ragweed, Mexican tea, Pigweed, Dog fennel, and false nettle. A minor weed season (March through July) consisted of Sorrel and Dock (3).

Other reactions

Allergic contact dermatitis following contact with Dog fennel has been reported (4-5).

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w4 False ragweed

Franseria acanthicarpa

Family: *Asteraceae* (*Compositae*)

Common names: False ragweed, Bur ragweed, Annual burweed

Synonym: *Ambrosia acanthicarpa*

Source material: Pollen

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Allergen Exposure

Geographical distribution

False ragweed grows almost over all the continental United States. Related species are found in Mexico, Hawaii and Australia. False ragweed is considered to be a major source of pollen allergy in certain areas of the USA where the plant is common.

False ragweed is an erect, bushy summer annual, similar to the genus *Ambrosia*, and growing to a height of 1.5 m. The leaves are 8 cm long and 7 cm wide, alternate on the upper stems, grey-green in colour and bipinnately lobed. The foliage is covered with white to grey short, bristly hairs.

The plant flowers from August to November. The flower heads are small, greenish, and composed of staminate (male) or pistillate (female) disc flowers. Staminate and pistillate heads are separate on a single plant (a monoecious structure). The pistillate heads are clustered in the leaf axils below the spikes. False ragweed is both insect- and wind-pollinated, but the relative rarity of the plant makes its copious pollen clinically less important overall than that of the other Ragweeds. The fruit becomes a bur. Burs are highly variable, but often golden-brown. The bur is 4 to 8 mm long, typically with 6 to 30, 2 to 5 mm-long sharp-pointed, flattened spines that are straight at the tip (not hooked). The seed matures from August to October. Burs disperse by clinging to shoes or clothing, or to the feet, fur or feathers of animals.

Environment

False ragweed may be found on dry slopes, sandy flats, alluvial plains, grasslands, coastal areas, forestry regeneration sites and other disturbed sites, and agricultural fields. Although the plant inhabits many natural plant communities, it can become a pest.

Allergens

No allergens from this plant have yet been characterised.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Asteraceae* (1). This was confirmed in a study using a serum pool from patients sensitive to Short ragweed, whereby the cross-reactivity of IgE antibodies to six Ragweeds was studied through the radioallergosorbent test. Extracts were analysed for their inhibitory activities, with solid-phase allergens prepared from all of the Ragweed pollens. Also, samples of serum were absorbed with the various solid-phase allergens and the reactivity of the remaining IgE antibodies was determined. Two patterns of reactivity were observed. Short, Giant, Western, and False ragweeds displayed comparable reactivity in both inhibition and absorption experiments. Slender and Southern ragweed were considerably less active, indicating that they lacked allergenic groupings possessed by the other species. These same patterns of cross-reactivity were found using Ragweed pollens from four commercial sources (2).

A second study documented close cross-reactivity between False ragweed and Short ragweed. A water-insoluble material, extracted from Short ragweed and False ragweed pollen, contained at least five proteins. Two (RFA2 and RFB2) were isolated and shown to possess antigenicity as well as allergenicity. Immunodiffusion tests of RFB2, isolated from False ragweed and Short ragweed, showed immunological identity (3).

Clinical Experience

IgE-mediated reactions

Asthma, allergic rhinitis and allergic conjunctivitis, similar to sensitisation from other Ragweeds, occur in sensitised individuals. Symptoms may be elicited either due to sensitisation to this species, or due to cross-reactive mechanisms with other members of the Ragweed genus.

Other reactions

Contact dermatitis to False Ragweed has been documented. (4)

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w17 Firebush (Kochia)

Kochia scoparia

Family: *Amaranthaceae* (*Chenopodiaceae*)

Common names: Firebush, Kochia, Common kochia

Synonyms: *Bassia scoparia*, *Chenopodium scoparia*

Source material: Pollen

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Allergen Exposure

Geographical distribution

Kochia is native to southern and eastern Russia, Europe and Asia. It is now naturalised across the northern half of the United States and spreading south-westwards. It is found in many other areas of the world. Kochia is a major source of pollen.

Kochia is an erect annual with many-branched stems. The branching is usually from the base. The branches are 1 to 2 m long, and the bush grows from 50 to 150 cm in height. The main stem is often tinged with red. The plant has a deep taproot, up to 5 m. The 2- to 5 cm-long narrow leaves are stalkless, pubescent to nearly glabrous, lance-like in shape with hairy margins, and often turning red to purple in autumn. Seedlings emerge in spring and have thick leaves, dull-green above and with magenta undersides.

Kochia flowers in midsummer. The inconspicuous green flowers lack petals and are borne in clusters at the ends of branches and bases of leaves, and each flower is surrounded by a cluster of long hairs. Kochia may be called ”Burning Bush” for its reddish-purple colour. Kochia usually flowers in late summer but there is great variation in the flowering time of different populations. The brown flattened seeds are approximately 1 to 2 mm long and grooved on each side. Like many other species of the *Chenopodiaceae*, Kochia becomes a tumbleweed when mature.

Kochia is difficult to differentiate from Fivehook Bassia. But unlike Kochia, which is usually branched from the base, Fivehook Bassia's branching is along the main stem.

Environment

Kochia is a highly aggressive and damaging weed, affecting crop production in many parts of the world, particularly cereal production. Kochia is highly adaptable. It is very drought-tolerant and is commonly found on saline soils, deserts, and coasts. It is found on pasture, rangeland, roadsides, ditch banks, wastelands, and cultivated fields. Kochia is often cultivated as a bedding plant or as an ornamental hedge.

Allergens

No allergens from this plant have yet been characterised.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the families *Chenopodiaceae* and *Amaranthaceae* (1-2).

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Kochia; however, few specific studies have been reported to date (3-5).

In one study in Thailand, Kochia was shown to be the second most important weed aeroallergen, with 14% of 100 patients with allergic rhinitis sensitised to it (3).

In a study in the Midwestern USA, evaluating the frequency of sensitisation to cannabis pollen, found that 61% were skin prick positive for cannabis and all subjects were also skin test positive to weeds pollinating during the same period: Ragweed, Pigweed, Cocklebur, Russian thistle, Marsh elder, and Kochia (6).

Among 1,159 patients attending an allergy clinic in Saudi Arabia, 51% of Saudi Arab patients and 28% of North American expatriates living in the area were sensitised to Kochia. This weed's pollen was the 2nd and 7th most prevalent allergen sensitising the respective groups (5).

Kochia pollen is also common in Tehran, Iran (7), and a common cause of sensitisation in St. Louis, Missouri, USA (8).

Of 327 adult patients with respiratory, dermatologic and ophthalmologic diseases of suspected allergic origin who attended a Hospital based in the United Arab Emirates, skin prick tests found that 244 patients (74.6%) were sensitised to at least one allergen. The twelve most common allergens were: Mesquite (45.5%), Grass Mix (40.7%), Cottonwood (33.1%), Bermuda grass (31.3%), Kochia (25.8%), Acacia (25.6%), Alfalfa (22.9%), *Chenopodium* (19.6%), Date palm (13.8%), Cockroach (14.7%), house dust (11.9%) and dust mite (9.5%) (4).

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w3 Giant ragweed

Ambrosia trifida

Family:	*Asteraceae* (*Compositae*)
Common names:	Giant ragweed, Great ragweed, Tall ragweed
Source material:	Pollen
See also:	Common ragweed (*A. elatior*) w1, Western ragweed (*A. psilostachya*) w2

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Allergen Exposure

Geographical distribution

Giant ragweed is native to eastern North America, and to Colorado and Mexico. It is most abundant along the flood plains of south-eastern rivers. In the Mississippi Delta it can form vast stands. It can also be found in Japan and has colonised Europe.

Giant ragweed is a coarse, unsightly, erect summer annual herbaceous plant that typically grows to 2 m in height but can reach 5 m in fertile soil. The stems are coarse, single or branched, and woody at the base. Longitudinal black lines occur on the stems, which are also covered with soft to bristly hairs. The 6 to 35 cm-long soft green leaves are broad and sparsely covered with minute, stiff hairs. The leaves are opposite or alternate and generally have three lobes. The leaf margins are finely serrate.

The plant is in flower from June to September. It is wind-pollinated, releasing millions of pollen grains into the air. However, the presence of the pollen in honey indicates some insect pollination. The flower heads are small, greenish, and composed of staminate (male) or pistillate (female) disc flowers. Staminate and pistillate heads are separate on a single plant (a monoecious structure).

The flowers produce fruits as brown-grey burs that are 6 to 12 mm long, stout, and blunt-beaked at the apex. The beak of the bur is surrounded by a crown of 5 to 8 short, thick, blunt teeth of vestigial spines terminating each rib. The seed matures from August to October. Most burs fall near the parent plant, but some can diperse long distances by water, or due to animal or human activities.

Environment

Giant ragweed typically colonises disturbed open sites and roadsides, sometimes forming vast pure stands. It can be found on low ground and alongside streams, often in waste places. It is also troublesome in agricultural fields and drainage areas.

Unexpected exposure

The leaves of the plant are used in herbal medications. A tea made from the roots is used as a herbal remedy. The pollen is harvested commercially and manufactured into homeopathic preparations for the treatment of allergies to the plant.

Allergens

The following allergens have been characterised:

Amb t 5 (Ra5G) (1-11).

Amb t 8, a profilin (12-14).

Potential cross-reactivity

With the use of a serum pool from patients sensitive to Short ragweed, the cross-reactivity of IgE antibodies to six Ragweeds was studied through the radioallergosorbent test. Extracts were analysed for their inhibitory activities, with solid-phase allergens prepared from all of the Ragweed pollens. Also, samples of serum were absorbed with the various solid-phase allergens and the reactivity of the remaining IgE antibodies was determined. Two patterns of reactivity were observed. Short, Giant, Western, and False ragweeds displayed comparable reactivity in both inhibition and absorption experiments. Slender and Southern ragweed were considerably less active, indicating that they lacked allergenic groupings possessed by the other species. These same patterns of cross-reactivity were found using Ragweed pollens from four commercial sources (15).

Further cross-reactivity among the various Ragweeds can be inferred due to the high cross-reactivity among various other members of the genus *Ambrosia* and of the family *Asteraceae*. For example, cross-reactivity among Chamomile tea extract, pollen of *Matricaria chamomilla*, *Artemisia vulgaris* (Mugwort), and *Ambrosia trifida* (Giant ragweed) was demonstrated by an ELISA-inhibition study (16). Further evidence confirming cross-reactivity among members of the Ragweed genus was obtained in a study using a fluorescent allergosorbent test, in which similar antigenic determinants were found among Short and Giant ragweed, Cocklebur, Lamb's Quarters, Rough Pigweed, Marshelder, and Goldenrod. Cocklebur and Giant ragweed were highly potent in their ability to competitively bind to Short ragweed IgE. The other pollens demonstrated lower potency of cross-reacting antigens (17). Also, a water-insoluble material, extracted from Short ragweed and False ragweed pollen, contained at least five proteins. Two (RFA2 and RFB2) were isolated and shown to possess antigenicity as well as allergenicity. Immunodiffusion tests of RFB2, isolated from False ragweed and Short Ragweed, showed immunological identity (18).

However, in a recent study, Short and Giant ragweed were reported to not be allergenically equivalent. The authors stated that allergenic differences involve both the major allergens Amb a 1-2/Amb t 1-2 and some minor allergens. In patients allergic to Ragweed, both diagnosis *in vivo* and immunotherapy should always be performed by using the Ragweed species present in that specific geographic area (19).

Considering the close cross-reactivity described above, the following further possibilities should be considered.

Mugwort, Ragweed, and Timothy grass pollen share IgE epitopes with Latex glycoprotein allergens. The presence of common epitopes might in part explain clinical symptoms on contact with Latex in patients allergic to pollen. In this study, any previously known panallergen was not detected (20).

An association between Ragweed pollinosis and hypersensitivity to *Cucurbitaceae* vegetables (*e.g.*, Watermelon, Cantaloupe, Honeydew Melon, Zucchini, and Cucumber) and Banana has been reported. Up to now three allergens have been identified as candidates for causing this cross-reactivity: profilin, Bet v 1, and a 60-69 kd allergen (21). Further evidence for cross-reactivity between *Cucurbitaceae* and Ragweed was found in a study that reported that of the sera of 192 allergic patients, 63% contained anti-Ragweed IgE, and among these patients, 28% to 50% had sera containing IgE antibodies specific for any single gourd family member. The extracts of Watermelon and Ragweed inhibited each other in a dose-dependent manner (22).

Ragweed profilin can be expected to result in cross-reactivity between this plant and other plants containing profilin. This has been demonstrated between Ragweed and Persimmon (13). In a second study, 35 of 36 patients' sera containing IgE to Ragweed profilin reacted with profilin from Latex, indicating structural homologies between profilin from Latex and Ragweed. Because profilin is also present in Banana extract, it is likely to be involved in cross-sensitivity between Banana and Latex (12).

In addition to profilin, Mugwort and Ragweed pollen contain a number of other cross-reactive allergens, among them the major Mugwort allergen Art v 1. These cross-reactive IgE antibodies could result in clinically significant allergic reactions (23). Evidence of further cross-reactivity between Mugwort and other members of the *Asteraceae* family (of which Ragweed is a member) consists in the high degree of *in vivo* cross-reactivity between *Matricaria chamomilla* (Camomile) and Mugwort (24).

Cross-reactivity between Sunflower and other *Asteraceae* pollens (Mugwort, Marguerite, Dandelion, Goldenrod, and Short ragweed) has also been demonstrated by RAST and immunoblotting inhibition experiments. Mugwort pollen exhibited the greatest degree of cross-reactivity with Sunflower pollen, whereas at the other end of the spectrum, Short ragweed showed fewer cross-reactive epitopes (25).

Celery cross-reacting to Ragweed has also been reported, but a panallergen was not identified in these studies (26-27).

Binding to IgE from Ginkgo pollen proteins (*Ginkgo biloba L.*) was shown to be almost completely inhibited by Oak, Ryegrass, Mugwort and Ragweed, but only partially by Japanese Hop and rBet v 2 (28). A panallergen may be indicated but was not isolated.

Sera from subjects allergic to White Cypress Pine, Italian cypress, Ryegrass or Birch pollen were shown to have IgE antibodies that reacted with pollens from these four species and from Cocksfoot, Couch grass, Lamb's quarters, Wall pellitory, Olive, Plantain and Ragweed. The authors concluded that the presence of pollen-reactive IgE antibodies may not necessarily be a true reflection of sensitising pollen species (29).

The Japanese cypress tree pollen allergen, Cha o 1, has a 46 to 49% similarly to the major allergens of Short ragweed, Amb a 1 and Amb a 2 (30).

A panallergen has been identified in Birch pollen, Ragweed pollen, Timothy grass pollen, Celery, Carrot, Apple, Peanut, Paprika, Anise, Fennel, Coriander and Cumin. EAST inhibition and immunoblot inhibition demonstrated that cross-reactions between Mango fruits, Mugwort pollen, Birch pollen, Celery, and Carrot are based on allergens related to Bet v 1 and Art v 1, the major allergens of Birch and Mugwort pollen, respectively (31).

Pollen of *Artemisia annua* is considered to be one of the most important allergens in autumnal hay fever in China, just as Ragweed is in North America. Extracts of pollen-free *Artemisia annua* components were found to contain similar allergens to those of Ragweed pollen. In 52 subjects sensitive to Artemisia pollen, 92.3% were shown on skin prick testing to have specific IgE to this allergen, 100% gave positive responses in intradermal tests, 66.7% gave positive responses in intranasal challenges, and 59.3% gave positive responses in bronchial provocation tests (32).

Ragweed pollen appears to also be cross-reactive with pollen from Yellow dock (*Rumex crispus*). When monoclonal antibodies with different specificity were applied against the major allergenic components of Ragweed pollen, the monoclonal antibodies reacted with antigens of Yellow dock pollen. In a preliminary study, sera of 2 patients containing IgE antibodies to Ragweed pollen antigens also reacted to the 40K component of Yellow dock pollen. In specific IgE tests on 109 patients with bronchial asthma, 22 had a positive reaction to a crude extract of Ragweed pollen, and 18 also reacted to a crude extract of Yellow dock pollen (33).

Clinical Experience

IgE-mediated reactions

Ragweed, and in particular Short ragweed (*A. artemisiifolia*), is clinically the most important source of seasonal aeroallergens, as it is responsible for both the majority of cases and the most severe cases of allergic rhinitis (34-39). Ragweed pollen also contributes significantly to exacerbation of asthma and allergic conjunctivitis. Ragweed pollen has also been implicated in eustachian tube dysfunction in patients with allergic rhinitis (40) and in contact dermatitis (41).

Considering the close cross-reactivity described above, the following clinical possibilities should all be considered, even when data on this specific Ragweed species are absent.

The efficacy of Ragweed pollen in exacerbating allergic symptoms may be due to the Ragweed pollen endopeptidase, which may be involved in the inactivation of regulatory neuropeptides during pollen-initiated allergic reactions (42). Studies have also shown that complement activation induced by the allergen may enhance the clinical symptoms of Ragweed allergy (43-44).

A genetic susceptibility to Ragweed allergens has been suggested based on HLA studies; Amb a V, Amb t V and Amb p V from Short ragweed, Giant ragweed and Western ragweed respectively are strongly associated with HLA-DR2 and Dw2 (DR2.2) in allergic Caucasoid individuals (45).

The measurement of allergen-specific IgE antibodies has been shown to be an accurate and useful diagnostic tool in the evaluation of sensitisation to Ragweed pollen (46-49).

Aerobiological and clinical studies from various cities in the USA have documented the importance of Ragweed pollen as an aeroallergen (50). Ragweed has been shown to contribute to symptoms in studies in Washington, DC (51), Tucson, Arizona (52), and Tulsa, Oklahoma (53).

The prevalence of Ragweed pollinosis in central Pennsylvania was shown to be significantly greater in the rural subjects than in inner-city ones (54). In Boston women, socio-economic differences in sensitisation to Ragweed differed between the highest and lowest poverty areas (49% *vs*. 23%) (55). Ragweed was shown to be a major aeroallergen in the Tampa Bay area, Florida (56).

In Chicago residents with asthma, Ragweed sensitivity occurred in 45%, more than those sensitised to pollen from all other weeds (42%) (57).

In a collaborative study on American Feverfew (*Parthenium hysterophorus*) pollen compared to an extract of Western ragweed, a study contributed to by 22 physicians from 18 Gulf Coast cities, 65.6% overall of the sera tested were positive for one or both of the pollen extracts examined. Thirty-five percent of the sera were sensitive to American feverfew and 57.6% were sensitive to Ragweed. Thirty percent of the sera were positive to Western ragweed only, 8% were positive to American feverfew only, and 27.9% were positive to both extracts (58-59). These studies support the findings of another study that examined cross-reactivity of allergens from the pollen of American feverfew and Ragweed in 2 groups of patients with different geographic distributions. *Parthenium*-sensitive Indian patients, who were never exposed to Ragweed, had positive skin reactions to Ragweed pollen extracts. A significant correlation in the RAST scores of *Parthenium*- and Ragweed-specific IgE was observed with the sera of *Parthenium*- and Ragweed-sensitive Indian and US patients, respectively. RAST inhibition experiments demonstrated that in the sera of Ragweed-sensitive patients the binding of IgE antibodies to Short and Giant ragweed allergens could be inhibited by up to 94% by *Parthenium* pollen extracts. Inhibition up to 82% was obtained when the sera of *Parthenium* rhinitis patients were incubated with Ragweed allergen extracts. The high degree of cross-reactivity between *Parthenium* and Ragweed pollen allergens suggests that individuals sensitised to *Parthenium* may develop type-I hypersensitivity reactions to Ragweed even though they never had contact with Ragweed, and vice versa. (60)

In Canada, Ragweed pollinosis studies have been conducted in Quebec. Of 3,371 subjects with a clinical diagnosis of symptomatic asthma or rhinitis, Ragweed sensitisation was documented in 44.9% (61). Ragweed pollen was shown to be the principal allergen causing allergic rhinitis (62).

