

Ragweed (*Ambrosia*) progression and its health risks: will Switzerland resist this invasion?

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Summary

The purpose of this article is to alert physicians for the environmental and health threats of *Ambrosia artemisiifolia* (common ragweed) in Switzerland. Switzerland borders several heavily ragweed colonised areas. Up to 12% of the population suffers from allergies (hay fever, asthma) to ragweed pollen in these areas. Switzerland is beginning to be invaded by this plant. Currently, the ragweed pollen counts are still low but can reach local peaks that induce symptoms in allergic individuals. Ragweed allergy, however, is still rare in Switzerland. Because the amount of ragweed pollen was increasing in the last few years, identification and surveillance of ragweed plant foci was started. Colonisation is currently systematically monitored in Geneva and southern Tessin. Major accumulation of ragweed foci have been detected in the canton of Geneva, the western shore of the lake of Geneva belonging to the canton of Vaud, and in

the southern part of the canton of Tessin, aside from minor foci registered all over Switzerland. The routes of ragweed invasion are presented and discussed. Current measures of ragweed containment and needs for the future are presented. The urge for these measures at an early stage of ragweed spread is underlined by the impracticability of eradication in highly colonised areas. The costs of preventing ragweed spread in Switzerland are likely to be several magnitudes lower than the treatment of a significant percentage of the Swiss population for ragweed pollen allergy. Because areas can change from low to heavy ragweed colonisation within a few years, the current window of opportunity to prevent further colonisation by ragweed should not be missed.

Key words: Ambrosia; allergy; health risk; allergic rhinitis; asthma; Switzerland

Introduction

Allergic rhinitis and asthma commonly coexist and are high-prevalence and high-cost diseases throughout the world. Two large Swiss cross-sectional studies performed last decade have evaluated the prevalence of rhinitis and asthma at respectively 11.1% and 6.8% in adults [1] and 17% and 9% in children [2]. The regular increase in the prevalence of asthma and allergic rhinitis since 40 years may have come to an end in the adolescent subpopulation as demonstrated recently [3]. This trend has not been confirmed in adults where the prevalence of both conditions seems to continue to rise. A low-grade ragweed colonisation has started in some areas of Switzerland more than a decade

ago. In the future this may lead to new cases of ragweed allergies. In heavily infested areas of neighbouring countries such as France and Italy, up to 12% of the population suffers from allergies (primarily hay fever and asthma) to ragweed pollen. We therefore risk a burst in the prevalence, the severity and the duration of asthma and rhinitis during the late summer/early autumn months causing additional health care costs.

The purpose of this article is to alert physicians for the environmental and health threats of *Ambrosia artemisiifolia* (common ragweed) in Switzerland.

Ecology

Ragweed (*Ambrosia artemisiifolia*) is an annual, monoecious (male and female flowers on the same plant) weed from the Asteraceae family [4], usually sized 20 to 120 cm (figure 1a, 1b, 1c). It spreads by its fruits some 10 weeks after the flowering season [5]. This invasive neophyte species likes bare or freshly moved grounds. It is greatly favoured by human activities and is growing along roads and cultivated fields, in fallow lands, in meadows, in gardens and on building sites. It appreciates hot, dry and rich soils with neutral or slightly acid pH. Sunflower fields frequently reveal the presence of ragweed. Both belong to the same botanical family: it is therefore difficult to control chemically the infestation and they become strongly competitive

within these fields. An information sheet is available on www.ville-ge.ch/cjb/neo.html. The ragweed pollen is sized from 18 to 22 μm and has small non-sharp spikes at its surface on electron microscopy (figure 2). Its pollination period extends in west Switzerland from beginning of August to mid October with a peak from mid August to the end of September. Ragweed pollen production begins at sunrise and continues during the morning reaching its highest count around midday [6]. Temperature and relative humidity have minimal effect on the day-by-day ragweed pollen count. In contrast rainfall and unstable atmospheric conditions have a considerable impact on ragweed pollen counts.

