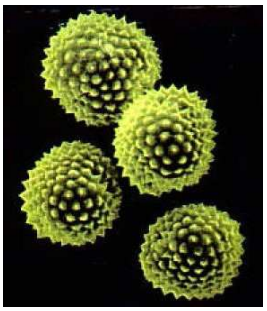
prolune
PROTEINES À LA >UNE<

Issue 13, December 2004

Amb's : The Spearheads of Ambrosia



Ambrosia artemisiifolia **is popularly known as "ragwort", "annual ragweed" or "short ragweed", and is really just that: a weed. And not a harmless one… Indeed, *A. artemisiifolia* has already put many people's lives in danger and is threatening to become an acute public health problem throughout the world. The good part though is that the battle waged against Ambrosia has brought about a better understanding of a number of proteins which are at the heart of the damaging effects the plant has on certain people.**

A modern ailment

Two hundred years ago, had you been suffering from the effects of hay fever and attempted to describe your symptoms to a doctor, he would have been – to say the least – puzzled. In fact, it was only in 1819 that the condition was first fully described in a scientific review by a London practitioner. For a long time, this mysterious affliction – known as 'Bostock's catarrh' – was described as 'a rare and most extraordinary condition'. It started as a minor medical curiosity to become, within the space of two centuries, a very common ailment which affects 10 to 18% of the population. However, it has spread mainly in the course of the 20th century. From the beginning of the 70s to the beginning of the 80s, twice as many cases of hay fever were recorded, both in Great Britain and in Sweden. In Switzerland, the increase was of 1% in 1926, 5% in 1958 and 10% in 1986. In the United States, the same order of increase has been observed. Whereas hay fever was almost unknown in Japan before 1950, it has spread so much in the last 40 years as to reach 10% of the population today.

Nowadays, farmers do not feed their cattle with hay but with fodder made up of grass that has been cut before it has had time to flower. Yet in spite of the resulting decrease in pollen, cases of hay fever continue to increase. And now, to cap it all, a new formidable enemy has cropped up in the last few years: Ambrosia.

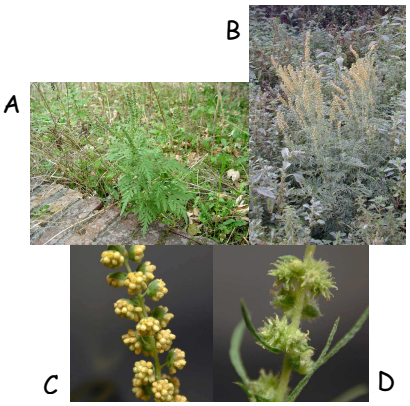
Once food for the Gods, now just a weed

Ambrosia –meaning 'food for the Gods' – covers 40 different species that are mainly found in the temperate regions of America. The plants are generally thought to relieve fever and be an effective remedy against worms. Maritime Ambrosia was the basic ingredient of a beverage believed to confer immortality in Ancient Times. Even *Ambrosia artemisiifolia* in particular was given as a tonic or fortifier in America, and could be used either externally or internally. But today, things have changed.

Ambrosia artemisiifolia comes from North America and was introduced accidentally to Europe

in 1863, probably mixed up in a batch of clover. It spread rapidly and finally became very common. It prospered in the vicinity of houses, then in wasteland and along waterways, before establishing itself as a weed few soils could withstand.

Ambrosia artemisiifolia is of the same family as the sunflower but is unlike it in appearance. It grows in small tufts and flowers from July to October. Besides 'ragweed', it has been given charming names such as 'homemade absinthe' or 'St John's herb' but for those who suffer from hay fever, it remains a plant to be avoided. The pollen may cause violent allergic reactions but contact with the flowers can also cause skin eruptions. Once there is a count of at least five grains of pollen per cubic meter of air, very sensitive people may develop rhinitis – with complications such as sinusitis or otitis coupled wih conjunctivitis or even a throat infection. Asthma may be a further complication, even leading some to the hospital. Skin rashes or eczema can also develop after contact with the plant…



A : Ambrosia artemisiifolia
B : Complete flower in bloom
C : Male flower
D : Female flower

Fig.1 *Ambrosia*

The late flowering season of Ambrosia prolongs by at least two months the period during which allergy-prone people are likely to succumb. August, September and October – when the plant pollinates – is the time to be careful; especially the first fortnight in September when pollen counts are at their highest. One average-sized Ambrosia plant can release up to several million grains of pollen in one day. The grains are small and spherical (18 to 20 µm in diameter[1]) with spikes all over them (see cover illustration). One gram of pollen can contain up to 90 million grains!