In Europe, the severity of Ragweed pollinosis varies according to geographical region. Expansion of the Ragweed genus is occurring across Europe, in particular in France, northern Italy, Austria, and Hungary (63).

Ragweed pollinosis has become a rapidly emerging problem in Italy (34). In 21 centres across Italy, in 2,934 consecutive outpatients with respiratory pathology of suspected allergic origin, 28.2% were positive to at least one "emerging" pollen: Birch, Hazelnut, Alder, Hornbeam, Cypress, or Ragweed. Ragweed pollen was shown to provoke asthma much more frequently than any of the other pollens (64). Children appear to be less sensitised to Ragweed pollen than adults are; only 5.9% of 507 asthmatic children aged between 1 and 17 years from a central Italian area had IgE antibodies to Ragweed species (65).

Ragweed pollinosis also has been documented in France (66-68). An epidemiological study of Ragweed allergy was conducted on 646 employees of 6 factories located in the Rhône valley south of the city of Lyon. In this study, 5.4% of subjects were symptomatic to Ragweed pollen, whereas 5.9% were shown to have allergen-specific IgE to this pollen (69). The spread of Ragweed in the middle Rhône area over the last ten years has been considerable; this is especially true of the Drome, along the river Rhône, but also of remote, very sheltered localities to the east and southeast of the province. Although Ragweed is said to grow only in the plains, in this area it appears to be extending into the mountains (70).

Ragweed has been found in the central region of Coahuila, Spain (71). In Canton Ticino, in the southern part of Switzerland, 17% of 503 consecutive patients suffering from hay fever were shown to be sensitised to Ragweed (72).

Ragweed pollinosis is very prevalent in Hungary. In the south of Hungary, among patients with hay fever symptoms during the late summer, 63% were sensitised to Ragweed pollen (73). In Budapest, 64.8% of allergic patients were sensitised to weed pollens, and 59% to Ragweed pollen (74). In other areas, Ragweed sensitisation has been shown to affect up to 83% of patients with late-summer seasonal allergic rhinitis (35).

Ragweed pollinosis is also spreading across Asia.

As Ragweed becomes widespread over China, Ragweed pollinosis tends to be more frequent. A survey of the distribution of Ragweed in the Qingdao district recorded that Ambrosia artemisiifolia was found to be widespread in many areas. Ragweed pollen was the chief allergen of the district and contributed over 18% of the total air-borne pollen in a year. Allergen-specific IgE determination with Ambrosia allergen extracts showed a prevalence of 67.7% in 624 pollen-allergic individuals (75).

Ragweed pollinosis is also prominent in Taiwan (76). Of 3,550 asthmatic patients who visited the Taipei Municipal Chung-shing Hospital, 52.3% were shown to be sensitised to Ragweed (77). A high prevalence of sensitisation to Ragweed pollen has been reported in a further study (78).

Ragweed pollinosis has also been documented in Korea (28,79) and Japan (80-81). In 226 children visiting a paediatric allergy clinic in Kyoto, Japan, 17.1% were shown to be sensitised to *Ambrosia artemisiifolia* (82).

Few studies have examined the prevalence of Ragweed sensitisation in South America. In Cartagena, Columbia, in 99 subjects with acute asthma and 100 controls, the prevalence of IgE antibodies to Short ragweed was shown to be 23% and 12% respectively (83).

Ragweed allergy has also been reported in northern New South Wales, Australia, where 70 of 153 atopic patients were sensitised to Ragweed, as shown by IgE antibody determination (84).

Although Ragweed is not present in most of Africa, it has been shown to be the third most prominent allergen for asthmatics in Egypt (85).

Other reactions

The food supplement bee pollen has been previously found to cause anaphylactic reactions. It has been advertised as useful for "everything from bronchitis to haemorrhoids". One study describes an atopic patient who experienced a non-life-threatening anaphylactic reaction upon her initial ingestion of bee pollen. The preparation of bee pollen caused 52% inhibition of IgE binding to Short ragweed (86).

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Solidago virgaurea

Family: *Asteraceae* (*Compositae*)

Common names: Goldenrod, European goldenrod , Woundwort

Source material: Pollen

Not to be confused with Rayless goldenrod (*Haplopappus heterophyllus*).

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Allergen Exposure

Geographical distribution

Solidago encompasses approximately 130 species, most of which are found in North America, though some are common to Europe and northern Asia as well (1). *Solidago* is also found in South America and other parts of the world, where some species within the genus are cultivated as ornamentals. The closely related species, Canada goldenrod, *S. canadensis*, is a common plant, found throughout Canada and the United States, from coast to coast (1). Several species, such as Late goldenrod, *S. gigantea*, have a high latex content of the leaves (1-2).

Goldenrod is a perennial weed often found along roadsides and in open fields. It has a single woody stem that grows as high as 2 m. It spreads by seed and creeping roots. It may be grown as an ornamental plant. The alternate, three-veined leaves at the base of the plant are bright green and oval-shaped, drawing to a point, while the leaves on the stem are smaller and wholly oval in shape. The leaves have either toothed or smooth edges.

The stems produce scented spikes of simple golden-yellow flowers, which have clusters of stamens, from mid- to late summer (August and September). Flowers are yellow, with numerous small heads with overlapping involucral bracts, having 10 to 17 rays (1). The ornamental Goldenrod is smaller, growing to 0.6 m and in flower from July to October. The flowers are small (6 mm) and are produced in profuse clusters. The flowers are hermaphrodite (have both male and female organs). As Goldenrod is insect-pollinated, the pollen grains are much heavier than those of ragweed and other plants that have airborne pollens associated with allergic symptoms. The plant is also self-fertilising. The seeds ripen from August to October.

In areas where Ragweed exists, as ragweed anthesis wanes, Goldenrods such as *S. speciosa* (Showy goldenrod) and S. sempervirens (Seaside goldenrod) are still producing large amounts of pollen, and captured Goldenrod pollen will exceed that of Ragweed (1).

Environment

Goldenrod is found along roadsides, in open fields, dry woods, grasslands, hedge banks and dunes.

Goldenrod has been used topically for healing wounds, and by American Indians as a salve for rattlesnake bites. Tea can be made from the leaves.

Allergens

No allergens from this plant have yet been characterised.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family Asteraceae, which includes *Solidago* (Goldenrod), *Ambrosia* (Ragweed), *Chrysanthemum*, *Matricaria chamomilla* (Chamomile) and *Artemisia vulgaris* (Mugwort) (3-5). Cross-reactivity between ragweed and goldenrod is minor (6).

Extensive cross-sensitisation was observed to pollen of several members of the *Compositae* family (*e.g.*, *Matricaria*, *Chrysanthemum*, *Solidago*) and to pollen of the *Amaryllidaceae* family (*Alstroemeria* and *Narcissus*) (7).

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Goldenrod, particularly in an occupational setting, e.g., that of flower sellers; however, few specific studies have been reported to date (4,8-9). However, whether Goldenrod is a significant cause of hay fever remains debatable and asthma has not been reported (1).

Thirty of 100 individuals with hayfever as a result of Ragweed were shown to be sensitised to Goldenrod (9).

Of 14 consecutive patients seen at an allergic clinic in the Netherlands, with complaints varying from allergic rhinoconjunctivitis and asthma to urticaria due to the handling of flowers, 12 reported *Solidago* as the responsible plant. Eleven were shown to have serum specific IgE directed at *Solidago* and 12 were skin prick test positive (7).

Although Goldenrod is mainly insect-pollinated, the pollen has been detected in gravimetric sampling *e.g.* in the Fairbanks area, Alaska (10).

Other reactions

Allergic contact dermatitis after systemic administration has been reported (11).

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w10 Goosefoot, Lamb´s quarters

Chenopodium album

Family: *Amaranthaceae* (*Chenopodiaceae*)

Common names: Goosefoot, Lamb's-quarters, Common lamb's quarters, Lambsquarter, White goosefoot

Source material: Pollen

See also: Quinoa (*C. quinoa*) f347

This plant is sometimes called Pigweed but needs to be differentiated from Common pigweed (*Amaranthus retroflexus*).

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Allergen Exposure

Geographical distribution

Goosefoot originated in Europe but is now found throughout the world.

Goosefoot is an annual herb varying from 30 cm to 2 m in height. The stems are erect, smooth, longitudinally grooved, and often red, purple or light-green striped. *Chenopodium* comes from the Latin for "goose foot", which describes the shape of the leaves. The leaves are 2.5 to 8 cm long, stalked, smooth, and covered with tiny white mealy particles/scales, particularly on the lower surface. Occasionally the plant may have purple leaf bases. The entire plant is covered with varying amounts of a waxy substance, giving a light-green appearance.

The flowers are inconspicuous: green, and without petals. These flowers are found in dense clusters at the tips of branches and at the top of the stem. Goosefoot flowers throughout the summer but predominantly in the autumn, producing abundant pollen. A full-grown plant can give off as many as 20,000 pollen grains. The flowers are hermaphrodite (have both male and female organs) and are pollinated by wind. The tiny seeds are disc-shaped with a notch. They are glossy black, brown or brownish-green, 1.2 to 1.6 mm in diameter, and ripen from August to October.

Environment

Goosefoot is found in open habitats, rubbish tips and cultivated fields, and especially on rich soils and old manure heaps. *Chenopodium* species are tolerant of salty soils. They do not grow in the shade.

Members of the *Amarantaceae* and *Chenopodiaceae* families, *e.g.*, Russian thistle (*Salsola kali-pestifer*) and Lamb's quarter (*Chenopodium album*), survive in aggressive climatic conditions such as dry summers and mild winters. These species are also cultivated in desert countries such as Saudi Arabia, Kuwait, and United Arab Emirates, as a part of the greening ground programs or to avoid erosion of drained zones. They are also spreading throughout areas of the United States and temperate regions of southern Europe (1).

Chenopod has been reported to cause allergy in desert countries were it is well adapted (2-5). A significant feature of chenopod sensitivity is its concomitant appearance with other pollinoses and probably explains the little attention that this allergy has received (1,6-7).

Unexpected exposure

The leaves and seeds of all members of this genus are more or less edible. They can be cooked and eaten as a spinach substitute, or dried. The seed can be dried and ground into a meal, eaten raw, baked into a bread, or added as a supplement to grain flour. The ground seeds can also be used as medication.

However, many of the species in this genus contain saponins, though usually in quantities too small to do any harm. The plants also contain some oxalic acid. In nitrogen-rich soils, the plants can also concentrate hydrogen cyanide.

Allergens

Although an allergen with a molecular weight of 35 kDa has been islolated, allergens from Goosefoot have not been fully characterised (7-8).

The following allergens have been characterised:

Che a 1, a 17 kDa protein, a trypsin inhibitor (9-13).

Che a 2, a 14 kDa protein, a profilin (9-11,14-16).

Che a 3, a 10 kDa protein, a polcalcin (calcium-binding protein) (9,15-18).

Seventy seven percent of sera from patients allergic to Chenopod pollen were reactive to Che a 1 (13).

Allergen-specific IgE to Che a 2 and Che a 3 were shown to be prevalent in 55% and 46% respectively, of 104 Goosefoot-allergic individuals (15).

A 2S albumin protein has been isolated from *Chenopodium* album seeds and is antigenically homologous to proteins of similar molecular weight in seeds of certain other members of *Chenopodiaceae* and *Amaranthaceae*. *Chenopodium* 2S albumin is, however, antigenically unrelated to the low-molecular-weight albumins of dicots belonging to other families (19). Whether 2S albumin protein is present in pollen from this plant has not been determined.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Chenopodiaceae* (20).

Atriplex latifolia, *Beta vulgaris*, *Salsola kali* and *Amaranthus retroflexus* were compared with an extract from *Chenopodium* album by both *in vivo* and *in vitro* methods, the results suggesting that common allergenic determinants were present (21).

Sera from individuals sensitised to White Cypress Pine, Italian cypress, Ryegrass or Birch pollen were shown to have IgE antibodies that reacted with pollens from these four species and from Cocksfoot, Couch Grass, Lamb's quarter, Wall pellitory, Olive, Plantain and Ragweed (22).

Homologues to both Che a 1 and Che a 2 have been detected in Sugar beet pollen extract (10).

The Ole e 1-like family of proteins, which may result in varying degrees of cross-reactivity between members, comprises allergenic members (Fra e 1, Lig v 1, Syr v 1 from *Oleaceae* species; Pla l 1 from *Plantago lanceolata*; Che a 1 from *C. album*; Lol p 11 from *Lolium perenne*; and Phl p 11 from *Phleum pratense*), as well as non-allergenic members such as BB18 from *Betula verrucosa*.(23). The amino acid sequence of Che a 1 exhibits 27-45% identity with known members of the Ole e 1-like protein family (13).

The three-dimensional structure of recombinant Che a 3 is essentially identical with that of the two EF-hand allergens from Birch pollen, Bet v 4, and Timothy grass pollen, Phl p 7, and extensive cross-reactivity between Che a 3 and Phl p 7 was demonstrated (17). Other studies have shown that Syr v 3 (Lilac tree), Ole e 3 (Olive tree), Che a 3 and Phl p 7 showed a similar IgG- and IgE-binding capacity although differences at quantitative level were observed depending on the population of patients' sera (24).

Cross-reactivity between Black locust tree (*Robinia pseudoacacia*) pollen and Goosefoot has been demonstrated (11).

Clinical Experience

IgE-mediated reactions

Goosefoot pollen can induce asthma, allergic rhinitis and allergic conjunctivitis (5,25-26).

Plants from the *Chenopodium* genus have been shown to have the highest atopic prevalence in a desert environment in Kuwait, where 64.3% of 706 patients with allergic rhinitis aged between 6 and 64 years were sensitised to this weed's pollen. A second, similar study in this environment reported that *Chenopodium* pollen was the most prevalent sensitising pollen in asthmatics, with 70.7% of 553 asthmatics sensitised. Plants from the *Chenopodium* genus were imported and cultivated for the purpose of "greening" the desert (25). Further evidence for the high prevalence of atopic sensitisation to this allergen was found in the sera of 505 young adult blood donors, which were examined for specific IgE to Goosefoot, where the prevalence of sensitisation to this allergen for the entire population was shown to be 22.5% (2).

Chenopodiaceae pollen has been found in the atmosphere of Cordoba, Spain, virtually throughout the year, although its presence was continual only between April and October, with maximum concentrations detected in the summer months. Of 1,000 patients, over 8% were sensitised to this pollen (27). A similar prevalence was reported in a second study from Cordoba, where 8.42% of pollen-sensitised patients were sensitive to pollen from the *Chenopodium* family (28). In Comarca Lagunera, Spain, 69% of 101 patients with asthma were positive to *Chenopodium* on skin prick tests. This was the second most prevalent pollen allergen to which these patients were sensitised (29). Pollen from this plant has also been detected in Salamanca, Spain (30).

In a Saudi-Arabian study, Goosefoot pollen allergens were detected in a sandstorm. The authors conclude that sandstorms could contribute to the triggering of allergy symptoms in sensitised individuals (31). A second study from this country demonstrated that Goosefoot pollen is a major sensitising allergen. In 806 Saudi Arabs, Chenopodium album was the most prevalent allergen to which they were sensitised to (53%). In 241 Western expatriates (mainly North Americans) living in the area, this was the 10th most common sensitising allergen, with 24% of patients sensitised to Goosefoot pollen (3).

Other European studies have reported the significance of Goosefoot pollen (32). Sites included Athens, Greece (33), and Poland, where examination of the records of 8,576 patients with "upper airway" allergy documented hypersensitivity to weed pollen allergens in 12.5%, the most prevalent sensitisation being to Wormwood (86.2%), Mugwort (82.9%), and White goosefoot (44.3%). Hypersensitivity to grass, tree and/or shrub pollens coexisted in 85.5% (34).

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w22 Japanese Hop

Humulus scandens

Family: *Cannabaceae*

Common names: Japanese Hop, Hop Japanese

Synonym: *H. japonicum*

Source material: Pollen

See also: Hop (*H. lupulus*) f324; the dried flower heads or the extract of the fruit of another Hop plant and are used in beer manufacture

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Allergen Exposure

Geographical distribution

Humulus is found in temperate and subtropical regions of the northern hemisphere. There are only three species: European hop, *H. lupulus*, found throughout Europe; Japanese hop, *H. scandens* (syn. *H. japonicus*), found in Japan and throughout most of China; and *H. yunnanensis*, native to Yunnan province (1-4). Both *H. lupulus* and *H. scandens* are now found throughout other parts of the world, including the eastern United States and Canada west to Manitoba (5-6).

Japanese Hop is an annual or weakly perennial climber (climbing twining vine), growing 3 to 6m high. It has deeply 5- to 7-lobed large leaves with serrate edges and rough surface, with pubescent underside, on a long petiole and prickly stems. The flowers are green spikes. Variegated forms are common.

Hop is dioecious, with separate male and female plants. Male flowers are yellow-green, arranged on 15-25 cm long, narrowly spreading panicles. Female flowers are catkin-like drooping spikes 5 mm in diameter. It is entirely wind-pollinated and a large amount of pollen is produced (1,6). Anthesis is in later July through mid-September in the U.S. and middle Europe, and July into October in China and Korea (1).

Environment

Japanese Hop is primarily a weed of pastures, hayfields, and other non-crop areas. It is found throughout Virginia, Tennessee, North Carolina, and West Virginia of the USA, as well as being widespread in both rural and urban areas of the Far East. It is one of the best twining climbers for screening off fences and other unsightly parts of the garden. Japanese Hop pollens are abundant in the air during the autumn season. In Korea, pollen from this tree is a particularly prominent autumn allergen (7).

In China and Japan this plant is commonly utilised as a tonic for the genito-urinary system. The young leaves and young shoots are cooked and eaten.

Allergens

Proteins of 10, 16, 20, 29 and 42 kDa have been isolated from *H. japonicus* in immunoblot analysis. In sera of *H. japonicus*-reactive patients, a protein of 10 kDa was the most prevalent allergen isolated; occurring in 72% of sera and therefore being classed as a major allergen (8). An earlier study reported isolating 12 IgE-binding components ranging from 13 to 89 kDa. Three protein bands of 13, 74, and 80 kDa were isolated and bound to serum IgE of more than 50% of patients allergic to this pollen (1).

The following allergens have been characterised:

Hum j 1 (9-11).

Hum j 10kD, a 10 kDa protein (2).

Hum j 2, a profilin (4,12).

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the family could be expected (13.) Members of this family include Hemp (*Cannabis sativa*) and commercial Hop (*Humulus lupulus*).

Patients allergic to Japanese Hop pollen were noted to have an associated sensitisation to Hop (*Humulus lupulus*), Celery and Sunflower pollen (14).

Ginkgo pollen, a prominent aeroallergen in Korea, was shown to have a minor degree of cross-reactivity with pollen from Japanese Hop. In patients with IgE antibodies to *Ginkgo* pollen, in inhibitory ELISA tests, IgE binding to *Ginkgo* pollen was inhibited by more than 80% by Oak, Ryegrass, Mugwort, and Ragweed; and 34% by Japanese Hop. In inhibitory immunoblot tests, IgE binding to *Ginkgo* pollen proteins was almost completely inhibited by Oak, Ryegrass, Mugwort and Ragweed, but only partially by Japanese Hop and rBet v 2 from Birch tree pollen (15).

Clinical Experience

IgE-mediated reactions

Japanese Hop is a very frequent cause of symptoms of asthma and allergic rhinitis in sensitised individuals in autumn, in particular in the East. Between 6.1% and 14% of Korean patients with asthma, rhinitis and conjunctivitis attending an allergy clinic have been shown to be sensitised to this allergen, and a similarly high prevalence occurs in China (1,16-20). Recent studies in Korea suggest that sensitisation to this pollen is increasing (4).