Figure 1

- a. Plantlet;
- b. Flowers just before pollinisation;
- c. Ambrosia plant flowering.



a



b



c

World epidemiology

In Europe, only *Ambrosia maritima* L. is native. Four species of ragweed, *Ambrosia artemisiifolia* L. (short or common ragweed), *Ambrosia trifida* L. (giant ragweed), *Ambrosia tenuifolia* (only in France

and Spain) and *Ambrosia coronopifolia* (perennial ragweed) were introduced accidentally to Europe, the first already at the end of the 19th century [7]. *Ambrosia artemisiifolia* is mentioned in France and

Figure 2

Ragweed pollen.



Germany since 1863. Common ragweed plant remained discreet over several decades and became more frequent for instance in France in the Lyon area only around 1950. In the US, up to 10% of the overall population is sensitised to short rag-

weed [8]. North America remains the main foyer of ragweed where up to 50% of all cases of pollinosis are related to *Ambrosia* pollen [9, 10]. Some areas of Japan [11], China [12] and subtropical Australia [13] are also infested by this weed. In Europe ragweed sensitisation is increasing [14, 15] and this weed is even appearing in Sweden since 1996 [16] and in the Baltic states [17]. Short ragweed is now growing on the footsteps of the mountains in a band ranging from the Rhone valley of France [18–20] to Hungary where 90% of the ground surface is colonised by ragweed [21]. It is also spreading in central Italy [22, 23] and through the Po valley [24–26], in Austria [27, 28], in Bulgaria [29] and in some states of former Yugoslavia where it benefits from the fallow lands created by the recent war [18]. In the colonised areas, ragweed becomes rapidly the main allergen as it is in North America and more recently in the French Rhône-Alpes region [18]. Natives who are living with ragweed pollen since a long time seem to develop a natural tolerance to it when compared to newly arrived immigrants who demonstrate a 3 fold increase in typical late summer allergic symptoms [30].

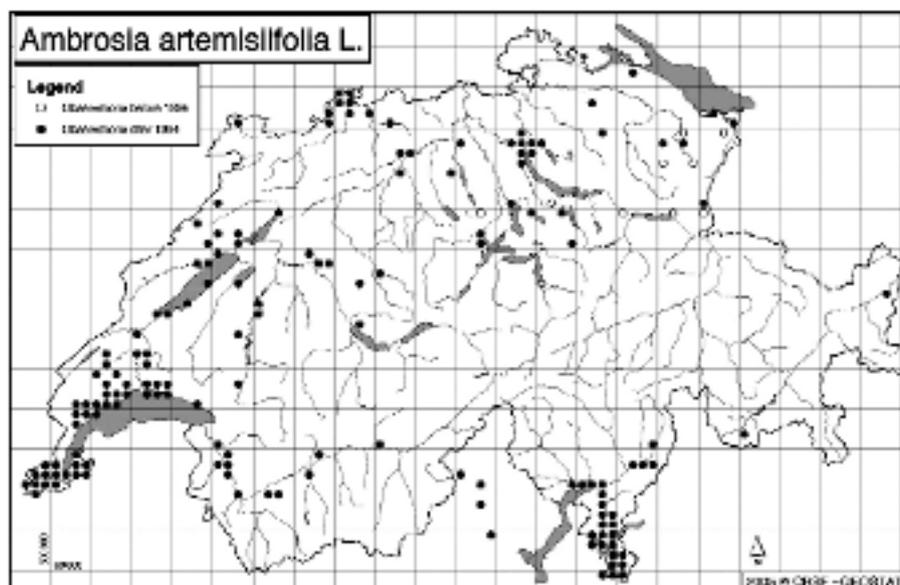
Swiss epidemiology

The presence of ragweed in Switzerland was reported for more than 100 years. Since the last decade signs of an increased presence of ragweed have been reported mainly in the cantons of Basel [31–33], Ticino [31, 34], Geneva [31] and recently Zurich [35]. It has been demonstrated that there is a good correlation between the high pollen counts of the Lyon area and the much lower counts of the Geneva area, suggesting the importance of long distance pollen transport by the wind [36]. Nevertheless during some days there are major discrepancies between the 2 towns suggesting that there is also a local production of ragweed in Geneva