[1] 1 micron = 0,000001 meter

In terms of frequency, allergies to Ambrosia are high: depending on the region under observation, between 6 to 12% of the population is affected. If the proliferation of Ambrosia continues unheeded, cases of hay fever are sure to increase accordingly.

The story of a misunderstanding

In a way, pollen is the equivalent of spermatozoa. And when the former lands in someone's nose, it thinks it is there to fertilize a flower. In a flower, the pollen first rests on the stigma which is at the tip of the pistil. The stigma is the female organ in which is lodged the ovule (cf. diagram). In order to reach the ovule and fertilize it, a grain of pollen has to penetrate the pistil. There are a number of small cavities on the grain's surface, in which are found proteins. Some of these proteins are enzymes which will 'break' through the outer layer of the stigma thus letting the grain of pollen into the pistil. Other proteins, called incompatibility factors, inhibit further fertilization with grains of pollen from the same flower or from some other closely related plant.

A grain of pollen releases its proteins in a matter of seconds. When that happens in our nasal cavity, the immunity system of those allergic to Ambrosia reacts as though it had been attacked by a microorganism. Some of these proteins can be powerful allergens, i.e. they will cause our immunity system to produce other proteins as a means of self defense: antibodies. It seems that the incompatibility factors are the most allergenic of all since they must require distinctive chemical properties – their role being to recognize one plant from another – to be able to prod the immunity system into action.

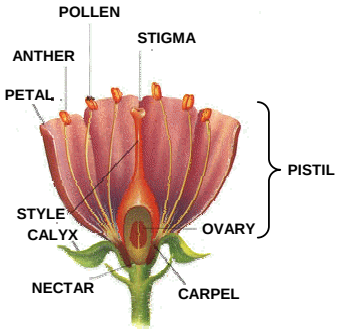


Fig.2 *Flower section*

Ambrosia pollen is more allergenic than the graminae's. There are at least 15 allergenic agents in one grain of Ambrosia pollen. Some are called 'major' for their predominant role in causing allergies in people. They are Amb.a.1 (of which

there are 4 types) and Amb.a.2, to which 90% of the patients allergic to Ambrosia have antibodies. There are other allergens known as 'minor' for which only 20 to 30% of allergic people have antibodies, but that does not in any way preclude the seriousness of the symptoms since those who produce antibodies against Amb.a.5 for instance seem to suffer more frequently from asthma. Other proteins found in a grain of pollen, such as profilin or certain enzymes, can also be allergenic. And since profilin is found in other allergenic plants too, it may explain why people allergic to Ambrosia are also frequently affected by celery, melons, bananas and sunflowers.

What exactly is an allergic reaction? We have seen that allergens induce our immunity system to produce certain types of antibody known as immunoglobulin E or IgE. Once synthesized and secreted (by cells known as B cells), IgEs bind to the surface of another type of cell, the mastocytes, which are found in the nasal mucous. When, in turn, allergens bind to the IgEs now on the mastocytes' surface, they cause the release of anaphylactic substances such as serotonin, histamine or heparin. These are the substances which cause an inflammation of the tissues and all the usual symptoms found in people subject to allergies, such as vasodilation and edema.

As a consequence, there must be a mechanism – in people who are not allergic to pollen – which is able to distinguish between microbes and a substance as inoffensive as pollen. There must be a means of control which, in normal circumstances, would stop B cells from producing IgEs. Why does this kind of control not exist in people who are allergic? No one really knows. What we do know is that there is a genetic factor. For instance, in one family, several members may suffer from hay fever whilst others develop asthma or eczema. Such families are known as 'atopical', meaning that there is a certain underlying 'weakness' in these families which shows up in different parts of their body. However, all 'atopical' people do not necessarily develop allergic illnesses. Currently, 30% of children with allergies are born into families who, up 'til then, had shown no signs of any allergy. This would indicate that there is a new environmental factor to contend with which seems to bring about an allergic response in otherwise only slightly susceptible families. But the identity of this factor is as yet unknown.