Although exposure to pollen from this plant appears to be less prevalent in Europe and the USA, aerobiological studies have detected this pollen in the city of Salamanca, Spain, as well as on the western United States Gulf Coast (21-22).

In Korean apple farmers, Japanese Hop was demonstrated to be a prevalent allergen, although the most common sensitising allergen was European red spider mite (23.2%), followed by *Tyrophagus putrescentiae* (21.2%), two-spotted spider mite (16.6%), *Dermatophagoides farinae* (16.3%), *D. pteronyssinus* (14.4%), and cockroach (13.1%). Twelve percent of the study group were found to be sensitised to Japanese Hop pollen (23).

Other reactions

Humulus japonicus vines are covered with hooked hairs which make working with them painful. Dermatitis and blistering may occur.

Hop (*Humulus lupulus*) f324 are the dried flower heads or the extract of the fruit of another Hop plant and are used in beer manufacture. Respiratory symptoms are common among Hop pickers, who may develop a contact urticaria or dermatitis from the leaves, as well as conjunctivitis and tenosynovitis, which is felt to be irritant rather than allergic, and due to the myrcene oxidation products, humulone and lupulone (1,24-26).

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w207 Lupin

Lupinus spp.

Family: *Fabaceae* (*Leguminosae*)

Common names: Lupin, Lupine

Source material: Pollen

See also: Lupin f335, for information on the seed

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Allergen Exposure

Geographical distribution

Lupin is a pea-like plant cultivated worldwide. Several hundred species of Lupinus are known, most native to the Americas. Many are grown in gardens as ornamentals. The agriculturally important species *L. albus* is native to Europe and has been introduced to other parts of the world, most importantly to the southeastern USA.

The Lupin is an erect annual growing to 1.2 m. The plants are bushy unless in dense stands, and have coarse stems. The leaves are palmate, with 6 to 8 leaflets.

Lupin albus produces white flowers, tinged with blue, from June to July. The flowers are hermaphrodite (have both male and female organs) and are pollinated by insects. The pods are of medium size and generally contain 3 to 5 seeds, which vary in colour from white to brown depending on the variety. *Albus* seeds are white with a flattened, oval shape. The seeds ripen from August to September.

Environment

Lupin is found in cultivated fields, but may escape.

Lupin is cultivated, especially in southern Europe, as an animal feed, ploughed under for its nutrients, and sold in health stores as a food item.

The seed may be cooked and eaten. The seed is also ground into flour and may be mixed with cereal flours for making bread. Some varieties have bitter seeds that contain toxic alkaloids and require leaching before they are eaten, but varieties without alkaloids have been developed. The roasted seeds can be used as a snack in much the same way as peanuts. Edible oil is obtained from the seed. The roasted seed is used as a coffee substitute.

Unexpected exposure

Food allergy, asthma and occupational allergy to Lupin flour (1-2). See Lupin f335 for information on allergy to Lupin seed.

Allergens

No allergens from this plant have yet been characterised. However, it has been demonstrated that stress on Lupin could activate a class-III chitinase, IF3. The protein was detected in the seed, leaves and roots. A thaumatin-like protein was also detected. The authors state that "the ubiquitous presence of this enzyme in healthy, non-stressed tissues of *L. albus* cannot be explained." The pollen was not evaluated for the presence of this allergen (3).

A 2S albumin has been isolated from the seed but not from the pollen as yet (4).

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Fabaceae* (5).

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Lupin; however, few specific studies have been reported to date (6).

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w7 Marguerite, Ox-eye daisy

Chrysanthemum leucanthemum

Family: *Asteraceae* (*Compositae*)

Common names: Marguerite, Ox-eye daisy

Synonym: *Leucanthemum vulgare*

Source material: Pollen

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Allergen Exposure

Geographical distribution

Ox-eye daisy originated in Europe and northern Asia, and is now naturalised as a weed in North America, India, Japan, Australia and other parts of the world. There are about 200 species of Daisy worldwide. It may be grown for its beautiful flowers, but it is also a plague on pastures and crop fields across Europe.

The Ox-Eye daisy is a short-lived, rhizomatous perennial, growing erect 0.6 m to 1 m in height. The leaves are dark and deeply lobed. The lower are spoon-shaped and stalked; the upper are narrower and stalkless or clasping the stem.

The composite flowers are borne at the ends of stems and consist of a central depressed yellow disc, 10 to 20 mm wide, surrounded by petal-like white ray flowers 1 to 2 cm long. Ox-Eye daisy flowers from June to August. The scented flowers are hermaphrodite (have both male and female organs) and are pollinated by insects. The plant is self-fertilising. The plant also reproduces vegetatively with spreading rootstalks.

A vigorous Daisy can produce 26,000 seeds, while smaller specimens produce 1,300 to 4,000. Tests have shown that 82% of the buried seeds remained viable after six years, and 1% were still viable after 39 years.

Environment

The flowers have escaped cultivation and now crowd out other plants on many rangelands. Other common sites are meadows and roadsides.

The Ox-Eye daisy's leaves and flowers are edible. Tea is made from the plant. It is also used as a herbal medication.

Unexpected exposure

Ox-Eye daisy and other *Chrysanthemum* plants contain sesquiterpene lactone, a strong inducer of allergic contact dermatitis, and allergic contact dermatitis associated with photosensitivity (1).

Allergens

No allergens from the pollen of this plant have yet been characterised. Although sesquiterpene lactones are allergens present in the plant and responsible for contact dermatitis, these allergens have not been isolated from the pollen.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a great degree among members of the family *Asteraceae* (*Compositae*) (2). This extensive cross-sensitisation is seen with pollen and other constituents of several members of the *Asteraceae*, *e.g.*, *Matricaria*, *Chrysanthemum*, *Solidago*, Feverfew, Tansy and *Chamomile* (3-6).

A study reported clinical cross-reactivity between *Artemisia vulgaris* and *Matricaria chamomilla*, suggesting the possibility that *Artemisia vulgaris* would be cross-reactive with other *Asteraceae*: *Ambrosia*; *Chrysanthemum*; *Matricaria*; *Solidago*, as cross-reactivity within the family is extensive (7).

Clinical Experience

IgE-mediated reactions

Plants that are insect-pollinated are often thought not to cause allergic symptoms usually associated with pollinosis. However this is not the case with many insect-pollinated plants, in particular Ox-Eye daisy and *Chrysanthemum*, which have been shown to result in pollinosis in *e.g.* *Chrysanthemum* growers (8).

Ox-Eye daisy pollen induces asthma, allergic rhinitis, allergic conjunctivitis and urticaria, particularly as occupational allergies in individuals working with flowers (5). A study from Turkey describes IgE sensitisation and inhalant allergies from Ox-Eye pollen (9).

Other reactions

Pollen from the *Chrysanthemum* genus of plants has also been shown to result in airborne contact dermatitis (10-11).

Ox-Eye daisy and other members of this family, *e.g.* *Chrysanthemum*, are very common and important causes for both occupational and non-occupational contact dermatitis, as a result of physical contact with the plant (3,12-16). *Compositae*-sensitive patients may present a localised dermatitis and, although this is uncommon, sensitisation may occur in early childhood (17).

Non-immunologic contact urticaria has also been described (18).

Triforine, a pesticide frequently used in *Chrysanthemum* nurseries, has been shown to cause delayed-type allergenicity in *Chrysanthemum* growers. Triforine also shows cross-reactivity with Dichlorvos (19).

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Artemisia vulgaris

Family:	*Asteraceae* (*Compositae*)
Common names:	Mugwort, Chrysanthemum weed, Common wormwood
Source material:	Pollen
See also:	Wormwood (*A. absinthium*) w5

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Allergen Exposure

Geographical distribution

Mugwort is native to Europe and Asia, but is now also found throughout the eastern US. It is rare, however, anywhere in the extreme north and south.

The plant is an aggressive, coarse perennial that spreads by persistent rhizomes. It generally reaches a metre or more in height, and has a rather untidy and unattractive appearance. The stem is downy, woody, grooved, and has a slight red tinge. The alternate, pinnate, deeply lobed leaves, 6 to 12 cm long and 3 to 9cm wide, have a pleasant smell when bruised. The foliage resembles that of cultivated *Chrysanthemum*, but can be distinguished by the heavy covering of white/light-gray woolly hairs on the lower leaf surface. Juvenile Mugwort can be confused with Ragweed, but the latter has more finely cut leaves. Mugwort also has a basal rosette of leaves that survives most winters.

Small, greenish-yellow to red-brown flower heads appear from summer to mid-autumn in clusters at the top of the plant, and produce tiny, inconspicuous yellowish-green flowers. The flowers are hermaphrodite (have both male and female organs) and are pollinated by wind.

The fruit is an achene that encloses the seed; however, viable seeds are rarely produced in North America. Seedlings are rarely encountered in the northeastern US. In the southeastern US, where seeds are spread by floods, seedlings are more common.

Environment

Mugwort is most common on rubbish heaps, roadsides, sites of demolished buildings in towns, and a variety of other disturbed situations. It is a problem weed in turf grass, nurseries, and natural areas; but is rarely encountered in cultivated fields. But once introduced to a landscape, Mugwort is difficult to control, spreading by cultivation acivities and encroaching on adjacent areas via rhizomes. It has been grown as an ornamental and a medicinal herb.

Allergens

Various allergens with molecular weights of 10, 14, 20, 28, 46, and 60 kDa have been detected (1).

Allergens characterised to date include:

Art v 1, a 28 kDa protein, a defensin (2-15).

Art v 2, a 20 / 34-38 kDa protein, previously known as Art v II, Ag 7 (8,16-21).

Art v 3, a 9.7-12 kDa protein, a lipid transfer protein (8,13,22-24).

Art v 4, a 14 kDa protein, a profilin, originally known as Art v 3 (1,5,8,25-28).

Art v 5, a 10 kDa protein, a calcium-binding protein (4,8,28-29).

Art v 6, a 42 kDa protein, a pectate lyase and a Amb a 1 homologue (4,8,28).

Art v 60kD, a 60 kDa protein, previously known as Art v I (13,30-31).

Art v 47kD, a 47 kDa protein, previously known as Art v I (13,15,19).

Approximately 79% - 95% of Mugwort-allergic patients are sensitised to Art v 1 (7,10-11). In contrast to other common pollen allergens that contain multiple T-cell epitopes, Art v 1 contains only 1 immunodominant T-cell epitope (10,15).

Earlier studies reported on the IgE-binding capacity of an allergen of 60 kDa (30) and a 47 kDa protein that was able to elicit positive skin specific responses in 70% of the Mugwort allergic individuals (19). Both were termed Art v 1 at one stage. These 2 proteins are no longer designated Art v 1 according to the rules of the IUIS allergen nomenclature subcommittee (32).

Art v 2 was shown to be antigenically identical with the allergen formerly isolated by Nilsen *et al*. and denoted Ag7 (20). Art v 2 bound IgE antibodies from 5 (33%) of 15 sera from patients with clinical allergy against Mugwort pollen and from 13 (52%) of 25 sera from patients selected only on the basis of a RAST-class 4 against Mugwort pollen (17).

In addition to the characterised allergens, Mugwort has been shown to contain many other allergens that will require further elaboration. Caballero *et al*. demonstrated that Mugwort pollen contained 9 allergens ranging from <16 to 65 kDa in size (33). Nilsen *et al*. isolated 15 components with molecular weights of 12 kDa –100 kDa, which bound IgE from sera from 16 Mugwort allergic patients. A 22 kDa component bound IgE antibodies from at least 94% of the sera tested. Five other components of 12, 17, 29, 39 and 42 kDa bound IgE antibodies from 75-94% of the patient sera. Ag 12 was shown to be a 22 kDa protein, and Ag 13 a 61 kDa protein (17).

A Lipid Transfer Protein, 9,7 kDa in size, and with a 43-50% sequence identity with the equivalent allergens of Apple, Peach and Chestnut, has been isolated (24).

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a large degree among members of the family *Asteraceae* (*Compositae*) (34-35). This has been confirmed by *in vitro* and *in vivo* studies. Strong *in vitro* cross-reactivity was demonstrated between nine *Artemisia* species: *A. frigida*, *A. annua*, *A. biennis*, *A. filifolia*, *A. tridentata*, *A. californica*, *A. gnaphalodes*, *A. ludoviciana*, and *A. vulgaris*. Electrophoretic studies showed a great deal of similarity in the bands among the 9 species, and nitrocellulose blots showed similar IgE binding patterns (36). Cross-reactivity was demonstrated between Sunflower and other *Compositae* pollens (Mugwort, Marguerite, Dandelion, Golden Rod, Short Ragweed, and *Chrysanthemum*). Mugwort pollen exhibited the greatest degree of allergenic homology with Sunflower pollen, whereas at the other end of the spectrum, Short ragweed showed fewer cross-reactive epitopes (37-38). Cross-reactivity has also been shown between Camomile-tea extract and pollen from *Matricaria chamomilla* (Camomile), *Ambrosia trifida* (Giant ragweed), and *Artemisia vulgaris* (Mugwort) (39-41). Studies have also demonstrated allergen similarity between Lettuce (*Lactuca sativa*) and Mugwort, both members of the same family (42).

The association between Mugwort and Ragweed pollens will require further studies for exact clarification; an earlier study indicated that there was no cross-antigenicity between Mugwort and Ragweed pollens (43). By contrast, it has been reported that despite the rare occurrence of Ragweed in Middle Europe, a surprisingly high number of patients allergic to Mugwort, a frequently encountered weed, displayed IgE reactivity against Ragweed pollen allergens. By using recombinant Birch profilin and specific antisera for IgE inhibition experiments, profilin was identified as one of the cross-reactive components in Mugwort and Ragweed pollen. In addition to profilin, Mugwort and Ragweed pollen contain a number of cross-reactive allergens, among them the major Mugwort allergen Art v 1. Cross-reactive IgE antibodies can lead to clinically significant allergic reactions (1). Furthermore, Mugwort, Ragweed, and Timothy grass pollen share IgE epitopes with glycoprotein Latex allergens, which confirms the probable cross-allergenicity between Mugwort and Ragweed, and the presence of common epitopes might in part explain clinical symptoms in patients allergic to pollen on contact with Latex (44).

Extensive cross-sensitisation has been reported between pollen from flower plants of this family and pollen of the Amaryllidaceae family (*Alstroemeria* and *Narcissus*). The authors suggest that Mugwort can be used as a screening test for possible flower allergy (38).

Cross-reactivity between Celery and Birch pollen occurs to a greater extent in Central Europe than Southern Europe, where cross-reactivity between Celery and Mugwort predominates (45). Cross-reactivity has also been demonstrated to be common between Mugwort, Celery, Carrot and spices from the *Apiaceae* family (Anise, Fennel, Coriander and Cumin extracts) (Celery-Carrot-Mugwort-Spice syndrome) (46-48).

No panallergen has been identified for the Celery/Mugwort/Carrot/Spice association (49) although various panallergens may be involved in some associations. Three groups of proteins have been identified as responsible for cross-reactivity between Celery and Birch pollen and were shown to be homologues of Bet v 1 and Birch profilin (Bet v 2). Although two of these groups of allergens (profilin and the 46 to 60 kDa proteins) were also present in Mugwort pollen, they were not solely responsible for the cross-reactivity between Celery and Mugwort (1,50-51).

Leitner *et al*. concluded that IgE cross-reactivity in the Mugwort-Birch-Celery-Spice syndrome to the spices Pepper and Paprika was not caused by homologues of Bet v 1 and profilin (52).

IgE binding to all 3 structures in Celeriac extract (Celery) was inhibited by Birch pollen extract, whereas Mugwort pollen extract could only inhibit IgE reactivity to Celery allergens, Api g 4 and common carbohydrate determinants (CCD) (53). Cross-reactivity has also been demonstrated between Mango, Mugwort pollen, Birch pollen, Celery and Carrot by EAST inhibition and immunoblot inhibition studies. The authors suggest that these are due to Bet v 1 and Art v 1, the major allergens of Birch and Mugwort pollen, respectively (54).

Additionally, an association between Mugwort pollinosis and sensitisation to Celery, Carrot, Spices, Nuts, Mustard and Leguminoseae vegetables has been reported (55). The existence of common antigenic epitopes in Pistachio and Mugwort pollen was demonstrated in a Mugwort-allergic patient (56).

Profilin will result in varying degrees of cross-reactivity between Mugwort and other pollen and food containing this panallergen. Profilin is found in Apple, Celery, Carrot and pollen from Birch, Bermuda grass (*Cynodon dactylon*), Johnson grass (*Sorghum halopense*), Meadow grass (*Poa pratensis*), and Short ragweed (*Ambrosia elatior*) (27,57-59). Mugwort also cross-reacts with Poppy seed extract due to cross-reacting homologues of pollen allergens including Bet v 1 and profilin (60). Mugwort cross-reacts with Kiwi, probably as a result of the profilin panallergen (61).

The Lipid Transfer Protein from Artemisia pollen could be expected to cross-react with LTPs from other plants. LTP from Mugwort and from Chestnut seed showed 43-50% sequence identity with the equivalent allergens of Apple and Peach in the first 30 N-terminal residues. A similar degree of sequence identity (50%) was found between the Artemisia and Chestnut proteins. Both isolated LTPs bound IgE antibodies of sera from Rosaceae fruit-allergic patients (24).

Bet v 4, a calcium-binding protein from Birch pollen, was able to drastically reduce IgE binding to proteins of similar molecular weight in pollen extracts from distantly related plant species (e.g. Timothy grass, Mugwort, Lily), but not in extracts from plant-derived foodstuffs (62).

Annual Mercury (*Mercurialis annua*) pollen sensitisation is prominent sensitising in several areas of Spain. A significant but low-antigenic cross-reactivity between *Mercurialis annua* and Olive tree (*Olea europaea*), Ash tree (*Fraxinus elatior*), Castor bean (*Ricinus communis*), Saltwort (*Salsola kali*), Wall Pellitory (*Parietaria judaica*) and Mugwort was demonstrated by several *in vitro* techniques (63).

A monoclonal antibody raised against the high molecular-weight (60 kDa), major Mugwort pollen allergen Art v 1 cross-reacted with moieties of comparable molecular weights in Birch and Timothy grass pollen, as well as in Apple and Celery extracts (31).

IgE binding to Ginkgo pollen was inhibited by more than 80% by Mugwort (and Oak, Ryegrass, and Ragweed). The panallergen Bet v 2 does not appear to be responsible (64).

A high inhibition of IgE binding of Olive pollen extract was exhibited by Birch, Mugwort, Pine, and Cypress pollens, suggesting that these extracts contain proteins which share common epitopes and thus can be recognised by Olive-allergic sera (65).

ImmunoCAP® inhibition experiments demonstrated that Tobacco, Mugwort pollen, and Tomato extracts inhibited the binding of a tobacco-allergic patient's serum to solid-phase tobacco leaf. Tobacco (*Solanaceae* family) is often used as a contact insecticide in gardens (66).

In a pool of 28 individual sera with IgE antibodies to Mugwort pollen and Hazelnut, RAST to Hazelnut was inhibited up to 63% by Mugwort pollen, but the Mugwort pollen RAST was only inhibited up to 36% by Hazelnut. In the SDS-PAGE immunoblotting inhibition Hazelnut partially inhibited all the Mugwort pollen bands, except that with 19 kDa, whereas Mugwort pollen produced a nearly total inhibition of all the Hazelnut allergens. In the isoelectrofocusing immunoblotting inhibition Hazelnut produced a partial inhibition of all the bands of Mugwort pollen and Mugwort pollen partially inhibited all the allergenic bands of Hazelnut (33).