[36]. Indeed since 2001, new infested fields have been discovered and higher pollen count measured [37–39]. This global increase did not yet result in a general increase in allergy during August and September, although a few possible native ragweed pollinosis have been described in Zurich [35] and Geneva [40]. In 2003, several ragweed populations were also discovered in southern Ticino [41]. Field research conducted by the Swiss Commission for Wild Flower Protection CPS/SKEW during 2002–2003 allowed drawing an actual distribution map of ragweed in Switzerland (figure 3 and www.cps-skew.ch).

Figure 3

Ambrosia artemisiifolia distribution in Switzerland updated in December 2003. Elaborated by the CPS (Commission suisse pour la protection des plantes sauvages) and the CRSF (Centre du réseau suisse de floristique) on a mandate of the SAEFL (Swiss Agency for Environment, Forest and Landscape).



Clinical spectrum

It is usually easy to diagnose ragweed related allergies because the symptoms occur typically in August and September after the pollination of other common grasses. The diagnosis should be confirmed by a positive skin prick tests and/or a positive serum specific IgE for ragweed. Clinical manifestations are rhino-conjunctivitis (87%), asthma (42%) and more rarely contact dermatitis or urticaria [42]. Symptomatic ragweed allergic rhinitis affects vigilance and cognitive functioning [8] and leads to a lower worker productivity [43]. Symptoms can begin with as little as 5–10 pollens/cubic metres [44]. Pollen grains reach the upper respiratory tract but are too large to penetrate in the lower airways to lead to asthma. Allergen carrying paucimicronic particles, sized less than 5 μm , which are smaller than pollens, can be released during light rain or thunderstorm and are responsible for asthma attacks [10]. The prevalence of asthma in ragweed infected areas such as the Rhône-Alpes area affects up to 12% of the population during the pollen period and can classically be severe [19].

Ragweed can cross-react with numerous other grasses from the Asteroidae subfamily such as mugwort and sunflower [45, 46]. Cross-reactivity

between mugwort and ragweed pollens is of at least 80% [47]. Reacting epitopes are profilins, but also the major mugwort allergens (Art v 1 and Art v 2) and the major ragweed allergens (Amb v 1 and Amb v 2), which are 2 highly homologous 60 kd and 28–46 kd components. This close botanical relationship has clinical relevance because it has been shown that mugwort and ragweed pollen extracts induce comparable nasal obstruction in patients allergic to mugwort [47]. Therefore it can be expected that mugwort allergic patients would also react to ragweed pollen. Because mainly mugwort pollen is accountable for late summer pollinosis and asthma in Switzerland [48], it can be assumed that the rise of ragweed may increase the prevalence and the severity of mugwort allergic related symptoms when the threshold value of ragweed pollen in the air will be reached. Allergenic relationship can also be found between taxonomically diverse pollens [49]. For instance, Amb v 1, the ragweed's major allergen, can also cross-react with Phl p 4, the timothy grass's major allergen [50]. An oral allergy syndrome has been described with Cucurbitaceae such as melon, watermelon or cucumber and the Musaceae such as banana [51, 52], as well as contact urticaria [53].

Treatment of ragweed allergy

The management of ragweed rhino-conjunctivitis and asthma includes allergen avoidance, medication and immunotherapy. Outdoor allergens are difficult to avoid but it can be recommended to practice sport in the evening when the pollen count is the lowest, except those evenings when long-range transport of pollen occurs. It is also advisable to avoid exercising on days that rains and dry periods alternate or just before or after a thunderstorm. The air concentration of submicronic particules is higher and well dispersed in these cases, increasing therefore the risk for a severe asthma attack. But if the rain is sufficiently abundant the risk of an allergic reaction is reduced. Medical treatment of rhino-conjunctivitis consists mainly in intranasal topical glucocorticosteroids and oral H₁-antihistamines [54]. There is an additive role for ocular topical H₁ antihistamines and oral or topical cromones in rare situations. Medical treatment of asthma includes intrabronchial glucocorticoids, long and short acting β_2 agonists and oral anti-leucotrienes [55]. Second line drugs are oral cromones, inhaled ipratropium, oral glucocorticoids and sustained release theophylline. Patients with moderate to severe ragweed related rhinitis benefit from omalizumab, a recombinant monoclonal antibody, in a dose dependent fashion [56]. Although there are no available publications in ragweed pollen induced asthma, several recent multicentre trials have demonstrated its efficacy