The end of a peaceful entente

Pollen is not a newcomer. It has been around for over 130 million years. So, what happened after so many years of peaceful coexistence between humans and pollen? There are as many theories as there is pollen… For some, the reason is simply that nowadays people think a lot about their health and are more aware of allergic illnesses than before, or that they do not hesitate to consult their doctor for minor ailments. And yet studies have revealed that there has been a definite and rapid increase of hay fever over the 19th century. Epidemiologists are therefore convinced that the illness is progressing.

In 1926 already, researchers had noted that there was a factor of 10 between the number of cases of hay fever in town and the countryside in Switzerland. But to everyone's astonishment, city dwellers were more allergic to pollen than farmers even though its concentration was higher in the countryside. Today, curiously this difference has disappeared. Some say the reason for this is pollution. Naturally. As a consequence of urban pollution, hay fever is alleged to have spread to the countryside with the ever-increasing number of motorcars driving through it. This connection with pollution is popular belief. The pollen grain's membrane could become less impermeable due to exposure to pollutants. Consequently, a grain's contents – its proteins and allergens – are more prone to being released. Up to now though, no laboratory test has been developed to confirm such a theory.

Furthermore, when hay fever first made its appearance in the 19th century, it was not amongst the underprivileged classes, who lived and worked close to factory chimneys, but amongst the aristocracy and wealthier classes. Of course, the working class in Britain had more to do than bother with a runny nose but a detailed study of the medical records of the time has revealed no case of hay fever within the disadvantaged population between 1820 and 1830.

Recently, David Strachan, an epidemiologist, made a surprising observation: the only factor that seems to correlate with hay fever is the size of a family. An only child, for instance, is far more likely to succumb than a child with brothers and sisters. Then again, parents with a large family may be less attentive to minor ailments such as hay fever or give little notice to it, but the difference remains when – as adults – these people are questioned on the subject. Besides, the more older brothers and sisters there are, the more this correlation exists. Strachan suggests that the decisive factor here is the repeated contact, often unhygienic, between a child with his or her older brothers and sisters. Games implying close contact expose children to each other's saliva or runny noses. As a consequence, these children catch more infantile infections than their peers and this would protect them, in later life, from certain allergies.

How? Repeated contact with infections has somehow 'taught' the immunity system not to react against inoffensive substances such as pollen. The theory as it stands is somewhat disconcerting for an immunologist but it is interesting. Smaller families and more advanced ideas of hygiene may have reduced this type of contact between children of the wealthier classes of the 19th century, before becoming common practice for the rest of the population. Nevertheless, it is indeed possible that older children expose their siblings to pollen via their saliva or by sneezing and that this would – in the long run – desensitize them. In fact, exposure to small quantities of pollen in childhood seems to decrease people's susceptibility to allergies. Moreover, exposure to tiny quantities of pollen that are progressively increased over a period of time is the basis of treatment against hay fever and is a method which has proved successful. To sum up, there are no doubt several factors that have to be considered and each one of these explanations may hold the key.

A campaign is being launched

Ambrosia is an opportunist but not competitive by nature; all it seeks is a piece of unoccupied land. As soon as other plants compete, it simply withdraws and finally disappears, leaving behind it – nevertheless – large quantities of seed in the soil that remain viable for ten years at least. One plant alone produces about 3'000 seeds. These seeds, however, have no particular means of spreading. Even the wind doesn't seem to have much effect. The main 'spreader' of Ambrosia seems to be due to human activity. In turning the soil, by plowing fields or digging up land on work sites, Ambrosia seeds are brought within centimeters of the surface which is an ideal place for them to germinate. Grains can also be transported passively from one place to another in earth which clings to farm machines and land in an empty space where it will prosper. Mechanization has a lot to answer for in the spreading of Ambrosia seed; in France, heavy reconstruction work after World War II disseminated the seed both in town and country.