Clinical Experience

IgE-mediated reactions

Mugwort sensitisation and allergy has been reported widely. Mugwort pollen is a major cause of asthma, allergic rhinitis, and allergic conjunctivitis. Exposure to Mugwort pollen contributes to the causation or exacerbation of the Oral Allergy Syndrome, eczema, urticaria; and anaphylaxis where pollen has contaminated a food, *e.g.*, honey (40,56,67-69).

Approximately 25% of Mugwort-allergic patients have reported subsequent hypersensitivity to a variety of foods: (in decreasing order) Honey, Sunflower seeds, Camomile, Pistachio, Hazelnut, Lettuce, Beer, Almond, Peanut, other nuts, Carrot, and Apple (56).

The measurement of IgE antibodies in blood has been reported to be a very useful test for determining sensitisation to Mugwort for epidemiologic studies of inhalant allergic diseases and for mass screening programs (70).

Mugwort is an important cause of sensitisation and allergy in Germany (71). A total of 1,235 children aged 5-6 years from two West and five East German locations were examined by specific IgE tests to a panel of inhaled and oral allergens. Twenty-three percent exhibited at least one positive reaction, and the prevalence of sensitisation to Mugwort pollen was found to be 4.5% (72). Exacerbation of eczema after contact with Mugwort pollen was reported by 10% of patients with sensitisation (69).

Mugwort has also been reported as an emerging aeroallergen in Italy, with sensitisation prevalence increasing (73-74). In a study of respiratory allergens in atopic asthmatic children in the Chieti-Pescara area, 17% of 507 patients were positive on IgE determination to Mugwort (75). Similar findings were reported in another study. Pollen allergy to *Parietaria* was found to be present in 82.02% of pollen-allergic patients, followed by *Gramineae* (32.12%), *Olea* (23.11%), and Mugwort (17.08%). The authors point out that pollinosis differs in northern Italy, the northern Mediterranean area, and the southern coast of France, where allergic sensitisation to *Poaceae* is the most important (76).

The prevalence of sensitisation to Mugwort has also increased in France (77). In the north of France, where no Ragweed grows, Mugwort was reported to be the third most important cause for pollinosis in children after grasses and *Plantago*. Allergen-specific IgE determination in 184 children with allergic symptoms during summer was positive in 21%. Of these, 2 were less than 5 years in age. None of this group were food-allergic (78).

In the central part of Switzerland, pollinosis is mainly caused by pollens of Birch, Alder, Hazel, and Ash trees, and by pollen of grasses and Mugwort. The pollen levels were reported to be highly dependent on geographic and climatic conditions and therefore to vary considerably between different regions in Switzerland (79-80). In 229 predominantly adult patients who demonstrated an immediate-type allergy to one or more specific foods at the Allergy Unit, Zurich University Hospital, 53.3% were also affected by pollinosis. Cross-reactivity between food allergy and Birch or Mugwort pollen was demonstrated by many patients (81).

A study conducted in Murcia, in Spain, reported that 3 consecutive pollen seasons of Artemisia occur each year, related to three different species (*A. campestris*, *A. herba-alba* and *A. barrelieri*), and that winter blooming of *Artemisia* could explain the incidence of subsequent pollinosis in the Murcia area. The *Artemisia* species are highly cross-reactive: hence, this study is relevant from the perspective of cross-reactivity to Mugwort (82). In Salamanca, Mugwort was detected in aerobiological studies, although not found to be one of the most abundant taxa (83). In contrast, *Artemisia* pollen levels recorded in the Iberian Peninsula were the highest recorded in Spain (84).

Mugwort pollen is an important aeroallergen in Poland (67,85). In an examination of the records of 8,576 patients with upper airway allergy, hypersensitivity to weed pollen allergens was found in 12.5%. The most prevalent sensitisation was to Wormwood (86.2%), followed by Mugwort (82.9%). (86) In another study, of 446 patients with pollinosis, 42% were sensitised to Mugwort. In 71% of these, the clinical symptoms appeared only after the age of 20. In half of these patients, the clinical symptoms were not only seasonal but also perennial. Approximately 25% of this group were affected by allergic skin reactions. Eighty percent of Mugwort-sensitised patients were also sensitised to pollen from other *Compositae* plants (87).

In south Hungary, of 642 patients with seasonal allergic rhinitis, 261 underwent specific IgE tests for common allergens, demonstrating that sensitisation had occurred to Poaceae in 84%, Secale in 63%, Ragweed in 63%, and Mugwort in 33% (88).

Mugwort pollen sensitisation has also been reported from Sweden and Finland (89-90). In a Swedish study, involving IgE antibody tests performed on 7,099 adult patients with asthma and/or rhinitis, the proportion of positive tests for Mugwort demonstrated that during a 12-year period, from 1981 to 1992, sensitisation to Mugwort showed a decrease, as compared to other pollen allergens (89).

In central Turkey, 24% of 100 patients with allergic rhinitis and/or asthma were reported to be sensitised to Mugwort (91.) A second study of 1,149 patients diagnosed with asthma from five major cities (Ankara, Izmir, Samsun, Elazig, and Adana), reported that the spectrum of allergen sensitisation included House Dust Mite, pollens, Cockroach, pet animals, and molds in decreasing order of frequency. *Phleum pratense* (Timothy) and *Artemisia vulgaris* (Mugwort) were the most common pollens in all regions (92).

Mugwort sensitisation has also been reported from Japan (93-94). In Hokkaido, positive IgE antibodies in 379 subjects to Artemisia was recorded in 16.9% (95). In 107 patients with nasal allergies in Sapporo, allergen-specific IgE was positive for Timothy grass in 22.4%, in 14.0% for Birch and in 12.1% for Mugwort (96).

Mugwort and Ragweed pollens have been considered to be important respiratory allergens in Korea. These two pollens are abundant in the air of Seoul from August through October (43).

w6 Mugwort

Mugwort is a common weed and an important source of allergens on the subtropical island of Tenerife, in the Canary Islands. It pollinates mainly from July to September, although, due to some local climatic conditions, it may flower throughout the year. Cross-reactivity with Hazelnut, Kiwi, Birch, several Compositae (*Ambrosia*, *Chrysanthemum*, *Matricaria*, *Solidago*) and grass allergens has been suggested (40,97-98).

Other reactions

Two patients sensitised to Mugwort pollen who experienced severe systemic reactions (anaphylaxis and generalised urticaria/ angioedema) due to ingesting honey and royal jelly containing this pollen were reported (99). Anaphylaxis was reported in a 32-year-old atopic patient following the ingestion of a pollen compound prepared at an herbalist's. A few minutes after ingestion, generalised pruritus, diffuse erythema, facial oedema, cough, hoarseness and dysphonia occurred. Analysis of the compound recorded the presence of *Taraxacum officinalis* (15%), *Artemisia vulgaris* (5%) and *Salix alba* (15%) pollens (100).

Artemisia vulgaris is widely used in the Philippines for its anti-inflammatory properties (101).

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Urtica dioica

Family: *Urticaceae*

Common names: Stinging nettle, American stinging nettle, European stinging nettle, Hoary nettle, Hairy nettle

Source material: Pollen

The following five subspecies are currently recognised:

U. dioica subsp. *dioica* (European stinging nettle). Europe, Asia, northern Africa.

U. dioica subsp. *afghanica*. Southwestern and central Asia. (Gazaneh in Iran)

U. dioica subsp. *gansuensis*. Eastern Asia (China).

U. dioica subsp. *gracilis* (Ait.) Selander (American stinging nettle). North America.

U. dioica subsp. *holosericea* (Nutt.) Thorne (hairy nettle). North America

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Allergen Exposure

Geographical distribution

The species is distributed throughout Europe, western Asia and North Africa, and has been introduced in western North America, Australia and parts of South America.

The Nettle is a fast-growing perennial reaching 1.2 m wide by 1 m tall. In *Urticaceae*, the plant grows as a large main stem with leaves in opposite pairs. Leaves are produced from March to November. The leaves are large, dark-green, triangular, coarsely toothed, and covered with poison-filled hairs. The leaves discharge their poison when touched, which results in a burning sensation and then a rash.

The reddish-brown to greenish-white flowers have no petals, are found in dangling clusters at the junction of stems and leaves, and are dioecious (individual flowers are either male or female, but only one sex is to be found on any one plant). The plant is wind-pollinated. Most Nettle species flower from April to October. The pollination mechanism is unusual: When the sun shines on the curly young flowers, the filaments become taut and eventually shoot up so quickly that the pollen is released in a puff. The small green seeds ripen from June to October.

Environment

Nettle is found in open areas and meadows, near buildings, and especially in nitrate-rich soils. Nettle has been used for salads, soups, tea, colouring, as a curdling agent, and in herbal remedies.

Allergens

No allergens from this plant have yet been characterised.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Urticaceae*, *e.g.*, *Parietaria judaica* and *Parietaria officinalis* (1). This however, does not appear to be the general case. RAST inhibition demonstrated the total absence of cross-reactivity between *Parietaria* and *Urtica* (2-3). Ramie (*Boehmeria nivea*), a plant of the *Urticaceae* family, is widely distributed in the Nagasaki area, and is known as a cause of asthma. Yet Ramie and *Parietaria*, examined by an ELISA inhibition test using *P. officinalis* and *P. judaica*, demonstrated no cross-reactivity (4).

Clinical Experience

IgE-mediated reactions

Nettle pollen frequently induces asthma, allergic rhinitis and allergic conjunctivitis (5).

Allergen-specific IgE to *Urtica* has also been detected due to occupational sensitisation (6).

Urticaceae pollen including both *Parietaria* and *Urtica* has been detected in large quantities in aeroallergen studies. It is reported to be the predominant pollen in northwest Spain (7). In Muros, Spain, pollen from this plant comprised 67% of the total aeroallergen load. The proportion of *Urticaceae* pollen found in Muros was the highest among all samples belonging to the Spanish Aerobiology Network (8). Other studies from Salamanca, Cordoba (9), and other parts of Spain (10-12) have documented the importance of this aeroallergen in this country. Urticaceae pollen has also been reported in Italy (13), Poland (14) and Switzerland (15).

Nettle pollen is also an important aeroallergen in England. IgE antibodies to Nettle pollen was found in 13 of 62 patients with a clinical history of summer seasonal respiratory symptoms (16).

Nettle pollen has also been detected in aeroallergen studies in Rochester, New York, Minnesota, (17) Nebraska, (18) and Texas, (19) in Balikesir, Turkey, (20) and in Korea (21).

Other reactions

Stinging Nettle can cause a wide range of cutaneous reactions (22), including Stinging Nettle-induced urticaria (23) and contact urticaria (24) following non-pollen contact with the Nettle plant. Immediate and delayed hypersensitivity reactions to the Nettle plant may also occur (25).

A 57-year-old woman showed symptoms of atropine poisoning after drinking Stinging Nettle tea. Belladonna (Atropa belladonna) was found on investigation to be present in the tea (26).

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w9 Plantain (English), Ribwort

Plantago lanceolata

Family: *Plantaginaceae*

Common names: English plantain, Ribwort plantain, Ribwort

Source material: Pollen

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Allergen Exposure

Geographical distribution

Plants in the genus *Plantago*, commonly known as Plantains, generally have a rosette of basal leaves and flowers on a dense, terminal spike. These green weedy plants are native to Europe and Asia, but now grow practically anywhere in the world. English Plantain is common in most temperate regions, and is considered a troublesome pollen weed in such diverse areas as New Zealand, Mauritania, Italy, Canada, Ecuador, Belgium, Germany, France and the USA.

English Plantain is an erect perennial growing 0.3 m to 0.5 m in height. The leaves are found at the base of the stalk, and are dark green, 5 to 40 cm long, 8 to 25 mm wide, and 3-ribbed, with a smooth, wavy texture. The margins are slightly toothed. The leaves are oblong or lance-shaped, tapering at the base into a slender stalk. The leaf axils are often filled with long brownish cottony hairs.

The plant flowers from April to August. The spike is 2 to 7.5 cm long at the tip of the flower stalks, and each crowded flower has 4 parchment-like petals 3mm long; 4 stamens on hair-like stalks ending in large, cream-coloured anthers; and bracts present under flowers. The flowers are hermaphrodite (have both male and female organs) and are pollinated by wind and insects. The plant is also self-fertilising. English Plantain produces more pollen than the other Plantains. Rugel Plantain has the potential to cause hay fever, but the pollen is produced in such small quantities that it is considered of less importance as an allergen. The seeds ripen from June to September. The 3mm-long seedpods are globe-shaped, dry and papery, and contain 2 seeds. They open by the upper half falling off as a lid. The seeds are boat-shaped, the surface usually shiny, and greenish brown to dark brown.

Environment

Plantain is found on grasslands, roadsides, and cultivated ground. The English Plantain is a troublesome weed; it often invades lawns and gardens.

Unexpected exposure

The leaves and stems are used in salads or for herbal therapies.

Allergens

Initially at least 16 different antigens were detected in Plantain pollen, and at least 6 of these antigens may be allergenic (1). Subsequent studies isolated 3 specific allergens of 17, 19, and 40 kDa (2).

The following allergens have been characterised:

Pla l 1, a major allergen (3-9).

Pla l Cytochrome C, a cytochrome c protein (10).

Pla l CBP, a calcium binding protein (11).

Pla l 1, occurs as 16 to 20 kDa isoforms. Pla l 1 shares a partial sequence identity with Ole e 1. The prevalence of specific IgE to purified Pla l 1 in Plantain-allergic patients was demonstrated to be 86%, and this represents about 80% of the total allergen-specific IgE-binding capacity of the Plantain extract (5).

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Plantaginaceae* (12). However, contrary to the taxonomical inferences, the results of two studies showed that there was little cross-allergenicity between English Plantain pollen and Psyllium (*P. ovata*), closely related members of the same genus (13-14). These studies are contrary to an earlier study which suggested that English Plantain may cross-react to Psyllium (15) thus indicating the presence of both common and species specific allergens.

Cross-reactivity between grass and Plantain pollen is mainly caused by a 30-kDa protein in Plantain pollen. A Group 5 grass pollen allergen is probably responsible for most grass/Plantain cross-reactivity (3).

Pla l 1 and Ole e 1 from Olive tree pollen share 38.7% of their amino acid sequences (5-6,8). The Ole e 1-like family of proteins comprises allergenic members (Fra e 1, Lig v 1, Syr v 1 from Oleaceae species; Pla l 1 from *P. lanceolata*; Che a 1 from *Chenopodium album*; Lol p 11 from *Lolium perenne*; and Phl p 11 from *Phleum pratense*) (16).

A 2 EF-hand calcium-binding allergen from Timothy grass pollen, Phl p 7, has been shown to contain the majority of relevant IgE epitopes among calcium-binding allergens occurring in pollen species of different plants, including ribwort (English Plantain) (11).

Immunoblotting inhibition experiments, performed with extracts of Melon, *P. lanceolata* pollen and *Dactylis glomerata* pollen, showed that all allergens of Melon blotting were almost completely inhibited by grass and *Plantago* pollen extracts. The results support the presence of structurally similar allergens in Melon, *Plantago* and grass pollens, and that all allergenic epitopes of Melon are present in these pollens (17-18).

Sera from subjects diagnosed as allergic to White Cypress Pine, Italian cypress, Ryegrass or Birch pollen were shown to have IgE antibodies that reacted with pollens from these four species and from Cocksfoot, Couch Grass, Lamb's quarters, Wall pellitory, Olive, Plantain and Ragweed. The authors concluded that the presence of pollen-reactive IgE antibodies might not necessarily be a true reflection of sensitising pollen species (19).

Preliminary evidence for cross-reactivity between English Plantain and Paterson's Curse (*Echium plantagineum*) was demonstrated by RAST inhibition studies (2).

A French study reported that Plantain is frequently associated with sensitisation to Latex, but no common allergen was detected (20).

Clinical Experience

IgE-mediated reactions

English Plantain pollen is an important cause of asthma, allergic rhinitis and allergic conjunctivitis, particularly in the temperate regions of North America, Australia and Europe (21-23).

Plantain pollen has been shown to be present in relatively large amounts in Montpellier, in southern France, and was the second most important cause of allergy, after grass pollen allergy, in pollen-allergic patients (24).

Plantago pollen has been found in aerobiological studies of the air of Badajoz (25) and Estepona in the "Costa del Sol" (26) in southwest Spain. Allergen-specific IgE to this pollen was demonstrated in Madrid in allergic individuals with Cupressaceae pollinosis (27). In Salamanca, in a study to evaluate allergy to plant-derived fresh foods among pollen-allergic patients from a Birch- and Ragweed-free area, in 95 pollen-allergic patients, the largest number were sensitised to grass (Lolium and Phleum; 97.9%), followed by tree (Olea; 82.1%) and Plantago (64.2%) (28). The flowering of grasses, along with *Plantago*, occurs earlier and lasts longer in the south than the north of Spain (29). Asthma-related hospital emergencies in Madrid was associated with a lag of 1 day for *Urticaceae*, a lag of 2 days for *Plantago*, and a day lag of 3 days for *Poaceae* (30).

Plantago pollen is also a prominent aeroallergen in Italy, depending on geographical location, as documented in a study involving 80 data-gathering stations and 40 clinical centres nationwide (31).

Several countries in Europe have documented the importance of *Plantago* pollen as an allergen. *Plantago* pollen has been shown to be a prominent allergen in aerobiological surveys in Cordoba, Salamanca and Seville, in Spain (32-34). In the north of France, this plant's pollen was the third most prevalent cause of pollinosis in children (35), and it was one of the most important pollens in Zurich, Switzerland (14,36-37).

In a Polish study involving 22 patients between 13 and 53 years of age with seasonal allergic rhinitis, specific IgE determination demonstrated the importance of English Plantain as an aeroallergen (38). In a second study from this country, in 2,561 patients suffering from upper airway allergy symptoms, hypersensitivity to weed pollen allergens was found in 1,069 patients with pollinosis. In patients sensitised to weeds, the most prevalent allergens were Wormwood (86.2%), Mugwort (82.9%), White Goosefoot (44.3%), and Narrowleaf Plantain (28.8%) (39).

Plantago pollen has also been found in aerobiological surveys in Athens (40), in Balikesir (41) and Bitlis (42) in Turkey, and in the Canary Islands (43). A study measuring specific IgE in patients with allergic rhinitis in south Hungary showed *Plantago* pollen to be an important allergen in sensitisation (44).

In a study of Kibbutz Netzer Sereni, a rural community in Israel, air sampling demonstrated that English Plantain was one of the most prevalent allergenic pollens (45).

English Plantain has also been shown to be a very prevalent allergen in England. In Surrey, 34% of sera from subjects with respiratory allergy had specific IgE to Plantain (46).

In New South Wales, Australia, in 3 populations of schoolchildren aged 8 to 11 years and living in different climatic areas, 95 to 97% of all atopic children were sensitised to one of seven allergens, including English Plantain, House Dust, *Dermatophagoides farinae*, *D. pteronyssinus*, Cat dander, Plantain, Rye grass, and *Alternaria tenuis* (47).

Few studies on English Plantain have emanated from the USA. In St. Louis, Missouri, English Plantain was found to be present but not a prominent problem (48). Similarly, a study of the United States Gulf Coast stated that *Plantago* pollen was very infrequently sampled (less than 0.1% in the air) even though several species were common in the area (49). Similarly, Plantago was detected in Alaska, but in low levels (50-51).

In children with wheezing bronchitis on the small Pacific island of Niue, skin testing and serologic results indicated that hypersensitivity to House Dust mite (*Dermatophagoides pteronyssinus*) and Plantain (*P. lanceolata*) antigens were associated with the wheezing bronchitis (52).

An early study of atmospheric counts of aeroallergens in Tehran, Iran, documented the presence of English Plantain in the atmosphere (53).