in the more severe spectrum of allergic asthma, regardless of the allergen [57–59]. Early controlled trials showed no or little efficacy of ragweed injection specific immunotherapy (SIT) [60, 61]. Later studies have recognised SIT as an efficacious procedure to reduce nasal symptoms during ragweed antigen exposure [62, 63]. SIT is also beneficial in asthma but this effect is not sustained during the second year of immunisation therapy [64]. The indication of SIT in ragweed-induced asthma is therefore still debated [64]. A few studies have postulated that SIT with a single allergen may exert a preventive effect against sensitisation to other airborne allergens. Unfortunately, a recent study has shown that SIT in monosensitised adults to common airborne allergens, does not prevent ulterior sensitisation to ragweed north of Milano [65]. Since 1900 oral administration of ragweed was used for hyposensitisation of hay fever. A pilot study on encapsulated oral immunotherapy with ragweed Amb a 1, proved to be safe and attenuated the symptomatic response to ragweed exposure [66]. A recent randomised controlled study on sublingual immunotherapy (SLIT) with ragweed extract, confirmed the efficacy and safety of this treatment and strongly suggested a dose response relationship [67]. A Cochrane systematic review on SLIT was unable to draw conclusions about ragweed SLIT because there was only one study that fulfilled the inclusion criteria [68].

Ragweed is particular health hazard

Ragweed is a true plague in the colonised areas where it becomes the main allergen for various reasons. Its pollen is very allergenic and very low concentration such as 5–10 pollen per cubic meter of air are sufficient to trigger allergic reactions in sensitive patients. Moreover, every ragweed plant produces enormous quantities of pollen if compared to other grasses. *Ambrosia artemisiifolia* spreads

very quickly and every single plant can produce an average of 3000 to 6000 seeds per plant and large specimens up to 60 000 seeds, which can germinate after lying up to 40 years in the ground [69]. These seeds are mainly disseminated by human activities such as vehicle movements, infested soil transports, plots of grains for birds and possibly by plots of agricultural seeds.

The situation in Geneva

In Geneva, the plant is mentioned by botanists since 1940 [70]. *Ambrosia* airborne pollen has been recorded in the air for the first time in 1967 [71], and then every year since the beginning of the continuous measurements in 1979. The Geneva *Ambrosia* Group, founded in 2000, was alarmed by the increase of annual pollen index, which could potentially result from local pollen sources: some heavy infested fields were found in 2001. Ground control for ragweed infestation in the canton of Geneva has started methodologically the same year [72]. There are now also reports from infested places in the canton of Vaud, along the lake of

Geneva, especially between Rolle and Aubonne, to Chavornay and around Lausanne [73].

Pollen

Daily average pollen counts are measured in Geneva with a Hirst type volumetric spore trap situated on top of the Geneva University Hospital since 1979. Suspended particulate matter is collected on coated plastic tape and was analysed by light microscopy by R. M. Leuschner (Basel) from 1979 to 1984 and 1989–1992. Since 1993 Meteo-Suisse in Payerne analyses the pollen, in accordance with international standard methods [74].

Figure 4
Ragweed pollen annual index in Geneva 1989–2004.