Today, the spreading of *Ambrosia artemesiifolia* is a substantial health risk which is beginning to be taken very seriously. Patients treated for allergy to Ambrosia are growing in number daily. Already in Canada, the Balkans and parts of Eastern Europe, Ambrosia is a real menace. It has been present for some time now in the 'Rhône-Alpes' region in France; in Switzerland, it is relatively thinly scattered but quite frequent around Geneva and Ticino – the Italian part of Switzerland – where it is found near motorways and railway lines, in fallow fields, near new buildings, on construction sites, in parks and farmland…

As a result, determined steps are being taken to make life as difficult as possible for this weed. The first course of action must be to reduce the release of pollen by reducing the number of plants and thereby the amount of seed. Complementary methods are used comprising all kinds of means: natural, mechanical, thermal, biological and, if necessary, chemical. Its lack of competitiveness is also one way of dealing with the plant by maintaining a thick cover of vegetation which keeps it from spreading. Pollen counts are permanently made by captors based on several sites in the 'Rhône-Alpes' region and then recorded in information bulletins.

So here are a few tips if you find Ambrosia in your garden. First, do not transplant it or scatter its seeds. Wear gloves to pull it out of the ground and do so, preferably, before it flowers. If it is already too late, wear goggles and a mask for extra protection. The remains of the plant must be burned and not put onto the compost heap or thrown onto the garden rubbish. If you feed birds, make sure that the seed mixtures do not contain Ambrosia seed which, unfortunately, is often the case... But if you are subject to hay fever and find yourself nose to nose with Ambrosia, linger not! Turn and make a bolt for it!

Sylvie Déthiollaz*

*Translation: Geneviève Baillie

For further information:

A little more advanced:

- On hay fever: 'The big sneeze', New Scientist, vol. 126, issue 1719(1990)

On the internet:

- On Ambrosia: www.ambroisie.info
- Geneva Botanical Gardens, records on invasive plants: www.cjb.unige.ch/events/invaders/pdf/envahisseurs.pdf
- National network of aerobiological surveillance (RNSA – Réseau national de Surveillance aérobiologique). Records daily associated pollen and clinical data and draws up bulletins.
- Le Grand Lyon: www.grandlyon.com. Relays data given by the pollen surveillance on the internet as well as the level of allergy risk, three times weekly.

In Switzerland:

- Groupe Ambrosia, Geneva: Botanists, agronomists, meteorologists and doctors combine their efforts to control the expansion of *Ambrosia artemisiifolia*.
  Contact: Dr Catherine Lambelet, Conservatoire et Jardin botanique, Ville de Genève, CP 60, 1292 Chambésy. Tel. 0041 22 418 51 60, fax. 0041 22 418 51 01, e-mail: Catherine.lambelet@cjb.ville-ge.ch

Illustrations:

- Heading illustration, Source: the Radio Netherlands site: http://www2.rnw.nl/rnw/en/features/science/climate011210.html
- Fig.1A, Source: Paul Busselen, Katholieke Universiteit Leuven: http://www.kulak.ac.be/facult/wet/biologie/pb/kulakbiocampus/buiten-kulak/lage_planten/Ambrosia%20artemisiifolia%20-%20alsemambrosia/alsemambrosia.htm
- Fig.1B,C,D, Source: Texas Agricultural Experiment Station: http://uvalde.tamu.edu/herbarium/amar.htm
- Fig.2, Source: Association Ecosphère: http://www.educ-envir.org/~ecospher/activites/enfants/insectes/jeu/jeux.htm

At UniProtKB/Swiss-Prot:

- Pollen allergen Amb a 1.1, Ambrosia artemisiifolia:: P27759
- Pollen allergen Amb a 1.2, Ambrosia artemisiifolia: P27760
- Pollen allergen Amb a 1.3, Ambrosia artemisiifolia: P27761
- Pollen allergen Amb a 1.4, Ambrosia artemisiifolia: P28744
- Pollen allergen Amb a 2, Ambrosia artemisiifolia: P27762
- Pollen allergen Amb a 3, Ambrosia artemisiifolia: P00304
- Pollen allergen Amb a 5, Ambrosia artemisiifolia: P02878
- Pollen allergen Amb a 6, Ambrosia artemisiifolia: O04004
- Pollen allergen Amb a 8, Ambrosia artemisiifolia: Q64LH1

Date of publication: December 14, 2004
Date of translation: September 1, 2005