Immediate and delayed cutaneous hypersensitivity are believed to be implicated in the physiopathology of atopic dermatitis. A study to evaluate Type I and Type IV allergy to aeroallergens in children with atopic dermatitis reported that of 59 children presenting with this condition and tested with common environmental aeroallergens, 9.8% were sensitised to Plantain pollen (54).

The measurement of allergen-specific IgE antibodies is one method of determining sensitisation to English Plantain. Various diagnostic tests may be required to confirm clinical sensitivity (55).

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Brassica napus

Family: *Brassicaceae* (*Cruciferae*)

Common names: Rape, Rapeseed, Rape seed, Oliseed rape, Rapa

Source material: Pollen

See also: Rape seed (*B. napus*) f316

Brassica napus is a variable species, with three subspecies: *B. napus oleifera* (Rape, Rapeseed etc.) *B. napus napobrassica* (Rutabagas/Swedes) and *B. napus pabularia* (Siberian Kale, Hanover Salad, etc.)

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Allergen Exposure

Geographical distribution

Rape is an annual plant similar to Turnip and Rutabaga. It is thought that *Brassica napus* originated from a hybridisation between the Turnip (*B. rapa*) and Kale (*B. oleracea acephala*). Rape originated in northern Europe and was cultivated in the Mediterranean area, but is now grown throughout the world. Canola, a selected genetic variant of Rape, was developed in the late 1970's in Manitoba, Canada, as a more nutritious source of vegetable oil than Rapeseed.

The Rape plant is an annual/biennial growing up to 1.2 m, with turnip-like flat leaves 10 to 30 cm long, slick, and generally lobed. Unlike Turnips, they have no swollen root, only a thin taproot.

The plant flowers from May to August, producing yellow cross-shaped flowers with four petals. The flowers are hermaphrodite (have both male and female organs) and are primarily insect-pollinated. The plant is also self-fertilising. During the 3- to 4-week flowering period, the crop fields become a conspicuous part of the rural landscape, when bright-yellow flowers are produced and a characteristic odour from the released volatile organic compounds is evident.

The pollen grains are covered with sticky lipoidal substances which result in the grains sticking together. This reduces the ability of the pollen to be airborne for a significant period, and thus this pollen is usually a small fraction of the total atmospheric pollen load. It is possible that dead grains or fragments lacking the sticky coating could become airborne. Sickle-shaped pods containing tiny round seeds are produced.

Environment

Rape is cultivated in fields, but the plant may escape and grow on banks of streams, ditches and fields of other crops.

Rape is grown primarily for green livestock fodder, seed oil (called colza oil), and birdseed. The oil contained in the seed of some varieties of this species can be rich in erucic acid, which is toxic. However, modern cultivars have been selected that produce oil almost free of erucic acid, e.g., canola oil.

Allergens

Characterisation of Rape pollen allergens by immunoblot revealed major allergens of 6/8 kDa and 12/14 kDa, and in the high molecular weight range 33, 42, 51, 58/61 and

70 kDa. These results suggest that Rapeseed pollen is a moderate source of allergy and may sensitise despite low pollen exposure (1).

A second study identified 2 low-molecular-weight allergens of 6/8 kDa and 14 kD as well as a high molecular-weight cluster (27-69 kDa). The 3 groups of allergens were recognised by 50, 34 and 80% respectively of serum of a group of Rape-allergic patients (2). These allergens represent cross-reacting homologues of well-known pollen allergens, *i.e.*, calcium-binding proteins, profilin, and high-molecular-weight glycoproteins (2). The profilin allergens of Rape pollen (6/8 and 14 kDa) could be totally inhibited by Rye pollen and moderately by Birch pollen, while Mugwort had little effect. The 6/8-kDa Rape allergen's binding could effectively be inhibited by rAln g 2, a calcium-binding protein from Alder. Carbohydrate determinants appeared to be involved in IgE binding to the 27- to 69-kDa Rape allergens. Furthermore, Timothy Grass pollen proteins appeared to cross-react with the 27- to 69-kDa cluster. The authors suggest that via cross-reactivity, exposure to Rape pollen may be a prolonging and aggravating factor in underlying Birch and Grass pollen allergy (2).

The following allergens have been characterised:

Bra n 4, a calcium-binding protein, previously known as Bra n 1 (3-7).

Bra n 7, a calcium-binding protein, previously known as Bra n 2 (2,7).

Bra n 8, a profilin (2,8).

Bra n Polygalacturonase, a 43 kDa protein (9).

Bra n Polygalacturonase was recognised by 5 of 18 Rape seed pollen allergic sera (9).

In a study, a patient sensitive to Brassica pollen reacted to a B. rapa pollen-coat protein of 7.5 kDa, a lipid-binding protein (LTP). This suggests that, due to a taxonomical relationship, the presence of LTP in Rapeseed pollen may be possible (10).

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Brassicaceae* (11).

Murphy reports that IgE antibodies, which reacts with most Rapeseed pollen allergens, also cross-reacts with Birch and Grass pollen allergens, which are far more prevalent in the atmosphere than Rapeseed allergens (1-2,6, 12-13). However, Welch *et al.* disagree, stating that the allergens of Rape and Grass pollen, although similar in molecular weights, are immunologically distinct and that there is no evidence of cross-reactivity between them, this study was limited to two subjects but indicates that species specific allergens may exist (14-15).

Rape pollen contains a profilin and a calcium-binding protein allergen, which may result in cross-reactivity between this plant and other non-*Brassicaceae* plants containing these panallergens (2,6,8).

A calcium-binding protein allergen from pollen of Bermuda Grass (*Cynodon dactylon*) also shows significant sequence similarity with the Ca^{2+} binding pollen allergens from Birch (Bet v 4) and Oilseed Rape (Bra n 1) (6). A calcium-binding protein allergen from Olive tree pollen, Ole e 3, exhibits sequence similarity with pollen allergens from Brassica species (16).

Clinical Experience

IgE-mediated reactions

Rape seed pollen (and related irritants) can induce asthma, allergic rhinitis and allergic conjunctivitis (17). It is still unclear whether Rape pollen is a common cause of allergic symptoms, or whether volatile organic compounds from Rape are more frequently responsible for these symptoms.

Early studies indicating a high incidence of Rapeseed allergenicity (18-19) have been challenged by recent studies showing that such allergies are uncommon, even in areas of intense Rapeseed cultivation (1,13,17,20-22). Fell *et al.* reported a low prevalence of allergy to Rape pollen (less than 0.2%), unless subjects were occupationally exposed (20).

Soutar *et al*. took samples from 1,000 randomly chosen adults, general practice patients living in two villages surrounded by Rape fields, and from 1,000 adults from one village far from such cultivation. On a previously validated questionnaire, there were small but significant excesses of cough, wheeze, and headaches in spring in the Rape area (2.3% *vs*. 1.1%, 6.8% *vs*. 4.6%, and 4.8% *vs*. 2.8%, respectively). Counts of Oilseed Rape pollen were generally low except adjacent to the Rape fields. Oilseed Rape was shown to give off terpenes, and these were detected close to fields (21).

In a study of patients with a history of reactions to Rape pollen, only 2 of 23 tested showed evidence of allergy to Rape, and only 10 of 23 tested, including these 2, were shown to be atopic. Eye, nasal, and headache symptoms increased in the Rape season in some patients, validating a previous cross-sectional questionnaire. Twelve of 16 cases tested and 7 of 15 controls showed a seasonal fall in PC_{20}; the fall in the cases was significantly greater than in the controls. However, peak flow charts showed no evidence of a fall or of increased variability during the Rape pollen season. The authors conclude that people who complained of symptoms in relation to the flowering of Rape were rarely allergic to the plant and fewer than half were atopic. Nevertheless, they usually showed increased bronchial reactivity during the season, which may have been due in some cases to other allergens but in others to non-specific irritant effects of the air (23).

These results conflict with those of other studies. In southern and central Sweden, where Rape is cultivated, Rape pollen allergy was reported to occur quite frequently in patients with bronchial asthma and other allergic manifestations. In 366 consecutive patients, IgE antibodies to Rape pollen extracts was found in 23%. Of 54 patients with IgE antibodies to Rape pollen, 81% were positive on Rape pollen provocation tests (18).

In 4,468 patients with suspected inhalant allergy investigated between June 1994 and May 1995, routine skin-prick testing demonstrated Rape pollen sensitisation in 7.1% of those found to be pollen-allergic. Mono-sensitisation was detected in nine patients (1).

Twenty-five residents of a small Scottish village reported symptoms when Rape virtually surrounded the village. Symptoms varied during the growing season of the crop and were at their highest coincident with peak flowering. Increased symptoms were reported by 12 of the subjects, though only 7 of these were judged to be atopic. At the same period of the following year when the crop was absent, symptom reporting was significantly lower. The symptoms were sneezing, cough, headache, and eye irritation. The symptoms did not correlate with levels of Oilseed Rape pollen but there was no clear evidence as to which of the other factors associated with the crop might be the cause (19).

Rape dust, and not pollen, should be considered as an asthma trigger. IgE- mediated occupational asthma was reported in an individual working with Rapeseed in the grain industry (24).

Other reactions

Allergic reactions to Rapeseed and by-products, *i.e*., Rapeseed flour, have been described. See Rapeseed f316 for more information.

More than 22 volatile compounds have been identified as being emitted during the flowering period. The main constituents were the monoterpenes limonene, sabinene, beta-myrcene and alpha-farnesene (a sesquiterpene), linalool (a monoterpene alcohol), and the "green leaf" volatile (E)-3-hexen-1-ol acetate. These compounds constituted between 50 and 87% (mean 68%) of the total volatiles emitted in all of the entrainments carried out with flowering Rape plants. The minor constituents included monoterpenes, sesquiterpenes, short-chain aldehydes and ketones, other "green leaf" volatiles, and organic sulphides, including the respiratory irritant dimethyl disulphide (25-26).

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w16 Rough marshelder

Iva ciliata
Family: *Asteraceae* (*Compositae*)
Common names: Rough marshelder, Rough marsh elder, Annual marshelder, Annual marsh-elder, Sumpweed
Synonym: *I. annua*
Source material: Pollen
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Allergen Exposure

Geographical distribution

Rough marshelder is native to Northern America, in particular to Mexico, and to Nebraska and Texas in the USA. Although some species of the genus Iva have been introduced in other parts of the world, most are found in the North American states of Texas, Louisiana, Mississippi, Oklahoma and Nebraska. Rough Marshelder pollen rivals Ragweed pollen in the Mississippi Delta. Related species are found in Canada and Australia.

Rough marshelder is an annual weed with fibrous roots, and grows up to 2 m in height. It usually reaches half this height. It has an odour like Ragweed and can be mistaken for that weed. The stems are erect, branched, and hairy. The leaves are hairy, opposite, simple, and oval in shape with a pointed tip. They grow up to 15 cm long and 7 cm wide. Each leaf is irregularly toothed.

Flowering occurs from July to October. The flowers are clustered in small heads, each head up to 4 mm long. The heads are in cylindrical spikes in a branched inflorescence, from the leaf axils and terminal. The flowers are green to cream in colour. The flower parts are not discernable with the naked eye. The flowers result in fruits that are 2 to 3 mm achenes, dark-brown, flattened, and with a somewhat triangular shape.

Species of *Iva* differ from species of *Ambrosia*, the Ragweeds, by having only one kind of flower, as opposed to the Ragweeds' pollen-producing flowers in elongated spikes and pistil-producing flowers in short clusters in the axils of the leaves. Rough sumpweed differs from other species in the genus by its rough and hairy leaves.

Environment

Marshelder grows in marshy areas, such as wet meadows, prairies, fallow fields and roadsides, stream banks and the shores of ponds and lakes.

Allergens

No allergens from this plant have yet been characterised.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Asteraceae* (1).

In a study using a fluorescent allergosorbent test, similar antigenic determinants were found between Short and Giant ragweed, Cocklebur, Lamb's quarters, Rough pigweed, Marshelder, and Goldenrod. Cocklebur and Giant ragweed were highly potent in their ability to competitively bind to Short ragweed IgE. The other pollens demonstrated lower potency of cross-reacting antigens (2).

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Rough marshelder; however, few specific studies have been reported to date (3-6).

Of 1,159 patients with asthma and allergic rhinitis attending an allergy clinic in Saudi Arabia who tested positive to one or more inhalants, 23.4% were sensitised to Rough marshelder. The prevalence of sensitisation to this allergen among the 806 Saudi Arabs was 23.4% and among 241 Western expatriates 20.7% (3).

In a study in Westchester County in the state of New York of skin prick tests to 48 aeroallergens in 100 patients referred for allergic rhinitis, 1% had a positive skin prick test for Marshelder (7).

In a study in Michigan in the USA, allergens with positive intradermal wheals after negative prick testing included Cocklebur, Rough marshelder, and Ragweed, all with incidences of 16% to 19% (5).

Other reactions

Contact with the leaves may result in contact dermatitis.

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Salsola kali

Family: *Amaranthaceae* (*Chenopodiaceae*)

Common names: Russian thistle, Prickly saltwort, Prickly glasswort, Tumbleweed

Synonyms: *S. pestifer, S. ruthenica*

Source material: Pollen

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Allergen Exposure

Geographical distribution

Saltwort / Russian thistle originated in Europe and Asia and have become naturalised and common throughout most arid and semiarid regions of the world, including central and western regions of Canada and the United States. It is commonly found on the coasts of Europe, North Africa, Asia and North America and Australia.

Saltwort is a rounded, erect annual, intricately branched, growing from 0.3 to 1 m in height and from 0.3 to 1.7 m in diameter. The stems are ridged and usually red or purple striped. The young plants are fleshy and tender, with narrow, dark-green, and fleshy 15 mm to 5 cm-long pointed leaves. These leaves drop off. The mature leaves are short, broader, stiff, awl-shaped, and tipped with stiff spines.

The plants flower in late summer and autumn. The inconspicuous whitish, green or pinkish flowers are clustered at the base of the leaves along the upper branches. The flowers are hermaphrodite (have both male and female organs) and are pollinated by wind. The winged, 2 mm grey to brownish-yellow seeds are cone-shaped coiled utricles with the coiled embryo visible, and are held in the leaf axils until after plant death. After the seeds mature in late autumn, the plant stem separates from the root, becoming "tumbleweed". The plant is then blown by wind. Seeds fall to the ground as the plant tumbles, and further dispersal is accomplished when wind scatters the winged seeds. These plants are prolific seeders.

Saltwort / Russian thistle is most common along beaches and sandy shores, in cultivated fields, waste places and disturbed grassland and deserts. The largest populations occur in semiarid regions. The weed is often found as a ruderale in Europe.

Environment

Members of the *Amaranthaceae* and *Chenopodiaceae* families, *e.g.*, Russian thistle (*Salsola kali-pestifer*) and Lamb's quarter (*Chenopodium album*), survive in aggressive climatic conditions such as dry summers and mild winters. These species are also cultivated in desert countries such as Saudi Arabia, Kuwait, and United Arab Emirates, as a part of the greening ground programs or to avoid erosion of drained zones. They are also spreading throughout areas of the United States and temperate regions of southern Europe (1).

Chenopod has been reported to cause allergy in desert countries were it is well adapted (2-5). A significant feature of chenopod sensitivity is its concomitant appearance with other pollinoses and probably explains the little attention that this allergy has received (1,6-7).

Allergens

The allergen profile of *Salsola* has been determined but not fully characterised. Three allergens were isolated, with masses of 39 kDa, 42 kDa, and 14 kDa (7). The two larger of these are glycoproteins, and were found to be immunologically identical (8).

An earlier study, utilising human IgE- and IgG-specific antibodies in *in vitro* studies, recognised twenty distinct protein bands of Russian thistle pollen extract. Molecular weights ranged from 12.2 kD to 85 kD. Allergic subjects had differing individual patterns of protein band recognition (9).

The following allergens have been characterised:

Sal k 1, a 43 kDa protein, a pectin methylesterase (10-13).

Sal k 2, a protein kinase homologue (14).

Sal k 8, a profilin (1,15).

Of the 39 individuals with a positive allergen-specific IgE determination to *S. kali*, 26 (66.6%) had detectable IgE antibodies to Sal k 1 (12).

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the families *Chenopodiaceae* (7,16-17) and *Amaranthaceae* (17-18). However, Sal k 1, a pectin methylesterase, does not have a counterpart in the closely related family member, *C. album* (Goosefoot) (13). A minor allergen from Birch pollen also belongs to the pectin methylesterase protein family (19). In addition, an allergenic pectin methylesterase was identified in Kiwi fruit (20).

A significant degree of cross-reactivity has been demonstrated between saffron and *Lolium*, *Salsola* or *Olea* (21).

A significant but low antigenic cross-reactivity between Annual mercury (*M. annua*) and *Salsola kali*, Olive tree (*Olea europaea*), *Fraxinus elatior*, *Ricinus communis*, *Parietaria judaica* or *Artemisia vulgaris* has been demonstrated by several *in vitro* techniques (22).

Clinical Experience

IgE-mediated reactions

Saltwort pollen commonly induces asthma, allergic rhinitis and allergic conjunctivitis in sensitised individuals (18,21,23-24).

In Sicily, 13.7% of 343 allergic patients were shown to be sensitised to *Salsola* pollen. Only one patient was monosensitised (18). In 263 United Arab Emirate nationals with a respiratory disease suspected of being of allergic origin, 45.2% were positive to pollen from the *Chenopodiaceae* subfamily, specifically *Salsola kali* (4).

Salsola also has been shown to be a prominent allergen in Iran. (24, 25)

In Tucson, Arizona, USA, a city that has a high prevalence of allergic rhinitis and asthma, Russian Thistle contributes largely to the overall aeroallergen load (26). *Salsola* pollen has also been found to be an aeroallergen in St. Louis, Missouri, and in other parts of the Midwest, USA (27-28).

Although not the predominant aeroallergen pollen in Spain, *Salsola* pollen has been found in aeroallergen surveys (29).

Other reactions

Russian thistle can cause dermatitis in persons who come into direct contact with it. The dermatitis appears to be due only to mechanical irritation from plant floral bracts, which pierce the skin and stimulate an urticarial reaction (30).

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Atriplex lentiformis

Family: *Amaranthaceae* (*Chenopodiaceae*)

Common names: Lenscale, Scale, Salt bush, Saltbrush, Quail-brush, Quailbush

Source material: Pollen

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Photo: Barbara J. Collins, California Lutheran University

Allergen Exposure

Geographical distribution

Lenscale is native to the temperate and tropical regions of North America, but a few species are grown as ornamentals throughout the world because of their attractive greyish foliage. The different *Atriplex* species are closely related to each other, and consist of annual and perennial weeds and shrubs.

Lenscale is a fast-growing, compact, woody perennial shrub usually growing between 0.15 and 1.5 m in height, but sometimes reaching 3 m. The plant is deciduous in arid areas, but tends to be evergreen elsewhere. Numerous slender and wide-spreading branches contain grey-green, thickish leaves 1.0 to 5.0 cm long and 0.5 to 4.0 cm wide, with a fine, scaly surface.

Lenscale produces inconspicuous yellow flowers from May to August. It is not yet clear whether the flowers are primarily dioecious (plants are male or female) or monoecious (individual flowers are either male or female, but both sexes can be found on the same plant). The plant is wind-pollinated and greatly contributes to the pollen loads of arid regions. These plants have the ability to alter their sexual state from one season to the next in response to environmental conditions. Many seeds are borne on bracts and wind-dispersed. The fruits and seeds mature from September to October.

Environment

Lenscale often occurs along seashores and in other saline soils, especially in arid regions, and has been used for windbreaks, borders, and range management.

All parts of the plant are edible. Native Americans ground this plant's seeds into meal for piñole or porridge, and for an emetic.

Allergens

No allergens from this plant have yet been characterised.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the subfamily *Chenopodiaceae* (1).

Atriplex latifolia, *Beta vulgaris*, *Salsola kali* and *Amaranthus retroflexus* were compared with an extract from *Chenopodium album* by both *in vivo* and *in vitro* methods. The presence of common allergenic determinants was suggested. This implied that as *A. latifolia* is cross-reactive with *A. lentiformis*, cross-reactivity will occur between this plant and other members of the *Amaranthaceae* (2).

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Lenscale; however, no specific studies have been reported to date.

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w18 Sheep sorrel

Rumex acetosella

Family:	*Polygonaceae*
Common names:	Sheep sorrel, Field sorrel, Red sorrel, Common sheep sorrel
Source material:	Pollen
See also:	Yellow dock (*R. crispus*) w23

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Allergen Exposure

Geographical distribution

Sheep sorrel is a perennial herb/weed that originated in Europe and Asia and has become naturalised throughout temperate North America and all other temperate regions across the world. Although grown as an herb, it is also classified as a noxious and invasive weed.

Sheep sorrel is a rhizomatous herb/weed that sometimes forms dense colonies by adventitious shoots from widely spreading roots and rhizomes. Stems are erect, slender, and 10 to 60 cm tall. The arrowhead-like mid-green to dark-green fleshy leaves are 2 to 10 cm long and 1 to 2 cm wide and are situated mostly at the stem base. The leaves are spicy and pungent to the taste and often turn red in autumn.

The plant produces tiny flowers in spring and summer, which are borne in slender, loose, panicled racemes at the end of stalks. The plant is dioecious (male and female flowers are borne on separate plants); male flowers are orange-yellow; female flowers are red-orange. Sheep Sorrel is wind-pollinated, shedding copious amounts of pollen. The pollen is dominant in the autumn. The seed is an achene and is dispersed by wind and insects. Sheep sorrel reproduces by seed or from creeping roots and rhizomes.

Environment

Sheep sorrel is common in lawns, fields, pastures, meadows and waste places, and along roadsides.

Sheep sorrel leaves are used in soups and salads, and can be chewed to quench thirst. They have also been used as herbal medication. Sheep sorrel contains selenium and oxalic acid, both of which can be poisonous in large quantities.

Allergens

No allergens from this plant have yet been characterised.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Polygonaceae* (1).

w18 Sheep sorrel

Clinical Experience

IgE-mediated reactions

Sheep sorrel pollen can induce asthma, allergic rhinitis and allergic conjunctivitis (2-3).

In Poland, examination of the records of 8,576 patients with "upper airway" allergy documented hypersensitivity to weed pollen allergens in 12.5%, the most prevalent sensitisation being to Wormwood (86.2%), Mugwort (82.9%), White goosefoot (44.3%) and Sheep sorrel (19.0%). Hypersensitivity to grass, tree and/or shrub pollens coexisted in 85.5% (2). Sorrel has been shown to also be important pollen in eastern Poland (4).

Sheep Sorrel pollen has also been shown to be a common aeroallergen in London, Leiden, Brussels, Munich and Marseilles (5), as well as in Athens (6) and Zurich (7.) Pollen from the *Rumex* species has been recorded as a significant aeroallergen in Salamanca (8), Murcia (9) and Seville, (10) Spain, but was found to be in low concentrations in the atmosphere in Madrid (11).

Various studies in North America have demonstrated the presence of *Rumex* pollen: in the Tampa Bay area, Florida (12), the Gulf Coast (13), Anchorage, Alaska (14), Philadelphia, Pennsylvania, and Cherry Hill, New Jersey (15). In a study in Westchester County in the state of New York of skin prick tests to 48 aeroallergens in 100 patients referred for allergic rhinitis, 3% had a positive skin prick test for Sorrel (16).

Rumex pollen has been documented as an important aeroallergen in La Laguna City, Tenerife, in the Canary Islands (17) and in Dehra Dun, India (18).

Rumex crispus, a member of the family, was detected in a sandstorm in Riyadh, Saudi Arabia. Sandstorms are potential triggers of asthma (19). Another close relative, *Rumex vesicarius*, has been shown to be an important aeroallergen (20).

Other reactions

Fatal oxalic acid poisoning from Sorrel soup has been reported (21).

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w210 Sugar-beet

Beta vulgaris

Family: *Amaranthaceae* (*Chenopodiaceae*)

Common names: Sugar beet, White beet

Source material: Pollen

See also: Sugar-beet seed (*B. vulgaris*) f227

The main varieties of *Beta vulgaris* are *Crassa*, which is the ordinary garden Beet with a thickened root; *Cruenta*, with a root that is not highly developed but foliage that is large and showy; and *Cicla*, with small-branched roots not thick or fleshy, and with very large, thick-ribbed leaves.

Sugar-beet (*B. vulgaris altissima*)

Spinach-beet (*B. vulgaris cicla*)

Beetroot (*B.vulgaris craca*)

Swiss chard (*B. vulgaris flavescens*)

Sea-beet (*B. vulgaris maritime*)

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Allergen Exposure

Geographical distribution

Sugar-beet is native to Europe and the Middle East, originating in the areas surrounding the Mediterranean Sea following selective breeding of Sea-beet (*Beta vulgaris maritime*). Sugar-beet is cultivated for commercial sugar crops in temperate climates worldwide. About one third of all sugar production in the world is derived from this plant. Sugar-beet contains between 18 and 20% sugar, while the common Beetroot is only about 6% sugar. Sugar-beet sugar is softer than cane sugar and does not crystallise as well as the latter. Cane sugar, unlike Beet sugar, has to be converted into fruit sugar before the body can absorb it.

Sugar-beet is an annual or biennial plant growing to around 1.5 m. The leaves are oval in shape, and dark-green or reddish in colour, frequently forming a rosette at the top of the underground stem. The roots are conspicuously swollen at the junction with the stem.

Sugar-beet flowers in summer. A flowering stalk 1.2 to1.8 m tall is produced in the second year from the top of the tuber. Numerous small green or red flowers are produced in a tall open panicle. The flowers are hermaphrodite (have both male and female organs) and are pollinated by wind. The fruit is an aggregate of 2 or more fruits forming an irregular dry body. Unlike garden Beets, whose roots are usually a deep red colour and may be globular or cylindrical, Sugar-beets have taproots that are white and reach deep into the soil.

Environment

Beets and their relatives are grown throughout the world for human and stock food. The leaves and root are edible, and are also used in herbal medication. Sweetener is extracted.

Plants from this family may contain high levels of nitrates and oxalates. The red colour in Beetroot is largely from betacyanin, a compound closely related to anthocyanin, which accounts for most of the red colours in plants.

Fresh leaf may also cause poisoning due to the 1% oxalic acid content. The leaf may also contain dangerous levels of hydrogen cyanide (HCN) and/or nitrates and nitrites. Betaine acts as a mild diuretic.

Allergens

Using serum of greenhouse workers sensitised to Sugar-beet pollen, the presence of 17 kDa and 14 kDa protein homologues to both the allergens Che a 1 and Che a 2 from Goosefoot / Lamb's quarter (*Chenopodium album*) have been detected in an extract from Sugar-beet pollen (1).

The following allergens have been characterised:

Beta v 1, a 17 kDa protein, a major allergen (1).

Beta v 2, a 14 kDa protein, a profilin, a major allergen (1).

Beta v 1 and Beta v 2 were both detected in 50% of sera of Sugar-beet-sensitised greenhouse workers investigated (1).

Although the allergens from this plant have not yet been fully characterised, 2 proteins have been isolated from Sugar-beet leaves that are related to the family of plant non-specific lipid transfer proteins (nsLTPs) (2). A protein with homology to the chitin-binding (hevein) domain of chitin-binding proteins, *e.g.* class I and IV chitinases, has been isolated from the leaves of Sugar-beet, but may be stress-induced (3-4).

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the subfamily *Chenopodiaceae* (5). Cross-reactivity among *Chenopodiaceae* and *Amaranthaceae* should be considered, as common allergenic determinants are present in both families (6).

Beta v 1 was reported to most likely be a homologue to the 17 kDa Che a 1 allergen from *Chenopodium album* (not confirmed) (1). Che a 1 is known to display a very low cross-reactivity with Ole e 1 as well as with Pla l 1 (7).

Beta v 2, a profilin, may result in cross-reactivity with other profilin-containing plants (1).

A novel gene has been isolated from a Sugar-beet cDNA library. The expression of this gene was enhanced in the root of the Beet plant. The protein encoded by this gene was found to resemble members of the latex allergen Hev b 5 family (8). The clinical significance of this is not clear yet, but cross-reactivity between Beet and other plants containing a Hev b 5-like protein will need to be considered.

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Sugar-beet; however, few specific studies have been reported to date in spite of reports in the literature which suggest that Sugar Beet pollen is highly antigenic (1,9-10).

Out of 31 greenhouse workers at a sugar beet seed station, 24 experienced work-related symptoms and several showed positive skin prick tests and IgE antibodies to sugar beet pollen. Serum samples from 15 individuals were evaluated. Of these 15, 7 had IgE antibodies against sugar beet pollen extract. All 7 plus one more showed a positive reaction in skin prick test and all these individuals had work-related symptoms of allergy. Of the 7 individuals that had specific IgE against sugar beet pollen extract, 6 also scored positively for *Salsola*, five for *Atriplex*, and two for *Chenopodium*, with values that were 2–5 fold lower than for sugar beet pollen (1).

A 29-year-old man with a history of atopic dermatitis developed both contact dermatitis and allergic rhinitis from Sugar-beet pollen through his job in a seed nursery (11).

Other reactions

A patient with occupational asthma in the Beet sugar processing industry is described in a report. Symptomatology, skin testing, immunologic testing, and specific bronchoprovocation testing indicated exposure to mouldy Sugar-beet pulp, and not Beet pollen, as the cause of the patient's occupational asthma (12).

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w204 Sunflower

Helianthus annuus

Family:	*Asteraceae* (*Compositae*)
Common names:	Sunflower, Common sunflower
Source material:	Pollen
See also:	Sunflower seed k84

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Allergen Exposure

Geographical distribution

The Common sunflower is a plant from which we obtain Sunflower oil and seeds. There are two other species of Sunflower, which are not food-related: *H. debilis* (Sunflower), and *H. decapetalus* (Perennial sunflower). *H. debilis* is a more slender plant, much branched, with rough, reddish stems.

The Sunflower is native to Central America but is now grown, mostly for its oilseeds, in many semi-arid regions of the world from Argentina to Canada and from central Africa into the Soviet Union. The leaves are usually used as fodder, and may be grown for this purpose alone, particularly where the season is too short and cool for maize.

The Common sunflower is an annual, broadleaf plant with a tall hirsute stem, often un-branched, growing to 3m at a fast rate and bearing a single yellow, circular, large flower with a black centre. The leaves are hairy, oval-shaped, 10 to 30 cm long and 5 to 20 cm wide.

The flowering head is at the terminal end of the main stem, 10 to 40 cm in diameter, rotating to face the sun (heliotropism), and sometimes drooping. Sunflower heads consist of 1,000 to 2,000 individual flowers joined together by a receptacle base. The large petals around the edge of a head are actually individual ray flowers. Pollination and seed development begin at the periphery of the grain head and move toward the centre. Flowers are produced through summer and autumn and are hermaphrodite (have both male and female organs). The plant may produce smaller heads on lateral branches. Insects pollinate the plant. The plant is self-fertilising.

The seeds ripen from September to October; a process usually completed about 30 days from the time the last flower is pollinated. The angular seeds are up to 6mm long, and are spirally arranged and densely packed in the flat, terminal head. The seeds are variable in size, and single-coloured or striped.

Environment

Sunflowers may escape from cultivation and occur on roadsides and wastelands.

Uses: For oil, coffee, flowers and edible seeds in various uses.

w204 Sunflower

Allergens

Four allergens have been detected in Sunflower pollen, with molecular masses of 32, 24, 55, and 55 kDa. Cross-reactivity among the four allergens was very high, and each allergen recognised IgE in a high proportion of patients sensitised to Sunflower pollen (1.)

Thirteen Sunflower-allergic patients with allergen-specific IgE values ≥ 0.7 kU_A/l showed 2 IgE-binding fractions at 34.0 and 42.8 kDa in 65% of sera and 3 IgE-binding fractions at pI 4.9, 9.6 and 10.2 in 54% of sera. A 34-kDa major allergen was purified (2).

The following allergens have been characterised:

Hel a 1 (2-3).

Hel a 2, a profilin (3-8).

Sunflower seed contains a 2S Albumin storage protein allergen, but this has not been detected in Sunflower pollen.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Asteraceae* (*Compositae*) (9).

Cross-reactivity has been demonstrated, by allergen-specific IgE and immunoblotting inhibition experiments, between Sunflower and other *Asteraceae* pollens: Mugwort, Marguerite, Dandelion, Golden Rod, and Short ragweed. Mugwort pollen exhibited the greatest degree of cross-reactivity with Sunflower pollen, whereas at the other end of the spectrum, Short ragweed showed less cross-reactivity (10).

The major allergen Hel a 1 shows cross-reactivity with other aster members (11).

Cross-reactivity with other non-*Asteraceae* plants can be expected, due to the presence of the panallergen profilin, Hel a 2 (3,12-13). Sunflower profilin is cross-reactive with profilins from Short ragweed, Mugwort, Olive, and *Annual mercury* (6).

Sunflower pollen does not significantly cross-react with Sunflower seed (14).

Clinical Experience

IgE-mediated reactions

Sunflower pollen is a cause of asthma, allergic rhinitis and allergic conjunctivitis, and is an important occupational allergen in areas where Sunflower is grown (2,15-18).

Sunflower pollen is a particularly significant aeroallergen in Korea (19). In the Ukrainain area, Kievites pollinosis (seasonal fever) in most cases is caused by *Ambrosia*, Sunflower and Dandelion pollen (12).

A study describes a 24-yr-old man who developed rhinitis and conjunctivitis over 5 years of occupational exposure to Sunflower pollens, and asthma which developed during the fifth year. All respiratory and ocular symptoms disappeared after he was removed from exposure, but he had a food-allergic reaction while he was eating honey containing 30% Sunflower pollens (8).

"Concealed" Sunflower pollen is a special problem, as illustrated by a report of a 22-year-old woman who developed rhinitis, nasal congestion, tearing, and facial and generalised urticaria to Sunflower pollen concealed in a commercial product of shelled Sunflower seeds (20).

Sunflower pollen has high allergenic potential, especially from close contact in occupational settings. In a study of 102 individuals working in a Sunflower processing plant, 23.5% were found to be sensitised to Sunflower pollen. (21)

Other reactions

In the case of 23 patients allergic to honey, including Sunflower honey, with symptoms ranging from itching in the oral mucosa to severe systemic symptoms to anaphylactic shock, proteins derived from secretions of pharyngeal and salivary glands of honeybee heads, along with pollen proteins, were found in the honey. The former were responsible for causing specific allergic reactions to honey (22). Some allergic symptoms may be due to the actual Sunflower pollen present in the honey (23, 24).

Although allergic symptoms and anaphylaxis can occur to Sunflower seeds (25) (see: Sunflower seed k84), occupational asthma may result from contact with Sunflower seed dust. This needs to be differentiated from Sunflower pollen, which contains different allergens (26).

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w21 Wall pellitory (*P. judaica*)

Parietaria judaica

Family: *Urticaceae*

Common names: Wall pellitory, Pellitory-of-the-wall, Parietaire, Spreading pellitory, Asthma weed, Sticky-weed

Source material: Pollen

See also: Wall pellitory (*P. officinalis*) w19

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Allergen Exposure

Geographical distribution

Wall pellitory is a common weed around the Mediterranean and along the West coast of Europe as far north as central England. It is found in Spain, Greece, Italy and Israel, and has been introduced in other parts of Western Europe and in Australia and Argentina. Two closely related species are found in the US and one in Brazil.

The genus *Parietaria* has about 10 species, which are highly cross-reactive to each other. *Parietaria* pollen allergens (*officinalis*, *judaica*, *lusitanica*, *creatica*) are one of the most common causes of pollinosis in areas where the plants grow. A close correlation exists between the species *P. judaica* and *P. officinalis*. In some geographical areas one species may dominate, and IgE antibodies to only one of the species can be found in sensitised individuals.

Parietaria judaica is a sprawling, many-branched, bushy perennial weed, with brittle, reddish stems. It grows from 30 to 100 cm. The leaves are 3 to 12 cm long and oval in shape, with hairs on the veins on the lower surface. The leaves of *P. judaica* (w21) are about 5 cm shorter than those of *P. officinalis* (w19).

The inconspicuous green stalkless flowers are clustered in the leaf axils. They are dioecious (individual flowers are either male or female, but only one sex is to be found on any one plant). In many countries the Wall pellitory flowers all year round but with distinct peaks in spring and around November. In some areas, Wall pellitory may flower only from early summer to late fall. This plant is pollinated by wind.

Environment

The plant lives preferably on walls (hence the name), rocks, banks, and hedgebanks. Wall pellitory may be used for medicinal purposes.

Allergens

The following allergens have been characterised:

Par j 1, a 12 kDa lipid transfer protein (1-26).

Par j 2, a 9 kDa lipid transfer protein (1,4-8,11,17,26-32).

Par j 3, a 14 kDa profilin (1,5,33-36).

Par j 4, a calcium binding protein (1,26,37-38).

A glucanase has been isolated from *P. judaica* pollen (39).

Par j 1 and Par j 2 are major allergens, both considered as non-specific lipid transfer proteins (4-6).

Two isoforms of Par j 1.0101 have been isolated and named Par j 1.0102 (a 14,7 kDa protein) and Par j 1.0201 (a 10,7 kDa protein). These proteins represent isoallergenic forms of the major allergen Par j 1.0101. These isoform allergens demonstrated a 98% and 89% amino acid sequence homology, respectively, with Par j 1.0101 (19). The epitope of the major allergen Par j 1.010 is also present on the Par j 2.0101 major allergen, representing a common IgE epitope. It is an immunodominant epitope, since it was capable of inhibiting 30% of all specific IgE against the *Parietaria judaica* major allergens (18).

Par j 1, a major allergen, induces IgE responses in 95% of *P. judaica*-allergic patients (2).

Par j 2.0101, a major allergen of *Parietaria judaica*, has been characterised and binds with IgE of 82% of *P. judaica*-allergic individuals (3).

A profilin has also been detected in *Parietaria judaica* pollen, but the allergen has not been fully characterised (40).

The IgE-binding epitopes of rPar j 2, a major allergen of *Parietaria judaica* pollen, are heterogeneously recognised among allergic subjects. At least four putative IgE-binding epitopes were identified (31).

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Urticaceae* (41). However, for *Parietaria* crossreactivity with other family members of different genera does not appear to be the case in general. RAST-inhibition demonstrated the absence of cross-reactivity between *Parietaria* and *Urtica* (42-43). Also, utilising an ELISA inhibition test, no cross-reactivity could be demonstrated between Ramie (*Boehmeria nivea*), a member of the *Urticaceae* family, a weed widely distributed throughout Japan and Southeast Asia, and *Parietaria* (*P. officinalis* and *P. judaica*) (44).

Extensive cross-reactivity occurs in the *Parietaria* genus. Par o 1 (13.5 kDa) and Par j 1 (12 kDa), the major allergens from *Parietaria*, are highly cross-reactive, and a high homology has been shown between *P. judaica* (Par j 1), *P. officinalis* (Par o 1), *P. lusitanica* and *P. mauritanica* (Par m 1) (20,45).

Although a profilin has not been characterised in *Parietaria* plants, by inference they must contain profilin (40). Significant but low antigenic cross-reactivity has been demonstrated among *Mercurialis annua*, *Olea europaea*, *Fraxinus elatior*, *Ricinus communis*, *Salsola kali*, *Parietaria judaica* and *Artemisia vulgaris* by several *in vitro* techniques (46). *Parietaria* profilin shows only limited cross-reactivity with Birch and grass profilins. Less than 50% of patients sensitised to Birch and grass profilin cross-react to *Parietaria* profilin (34).

Sera from subjects sensitised to White Cypress, Pine, Italian cypress, Ryegrass or Birch pollen were shown to have IgE antibodies that reacted with pollen from these and from Cocksfoot, Couch Grass, Lamb's quarter, Wall pellitory, Olive, Plantain and Ragweed. The authors conclude that the presence of pollen-reactive IgE antibodies may not necessarily be a true reflection of sensitising pollen species (47).

The recombinant *Juniperus oxycedrus* pollen allergen rJun o 2 (*Cupressaceae* family) has a significant sequence similarity to the calcium-binding proteins called calmodulins, and immunoblotting inhibition tests demonstrated that *J. oxycedrus*, *J. ashei*, *Cupressus arizonica*, *C. sempervirens*, *Parietaria judaica*, *Olea europaea*, and *Lolium perenne* pollen extracts were able to inhibit IgE binding to blotted rJun o 2 (48). The inference is that that if close cross-reactivity occurs between *Juniperus oxycedrus*, other members of the *Cupressaceae*, and *Parietaria judaica*, then the possibility exists that these pollens may affect individuals sensitised to *Pareitaria judaica* (and *Pareitaria officinalis*).

Sensitisation to pistachio is common in *Parietaria allergy* (49).

w21 Wall pellitory (*P. judaica*)

Clinical Experience

IgE-mediated reactions

Wall pellitory pollen has been recognised as an important allergen, causing symptoms of asthma, allergic rhinitis and allergic conjunctivitis (50-58). Allergy to *Parietaria* has been increasing (59).

Rhinoconjunctivitis and bronchial asthma, alone or in association, represent the most common clinical manifestations of this allergy. The season in which patients experience clinical symptoms is prevalently spring. However, many people show a multiseasonal pattern. Studies have indicated that many *Parietaria*-allergic patients are monosensitised (60-61).

In children, sensitisation to *Parietaria* is low, but becomes the most frequent cause of sensitivity as individuals grow older. (54,56).

In some parts of the world, *e.g.*, Catalonia, Spain, and the Balearic Islands, this pollen is present practically all year round (54,56).

Parietaria allergy is strongly associated with Mediterranean countries, and in particular with Greece and Italy (62-63).

Various studies from Italy have recorded a high prevalence of sensitisation to *Parietaria* pollen. *Parietaria* is responsible for 60% to 65% of hay fever pollinosis in Italy: approximately 8% in Northern Italy, 32% in Central Italy, and up to 70% in Liguria (64-66). In Rome, 39.8% of 1,612 subjects with respiratory allergy were shown to be sensitised to *Parietaria* (67).

Allergen-Specific IgE determination in 2,934 consecutive outpatients with respiratory pathology of suspected allergic origin in 21 centres across Italy showed that 28.2% were positive to at least one of the pollens in the panel tested for, which included *Parietaria*, and that the prevalence of individual pollen species was related to geographical area (68).

Although sensitisation to *Parietaria* is less prevalent in children, it is still significant. In a survey of 600 atopic children (3 to 12 years old) in Naples, 9.9% were sensitive to the pollen of *P. officinalis*, compared to 30.8% of 1,400 atopic adults (69). This study is also relevant because of the high degree of cross-reactivity between this plant and *P. judaica*. In a study of 507 asthmatic atopic children in the Chieti-Pescara area of Italy, allergen-specific IgE investigation for 12 common aeroallergens found that 23% of 507 patients were positive to *Parietaria* (70). In Naples, allergy to *Parietaria* as an isolated allergen or in association with other allergens was recorded in 82.02% of pollen-allergic patients (71). In San Remo, 41.8% of 5,481 patients where shown to be clinically sensitised to *P. officinalis* pollen (72), and by inference, probably to *P. judaica*. In *Parietaria*-polysensitised patients, *Gramineae* were the most frequently associated allergens (84.8%), followed by *Olea Europaea* (41.1%), *Dermatophagoides farinae* (37.4%) and *Dermatophagoides pteronyssinus* (36.2%) (56).

Parietaria pollen is also the most common weed pollen in the Aegean region of Turkey; 52% of 132 patients with allergic rhinitis were positive to *Parietaria* on specific IgE testing; seven of these (10%) were monosensitised. Fifty-six out of 69 patients (81%) had serum IgE antibodies to *Parietaria* pollen (73).

Studies from Spain have produced similar findings. In Catalonia and the Balearic Islands, *Parietaria* pollen is present throughout the year. Sensitisation to *Parietaria* in children is reported to be low, but becomes the most frequent cause of sensitivity as the patients grow older (54). In a survey, allergy to *Parietaria* allergy was detected in 25% of a group of allergic patients (53). Patients exclusively sensitive to this pollen have been described, indicating high allergenic specificity of *Parietaria* (74). High amounts of *Parietaria* pollen have also been recorded in aerobiological studies in Salamanca (75) and in Bilbao (76).

In the southern part of Switzerland (Canton Ticino), 18% of 503 consecutive patients with hay fever were shown to be sensitised to *Parietaria* using specific IgE tests (77). The south of France also has a high prevalence of allergy to *Parietaria* (78).

Parietaria pollen sensitisation is high in Split, Croatia (79). Sensitisation to *P. officinalis* pollen alone was found in 52.5% of hay fever pollinosis patients, whereas 12.5% of patients were allergic to both *P. officinalis* and grass pollen. Thus, over 65% of this population of hay fever pollinosis patients are allergic to *P. officinalis* pollen. Further studies in Croatia have recorded that of 4,116 atopic patients with respiratory symptoms, 38.8% were allergic to various pollen allergens, and that of these, 62.5% were sensitised to *Parietaria* pollen (61). In Dubrovnik, the far south of Croatia, *P. officinalis* sensitisation is as high as 92.3% of atopic patients (80), but this decreases towards the north of the Adriatic, reaching 35.1% in Istria (81).

Parietaria judaica, although native to the UK, has not usually been considered to be of any clinical importance. Holgate *et al*. demonstrated, using IgE antibody tests, that 8 of 62 patients with a clinical history of summer seasonal respiratory symptoms were sensitised to this plant. Five of these 8 had never visited the Mediterranean area, and therefore it is possible that sensitisation occurred in the U.K (82).

Similarly in the USA, 8% of 100 grass-sensitive patients who suffered from seasonal respiratory allergy were found by IgE antibody tests to be sensitised to *P. judaica* and *P. officinalis* (83).

The antibody response to the major allergen from the pollen of *Parietaria* on the part of allergic patients from three European populations was shown to be associated with HLA-DRB1*1101 and/or 1104. The data suggested that this association is stronger in subjects monosensitised to *Parietaria* (84-86).

The measurement of serum-specific IgE has been shown to be specific and reliable in determining sensitisation to *Parietaria* (87-88).

Other reactions

Although the allergens in pollen may generally be different from those of the rest of the plant, in the case of *Parietaria judaica* and *Dactylis glomerata* plants, the allergenic components are present throughout most of the plant: most highly concentrated in the pollen but present in the leaves and in trace amounts in the stems (89).

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w19 Wall pellitory (*P. officinalis*)

Parietaria officinalis

Family: *Urticaceae*

Common names: Wall pellitory, Pellitory-of-the-wall, Parietaire, Spreading pellitory, Lichwort, Hammerwort

Source material: Pollen

See also: Wall pellitory (*P. judaica*) w21

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Allergen Exposure

Geographical distribution

Wall pellitory is a common weed around the Mediterranean and along the west coast of Europe as far north as central England. It is found in Spain, Greece, Italy, Israel, and has been introduced in other parts of Western Europe and in Australia and Argentina. Two closely related species are found in the US and one in Brazil.

The genus *Parietaria* has about 10 species, which are highly cross-reactive to each other. *Parietaria* pollen allergens (*officinalis*, *judaica*, *lusitanica*, *creatica*) are one of the most common causes of pollinosis in areas where the plants grow. A close correlation exists between the species *P. judaica* and *P. officinalis*. In some geographical areas one species may dominate, and IgE antibodies to only one of the species can be found in sensitised individuals.

Parietaria officinalis is a sprawling, many-branched, bushy perennial weed, with brittle, reddish stems. It grows from 30 to 100 cm. The leaves are 8 to 17 cm long and oval in shape, with hairs on the veins on the lower surface. The leaves of *P. judaica* (w21) are about 5cm shorter than those of *P. officinalis* (w19).

The inconspicuous green stalkless flowers are clustered in the leaf axils. They are dioecious (individual flowers are either male or female, but only one sex is to be found on any one plant). In many countries the Wall pellitory flowers all year round but with distinct peaks in spring and around November. In some areas, Wall pellitory may flower only from early summer to late fall. This plant is pollinated by wind.

Environment

The plant lives preferably on walls (hence the name), rocks, banks, and hedge banks. Wall pellitory may be used for medicinal purposes.

Allergens

The following allergen has been characterised:

Par o 1; a major allergen of *Parietaria officinalis* (1-11).

Par o 1 (13.5 kDa) and Par j 1 (12 kDa), the major allergens from *Parietaria*, are highly cross-reactive (5). In this event, it may be that Par o 1 is a lipid transfer protein, in lieu of Par j 1 being one.

A profilin has also been detected in *Parietaria judaic*a pollen, but the allergen has not been fully characterised (12). As a high degree of cross-reactivity exists between this plant and *P. officinalis*, it is likely that the latter also contains a profilin.

See also the more extensively studied and highly cross-reactive Wall pellitory w21.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Urticaceae* (13). However, for *Parietaria* cross-reactivity with other family members of different genera does not appear to be the case in general. RAST-inhibition demonstrated the absence of cross-reactivity between *Parietaria* and *Urtica* (14-16). Also, utilising an ELISA inhibition test, no cross-reactivity could be demonstrated between Ramie (*Boehmeria nivea*), a member of the *Urticaceae* family, a weed widely distributed throughout Japan and Southeast Asia, and *Parietaria* (*P. officinalis* and *P. judaica*) (17).

Extensive cross-reactivity occurs within the *Parietaria* genus. Par o 1 (13.5 kDa) and Par j 1 (12 kDa), the major allergens from *Parietaria*, are highly cross-reactive, and a high homology has been shown between *P. judaica* (Par j 1), *P. officinalis* (Par o 1), *P. lusitanica* and *P. mauritanica* (Par m 1) (18-19).

Although a profilin has not been characterised in *Parietaria* plants, by inference they must contain profilin (3). Significant but low antigenic cross-reactivity has been demonstrated among *Mercurialis annua*, *Olea europaea*, *Fraxinus elatior*, *Ricinus communis*, *Salsola kali*, *Parietaria judaica* and *Artemisia vulgaris* by several *in vitro* techniques (20). *Parietaria* profilin shows only limited cross-reactivity with Birch and grass profilins. Less than 50% of patients sensitised to Birch and grass profilin cross-react to *Parietaria* profilin (21).

Sera from subjects sensitised to White cypress, Pine, Italian cypress, Ryegrass or Birch pollen were shown to have IgE antibodies that reacted with pollen from these and from Cocksfoot, Couch Grass, Lamb's quarter, Wall pellitory, Olive, Plantain and Ragweed. The authors conclude that the presence of pollen-reactive IgE antibodies may not necessarily be a true reflection of sensitising pollen species (22).

The recombinant *Juniperus oxycedrus* pollen allergen rJun o 2 (*Cupressaceae* family) has a significant sequence similarity to the calcium-binding proteins called calmodulins, and immunoblotting inhibition tests demonstrated that *J. oxycedrus*, *J. ashei*, *Cupressus arizonica*, *C. sempervirens*, *Parietaria judaica*, *Olea europaea*, and *Lolium perenne* pollen extracts were able to inhibit IgE binding to blotted rJun o 2 (23). The inference is that that if close cross-reactivity occurs between *Juniperus oxycedrus*, other members of the *Cupressaceae*, and *Parietaria judaica*, then the possibility exists that these pollens may affect individuals sensitised to *Pareitaria judaica* and thus also to *Pareitaria officinalis*.

Sensitisation to Pistachio is common in *Parietaria* allergy (24).

This study describes two patients with allergic rhinitis and positive skin prick tests to *Parietaria* and Beet only. Laboratory assays showed beet-specific IgE antibodies in the sera of both patients and possible cross-reactivity between *Parietaria* and Beet in one patient (25).

A study investigating immunological cross-reactivity between Par o 1 and the VP4 protein of rotavirus, the main etiological agent of gastroenteritis in children, found that antibodies specifically binding Par o 1 were extensively cross-reactive with RRVP4 (2).

Clinical Experience

IgE-mediated reactions

Parietaria pollen can induce asthma, allergic rhinitis and allergic conjunctivitis (5,26-27).

For further information see the more extensively studied and highly cross-reactive Wall pellitory w21 (*Parietaria judaica*).

In vitro determination of IgE antibodies to *P. officialis* is a tool in detection of *Parietaria* sensitisation (28).

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Ambrosia psilostachya

Family:	*Asteraceae* (*Compositae*)
Common names:	Western ragweed, Perennial ragweed
Source material:	Pollen
See also:	Common ragweed (*A. elatior*) w1, Giant ragweed (*A. trifida*) w3

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Allergen Exposure

Geographical distribution

Western ragweed is found across most of North America, including northern Mexico. Its range is extensive but its incidence is only significant in the Great Plains and Great Basin in the US. It is also common in Australia and Mauritania.

Western ragweed is an erect, coarse herbaceous perennial with a creeping rootstock. The leaves are soft, green and opposite or alternate. The leaves are deeply pinnately lobed, hairy, and with irregularly toothed margins. Its foliage is similar to that of False ragweed, but its burs are shaped like those of Giant ragweed. Unlike Ragweed and Giant ragweed, Western ragweed can reproduce vegetatively from creeping roots (rhizomes), which often gives it a straight-line pattern across lawns and waste areas.

Western ragweed flowers from July to November. It is wind-pollinated, releasing millions of pollen grains into the air. However, the presence of the pollen in honey indicates some insect pollination. The plant is monoecious (male and female organs are separate, but occur on the same plant), with the staminate (pollen-producing) heads at the leafless tips of the branches, and the single-flowered pistillate (seed-producing) heads clustered lower down. The fruits are small burs, with the involucre, sometimes slightly spiny or beaked, enclosing the fruit.

Western ragweed is not as large or as abundant as the Ragweed of the more eastern parts of the continent, and is therefore less of an allergy problem.

Environment

Western ragweed occurs on plains, dry fields, meadows and prairies, but also along roadsides and in waste places. It spreads rapidly and becomes a pest, especially when it invades cultivated lands and pastures. If dairy cows eat it, their milk becomes bitter.

Unexpected exposure

The leaves of the plant are used in herbal medications. A tea made from the roots is used as a herbal remedy. The pollen is harvested commercially and manufactured into homeopathic preparations for the treatment of allergies to the plant.

Allergens

The following allergen have been characterised:

Amb p 5 has been characterised (1-3).

Ragweed pollen contains a profilin, though this allergen has not been characterised (4-5).

Potential cross-reactivity

With the use of a serum pool from patients sensitive to Short ragweed, the cross-reactivity of IgE antibodies to six Ragweeds was studied through the radioallergosorbent test. Extracts were analysed for their inhibitory activities, with solid-phase allergens prepared from all of the Ragweed pollens. Also, samples of serum were absorbed with the various solid-phase allergens and the reactivity of the remaining IgE antibodies was determined. Two patterns of reactivity were observed. Short, Giant, Western, and False ragweeds displayed comparable reactivity in both inhibition and absorption experiments. Slender and Southern ragweed were considerably less active, indicating that they lacked allergenic groupings possessed by the other species. These same patterns of cross-reactivity were found using Ragweed pollens from four commercial sources (6).

Further cross-reactivity among the various Ragweeds can be inferred due to the high cross-reactivity among various other members of the genus Ambrosia and of the family Asteraceae. For example, cross-reactivity among Chamomile tea extract, pollen of *Matricaria chamomilla*, *A. vulgaris* (Mugwort), and *A. trifida* (Giant ragweed) was demonstrated by an ELISA-inhibition study (7). Further evidence confirming cross-reactivity among members of the Ragweed genus was obtained in a study using a fluorescent allergosorbent test, in which similar antigenic determinants were found among Short and Giant ragweed, Cocklebur, Lamb's quarters, Rough pigweed, Marshelder, and Goldenrod. Cocklebur and Giant ragweed were highly potent in their ability to competitively bind to Short ragweed IgE. The other pollens demonstrated lower potency of cross-reacting antigens (8). Also, a water-insoluble material, extracted from Short ragweed and False ragweed pollen, contained at least five proteins. Two (RFA2 and RFB2) were isolated and shown to possess antigenicity as well as allergenicity. Immunodiffusion tests of RFB2, isolated from False ragweed and Short ragweed, showed immunological identity (9).

Considering the close cross-reactivity described above, the following further possibilities should be considered.

Mugwort, Ragweed, and Timothy grass pollen share IgE epitopes with Latex glycoprotein allergens. The presence of common epitopes might in part explain clinical symptoms on contact with Latex in patients allergic to pollen. In this study, any previously known panallergen was not detected (10).

An association between Ragweed pollinosis and hypersensitivity to *Cucurbitaceae* vegetables (*e.g.*, Watermelon, Cantaloupe, Honeydew Melon, Zucchini, and Cucumber) and Banana has been reported. Up to now three allergens have been identified as candidates for causing this cross-reactivity: profilin, Bet v 1, and a 60-69 kDa allergen (11). Further evidence for cross-reactivity between *Cucurbitaceae* and Ragweed was found in a study that reported that of the sera of 192 allergic patients, 63% contained anti-Ragweed IgE, and among these patients, 28% to 50% had sera containing IgE specific for any single gourd family member. The extracts of Watermelon and Ragweed inhibited each other in a dose-dependent manner (12).

Ragweed profilin can be expected to result in cross-reactivity between this plant and other plants containing profilin. This has been demonstrated between Ragweed and Persimmon (5). In a second study, 35 of 36 patients' sera containing IgE to Ragweed profilin reacted with profilin from Latex, indicating structural homologies between profilin from Latex and Ragweed. Because profilin is also present in Banana extract, it is likely to be involved in cross-sensitivity between Banana and Latex (4).

In addition to profilin, Mugwort and Ragweed pollen contain a number of other cross-reactive allergens, among them the major Mugwort allergen Art v 1. These cross-reactive IgE antibodies could result in clinically significant allergic reactions (13). Evidence of further cross-reactivity between Mugwort and other members of the *Asteraceae* family (of which Ragweed is a member) consists in the high degree of *in vivo* cross-reactivity between *Matricaria chamomilla* (Camomile) and Mugwort (14).

Cross-reactivity between Sunflower and other *Asteraceae* pollens (Mugwort, Marguerite, Dandelion, Goldenrod, and Short ragweed) has also been demonstrated by RAST and immunoblotting inhibition experiments. Mugwort pollen exhibited the greatest degree of cross-reactivity with Sunflower pollen, whereas at the other end of the spectrum, Short ragweed showed fewer cross-reactive epitopes (15).

Celery cross-reacting with Ragweed has also been reported, but a panallergen was not identified in these studies (16-17).

Binding to IgE from Ginkgo pollen proteins (*Ginkgo biloba L.*) was shown to be almost completely inhibited by Oak, Ryegrass, Mugwort and Ragweed, but only partially by Japanese Hop and rBet v 2 from Birch tree pollen (18). A panallergen may be indicated but was not isolated.

Sera from subjects allergic to White Cypress Pine, Italian cypress, Ryegrass or Birch pollen were shown to have IgE antibodies that reacted with pollens from these four species and from Cocksfoot, Couch grass, Lamb's quarters, Wall pellitory, Olive, Plantain and Ragweed. The authors concluded that the presence of pollen-reactive IgE antibodies may not necessarily be a true reflection of sensitising pollen species (19).

The Japanese Cypress tree pollen allergen, Cha o 1, has a 46 to 49% similarly to the major allergens of Short ragweed, Amb a 1 and Amb a 2 (20).

A panallergen has been identified in Birch pollen, Ragweed pollen, Timothy grass pollen, Celery, Carrot, Apple, Peanut, Paprika, Anise, Fennel, Coriander and Cumin. EAST inhibition and immunoblot inhibition demonstrated that cross-reactions between Mango fruits, Mugwort pollen, Birch pollen, Celery, and Carrot are based on allergens related to Bet v 1 and Art v 1, the major allergens of Birch and Mugwort pollen, respectively (21).

Pollen of *Artemisia annua* is considered to be one of the most important allergens in autumnal hay fever in China, just as Ragweed is in North America. Extracts of pollen-free *Artemisia annua* components were found to contain similar allergens to those of Ragweed pollen. In 52 subjects sensitive to *Artemisia* pollen, 92.3% were shown on skin prick testing to have IgE antibodies to this allergen, 100% gave positive responses in intradermal tests, 66.7% gave positive responses in intranasal challenges, and 59.3% gave positive responses in bronchial provocation tests (22).

Ragweed pollen appears to also be cross-reactive with pollen from Yellow dock (*Rumex crispus*). When monoclonal antibodies with different specificity were applied against the major allergenic components of Ragweed pollen, the monoclonal antibodies reacted with antigens of Yellow dock pollen. In a preliminary study, sera of 2 patients containing IgE antibodies to Ragweed pollen antigens also reacted to the 40K component of Yellow dock pollen. In specific IgE tests on 109 patients with bronchial asthma, 22 had a positive reaction to a crude extract of Ragweed pollen, and 18 also reacted to a crude extract of Yellow dock pollen (23).

Clinical Experience

IgE-mediated reactions

Ragweed, and in particular Short ragweed (*A. artemisiifolia*), is clinically the most important source of seasonal aeroallergens, as it is responsible for both the majority of cases and the most severe cases of allergic rhinitis (24-29). Ragweed pollen also contributes significantly to exacerbation of asthma and allergic conjunctivitis. Ragweed pollen has also been implicated in eustachian tube dysfunction in patients with allergic rhinitis (30) and contact dermatitis (31).

Considering the close cross-reactivity described above, the following clinical possibilities should all be considered, even when data on this specific Ragweed species are absent.

The efficacy of Ragweed pollen in exacerbating allergic symptoms may be due to the Ragweed pollen endopeptidase, which may be involved in the inactivation of regulatory neuropeptides during pollen-initiated allergic reactions (32). Studies have also shown that complement activation induced by the allergen may enhance the clinical symptoms of Ragweed allergy (33-34).

A genetic susceptibility to Ragweed allergens has been suggested based on HLA studies; Amb a V, Amb t V and Amb p V from Short ragweed, Giant ragweed and Western ragweed respectively are strongly associated with HLA-DR2 and Dw2 (DR2.2) in allergic Caucasoid individuals (3).

The measurement of IgE antibodies has been shown to be an accurate and useful diagnostic tool in the evaluation of sensitisation to Ragweed pollen (35-38).

North America remains the main repository of ragweed, where up to 50% of all cases of pollinosis are related to *Ambrosia* pollen (39). *Ambrosia* pollen and allergy are also documented in Australia and China, and *Ambrosia* is the second most important pollen allergen in Japan (40).

Aerobiological and clinical studies from various cities in the USA have documented the importance of Ragweed pollen as an aeroallergen (41). Ragweed has been shown to contribute to symptoms in studies in Washington, DC (42), Tucson, Arizona (43), and Tulsa, Oklahoma (44).

The prevalence of Ragweed pollinosis in central Pennsylvania was shown to be significantly greater in the rural subjects than in inner-city ones (45). In Boston women, socio-economic differences in sensitisation to Ragweed differed between the highest and lowest poverty areas (49% *vs.* 23%) (46). Ragweed was shown to be a major aeroallergen in the Tampa Bay area, Florida (47).

In Chicago residents with asthma, Ragweed sensitivity occurred in 45%, more than those sensitised to pollen from all other weeds (42%) (48).

In a collaborative study on American feverfew (*Parthenium hysterophorus*) pollen compared to an extract of Western ragweed, a study contributed to by 22 physicians from 18 Gulf Coast cities, 65.6% overall of the sera tested were positive for one or both of the pollen extracts examined. Thirty-five percent of the sera were sensitive to American feverfew and 57.6% were sensitive to Ragweed. Thirty percent of the sera were positive to Western ragweed only, 8% were positive to American feverfew only, and 27.9% were positive to both extracts (49-50). These studies support the findings of another study that examined cross-reactivity of allergens from the pollen of American feverfew and Ragweed in 2 groups of patients with different geographic distributions. *Parthenium*-sensitive Indian patients, who were never exposed to Ragweed, had positive skin reactions to Ragweed pollen extracts. A significant correlation in the RAST scores of *Parthenium*- and Ragweed-specific IgE was observed with the sera of *Parthenium*- and Ragweed-sensitive Indian and US patients, respectively. RAST inhibition experiments demonstrated that in the sera of Ragweed-sensitive patients the binding of IgE antibodies to Short and Giant ragweed allergens could be inhibited by up to 94% by *Parthenium* pollen extracts. Inhibition up to 82% was obtained when the sera of *Parthenium* rhinitis patients were incubated with Ragweed allergen extracts. The high degree of cross-reactivity between *Parthenium* and Ragweed pollen allergens suggests that individuals sensitised to *Parthenium* may develop type-I hypersensitivity reactions to Ragweed even though they never had contact with Ragweed, and vice versa (51).

In Canada, Ragweed pollinosis studies have been conducted in Quebec. Of 3,371 subjects with a clinical diagnosis of symptomatic asthma or rhinitis, Ragweed sensitisation was documented in 44.9% (52). Ragweed pollen was shown to be the principal allergen causing allergic rhinitis (53).

In Europe, the severity of Ragweed pollinosis varies according to geographical region. Expansion of the Ragweed genus is occurring across Europe, in particular in France, northern Italy, Austria, and Hungary (54).

Ragweed pollinosis has become a rapidly emerging problem in Italy (24). In 21 centres across Italy, in 2,934 consecutive outpatients with respiratory pathology of suspected allergic origin, 28.2% were positive to at least one "emerging" pollen: Birch, Hazelnut, Alder, Hornbeam, Cypress, or Ragweed. Ragweed pollen was shown to provoke asthma much more frequently than any of the other pollens (55). Children appear to be less sensitised to Ragweed pollen than adults are; only 5.9%

of 507 asthmatic children aged between 1 and 17 years from a central Italian area had IgE antibodies to Ragweed species (56).

Ragweed pollinosis also has been documented in France (57-59). An epidemiological study of Ragweed allergy was conducted on 646 employees of 6 factories located in the Rhône valley south of the city of Lyon. In this study, 5.4% of subjects were symptomatic to Ragweed pollen, whereas 5.9% were shown to have IgE antibodies to this pollen (60). The spread of Ragweed in the middle Rhône area over the last ten years has been considerable; this is especially true of the Drome, along the river Rhône, but also of remote, very sheltered localities to the east and southeast of the province. Although Ragweed is said to grow only in the plains, in this area it appears to be extending into the mountains (61).

Ragweed has been found in the central region of Coahuila, Spain (62). In Canton Ticino, in the southern part of Switzerland, 17% of 503 consecutive patients suffering from hay fever were shown to be sensitised to Ragweed (63).

Ragweed pollinosis is very prevalent in Hungary. In the south of Hungary, among patients with hay fever symptoms during the late summer, 63% were sensitised to Ragweed pollen (64). In Budapest, 64.8% of allergic patients were sensitised to weed pollens, and 59% to Ragweed pollen (65). In other areas, Ragweed sensitisation has been shown to affect up to 83% of patients with late-summer seasonal allergic rhinitis (25).

Ragweed pollinosis is also spreading across Asia.

As Ragweed becomes widespread over China, Ragweed pollinosis tends to be more frequent. A survey of the distribution of Ragweed in the Qingdao district recorded that *A. artemisiifolia* was found to be widespread in many areas. Ragweed pollen was the chief allergen of the district and contributed over 18% of the total air-borne pollen in a year. IgE antibody determination with *Ambrosia* allergen extracts showed a prevalence of 67.7% in 624 pollen-allergic individuals (66).

Ragweed pollinosis is also prominent in Taiwan (67). Of 3,550 asthmatic patients who visited the Taipei Municipal Chung-shing Hospital, 52.3% were shown to be sensitised to Ragweed (68). A high prevalence of sensitisation to Ragweed pollen has been reported in a further study (69).

Ragweed pollinosis has also been documented in Korea (18,70) and Japan (71-72). In 226 children visiting a paediatric allergy clinic in Kyoto, Japan, 17.1% were shown to be sensitised to *A. artemisiifolia* (73).

Few studies have examined the prevalence of Ragweed sensitisation in South America. In Cartagena, Columbia, in 99 subjects with acute asthma and 100 controls, the prevalence of IgE antibodies to Short ragweed was shown to be 23% and 12% respectively (74).

Ragweed allergy has also been reported in northern New South Wales, Australia, where 70 of 153 atopic patients were sensitised to Ragweed, as shown by IgE antibody determination (75).

Although Ragweed is not present in most of Africa, it has been shown to be the third most prominent allergen for asthmatics in Egypt (76).

Other reactions

The food supplement bee pollen has been previously found to cause anaphylactic reactions. It has been advertised as useful for "everything from bronchitis to haemorrhoids". This study describes an atopic patient who experienced a non-life-threatening anaphylactic reaction upon her initial ingestion of bee pollen. The preparation of bee pollen caused 52% inhibition of IgE binding to Short ragweed (77).

w2 Western ragweed

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w5 Wormwood

Artemisia absinthium

Family: *Asteraceae* (*Compositae*)

Common names: Wormwood, Common wormwood, Absinthe, Sagewort

Source material: Pollen

Not to be confused with Wormwood/ Sweet Annie/Annual Wormwood (*A. annua*).

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Allergen Exposure

Geographical distribution

The *Artemisia* family includes Wormwood (*A. absinthum*), Scoparia wormwood (*A scoparia*), Tarragon syn. esdragol, estragon (*A. dracunculus*), and the very important aeroallergen, Mugwort (*A. vulgaris*).

Wormwood is native to and grows wild in temperate Europe, western Asia and North Africa. It was introduced to North America in 1841 and is now naturalised across the northern United States and in Canada. The leaves and flowers, and the oil obtained from them, are used as medicine.

Artemisia absinthium is a medium-sized perennial herbaceous shrub with an aromatic sage-like odour and a very bitter taste. The plant reaches 1m tall by 0.6 m wide. It grows each year from a woody base. It is often seen as one of the only surviving plants in drought areas. The light-green to olive-green leaves are 5 to 12 cm long and divided two or three times into deeply lobed leaflets. The leaves and stems are covered with fine silky hairs that give the plant a greyish appearance.

Wormwood flowers from July to August. Flower stalks appear at each upper leaf node and produce numerous flower heads 2 to 3 mm long and 1 to 2 mm in diameter, ovoid or hemispherical and arranged in panicles. Many tiny, inconspicuous yellow flowers are produced in each head. The scented flowers are hermaphrodite (have both male and female organs) and are pollinated by wind. The fruit is an achene without a pappus. Each fruit contains one seed, which is less than 1mm long, smooth, flattened, and light grey-brown in colour. *Artemisia absinthium* reproduces primarily by seed and is a prolific seed producer.

Environment

Artemisia absinthium grows primarily on disturbed sites within grasslands, in pastures and perennial crops, and on land abandoned from cultivation, as well as on other wasteland, and on roadsides and rocks. It is cultivated in beds as a medicinal herb.

The flowering tops are collected during the late summer and used as a spice, in the preparation of various liqueurs and aperitifs, or in herbal medication. *Artemisia absinthium* yields a volatile oil containing thujone (absinthol), thujyl alcohol and iso-valeric acid. It contains, in addition, absinthin and a bitter glycoside. The plant is poisonous if used in large quantities. Even small quantities have been known to cause nervous disorders, convulsions, insomnia, *etc*. The scent of the plant alone has been known to cause headaches and other symptoms in some individuals.

Allergens

No allergens from this plant have yet been characterised.

Potential cross-reactivity

An extensive cross-reactivity among the different individual species of the genus could be expected, as well as to a certain degree among members of the family *Asteraceae* (1). This is demonstrated by a study whose purpose was to investigate the *in vitro* cross-reactivity among nine *Artemisia* species: *A. frigida*, *A. annua*, *A. biennis*, *A. filifolia*, *A. tridentata*, *A. californica*, *A. gnaphalodes*, *A. ludoviciana*, and *A. vulgaris*. Results of the enzyme-linked immunosorbent assay inhibitions revealed strong cross-reactivity among all nine species, with *A. biennis* and *A. tridentata* being two of the strongest inhibitors. The polyacrylamide gel electrophoresis showed a great deal of similarity in the bands among the nine species. The nitrocellulose blots showed similar IgE binding patterns among the Artemisia species, with strong inhibition among all nine extracts (2). Although *A. absinthium* was not included, one may infer that a strong degree of cross-reactivity exists between this species and other members of the *Artemisia* genus.

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Wormwood; however, few specific studies have been reported to date (3-4).

In a study in Poland, among 2,561 patients suffering from upper airway allergy symptoms, hypersensitivity to weed pollen allergens was found in 1,069 patients with pollinosis. In patients sensitised to weeds, the most prevalent allergens were Wormwood (86.2%), Mugwort (82.9%), White Goosefoot (44.3%), and Narrowleaf Plantain (28.8%) (5).

Common Wormwood is also an important aeroallergen in Japan (3). A study in Korea reported that pollen from this plant might be considered as one of the important allergenic etiologies of atopic asthma in that country (4).

Other reactions

Consumption of Absinthe may cause hallucinations, tremors, convulsions, and paralysis over the long term. The responsible substance for the toxicity of the drink is that Absinthe contains the compound thujone (6-7).

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w23 Yellow dock

Rumex crispus

Family: *Polygonaceae*

Common names: Yellow dock, Curled dock, Curly dock, Narrowleaf dock, Sour dock

Source material: Pollen

See also: Sheep Sorrel (*R. acetosella*) w18

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Allergen Exposure

Geographical distribution

Yellow dock is a perennial flowering plant in the family *Polygonaceae*, native to Europe, including Britain, and western Asia. It has become a serious invasive species in many areas, including throughout North America, southern South America, New Zealand and parts of Australia, by spreading through the seeds contaminating crop seeds, and sticking to clothing (1).

Dock is a perennial growing to 1 m by 0.3 m. The mature plant is a reddish brown colour, and produces a stalk that grows to about 1 m high. It has smooth leaves shooting off from a large basal rosette, with distinctive waved or curled edges. The pointed light green leaves are lanceolate to oblong-lanceolate in shape, and have predominantly wavy margins. The basal leaves are 5-36 cm long and 2-12 cm wide. The flowering portion is placed at the top of the plant has many dense flower clusters. On the stalk drooping flowers are loosely whorled in panicled racemes. The seeds are produced in clusters on branched stems, with the largest cluster being found at the apex.

Yellow dock is in flower from June to October. The flowers are hermaphrodite (have both male and female organs) and are wind pollinated. The seeds ripen from July to October. The calyx (fruit) is a pointed three-angled and heart-shaped nut. The seeds are shiny, brown and encased in the calyx of the flower that produced them. This casing enables the seeds to float on water and get caught in wool and animal fur, and this helps the seeds to spread to new locations

Environment

It grows almost anywhere, but particularly in grassy places, waste ground, and roadsides and near sand dunes. It is a serious weed of agriculture.

Unexpected exposure

The leaves, stems and seeds are eaten raw or cooked. The roasted seed has been used as a coffee substitute. These plants can contain quite high levels of oxalic acid, which is what gives the leaves of many members of this genus an acid-lemon flavour.

Allergens

Antigenic proteins of 40, 38, 24, and 21 kDa have been detected (2).

No allergens have been characterised to date.

Potential cross-reactivity

Cross-reactivity could be expected between species of the family *Polygonaceae*.

Similar allergenic components of Ragweed pollen have been detected in Yellow dock pollen. In a preliminary study, sera of two patients with IgE antibodies to Ragweed pollen antigens also reacted to a similar 40 kDa component in Yellow dock pollen. Of 109 patients with asthma, of 22 patients who were sensitised to a crude extract of Ragweed pollen, 18 (81.8%) also reacted to the crude extract of Yellow dock pollen (2).

Clinical Experience

IgE-mediated reactions

Anecdotal evidence suggests that asthma, allergic rhinitis and allergic conjunctivitis are common following exposure to pollen from Yellow dock; however, few specific studies have been reported to date (3-4).

In a study examining aeroallergen sensitisation rates in military children in Texas with rhinitis, of 209 patients, 17% were sensitised to Yellow dock or Sorrel (4).

In an aeroallergen study in Bitlis, Turkey, *Rumex spp*. was one of the pollens responsible for the greatest amounts of pollens. (5) Pollen from *Rumex spp*. has also been reported in aerobiological studies in Lublin, Eastern Poland (6), in Dehra Dun, in India (7), and evaluated in a number of European communities (London, Leiden, Brussels, Munich and Marseilles) (8). *Rumex* was also reported to be one of 22 types of pollen found in the air of Athens, Greece, mostly during the March-July period (9).

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Mixes

These tests consist of a mixture of different allergens, related or unrelated. For specific information about the included allergens consult the separate descriptions.

wx1

Common ragweed	*Ambrosia elatior* (w1)	page 22
Mugwort	*Artemisia vulgaris* (w6)	page 65
Plantain	*Plantago lanceolata* (w9)	page 78
Goosefoot	*Chenopodium album* (w10)	page 53
Saltwort	*Salosala kali* (w11)	page 89

wx2

Western ragweed	*Ambrosia psilostachya* (w2)	page 115
Mugwort	*Artemisia vulgaris* (w6)	page 65
Plantain	*Plantago lanceolata* (w9)	page 78
Goosefoot	*Chenopodium album* (w10)	page 53
Scale	*Atriplex lentiformis* (w15)	page 93

wx3

Mugwort	*Artemisia vulgaris* (w6)	page 65
Plantain	*Plantago lanceolata* (w9)	page 78
Goosefoot	*Chenopodium album* (w10)	page 53
Goldenrod	*Solidago virgaurea* (w12)	page 51
Nettle	*Urtica dioica* (w20)	page 75

wx5

Common ragweed	*Ambrosia elatior* (w1)	page 22
Mugwort	*Artemisia vulgaris* (w6)	page 65
Marguerite	*Chrysanthemum leucanthemum* (w7)	page 62
Dandelion	*Taraxacum vulgar*e (w8)	page 33
Goldenrod	*Solidago virgaurea* (w12)	page 51

wx6

Plantain	*Plantago lanceolata* (w9)	page 78
Goosefoot	*Chenopodium album* (w10)	page 53
Saltwort	*Salosala kali* (w11)	page 89
Sheep sorrel	*Rumex acetosella* (w18)	page 95

wx7

Marguerite	*Chrysanthemum leucanthemum* (w7)	page 62
Dandelion	*Taraxacum vulgare* (w8)	page 33
Plantain	*Plantago lanceolata* (w9)	page 78
Goosefoot	*Chenopodium album* (w10)	page 53
Goldenrod	*Solidago virgaurea* (w12)	page 51

wx209

Common ragweed	*Ambrosia elatior* (w1)	page 22
Western ragweed	*Ambrosia psilostachya* (w2)	page 115
Giant ragweed	*Ambrosia trifida* (w3)	page 42

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