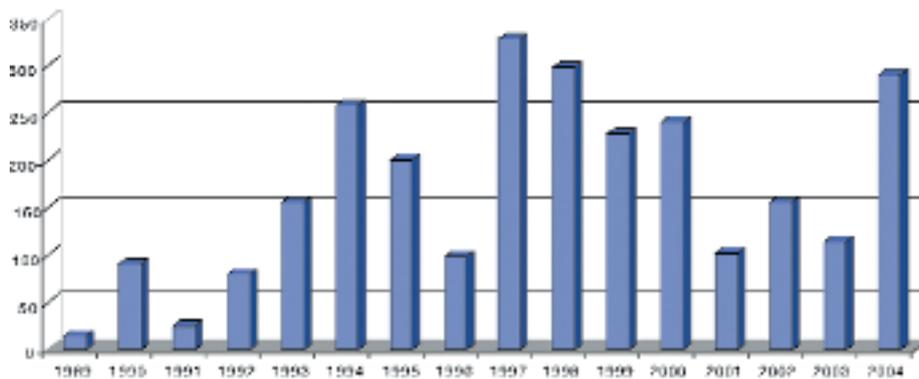
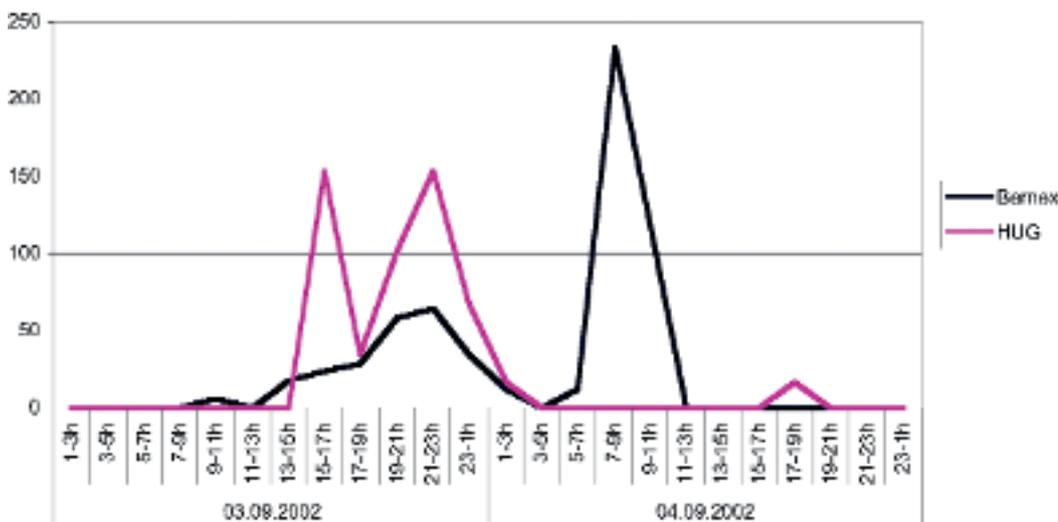


Figure 5
(Modified from Maurer 2003 [57]) Two-hours concentration of ragweed pollen recorded by the pollen traps located in the centre of the city (HUG) and in the surrounding of an infested field near Geneva (Bernex): episode showing long-range transported pollen registered in the evening on 3rd September and local pollen peak on 4th September in the morning.



Annual pollen index reached the value of 150 for the first time in 1993 (figure 4). The pollen counts then rose sharply from 1993 before dropping in 2001, 2002 and 2003, mainly because adverse weather conditions that limited the amount of long-range transport of ragweed pollen from the French Rhône-Alpes area like the local dispersal. Results from 2004 show evidence that the problem has not diminished. A more detailed study including several pollen traps has confirmed that long-distance transport of pollen from French Rhône-Alpes region under south-west wind episodes is an important source for the ragweed pollen registered in Western Switzerland and in particular in Geneva [36, 72]. Figure 5 shows that pollen from long-distance transport is recorded in the evening in different pollen traps from the area, while pollen from local sources is recorded in the morning, at the time it is released from plants, a result that confirms those from Laaidi et al. 2003 [18]. It is remarkable that local pollen peaks are very high, even if the infested field is still not yet very ex-

tended. Bernex is a densely inhabited area and repeated exposition to such pollen concentrations can lead to sensitisation [72].

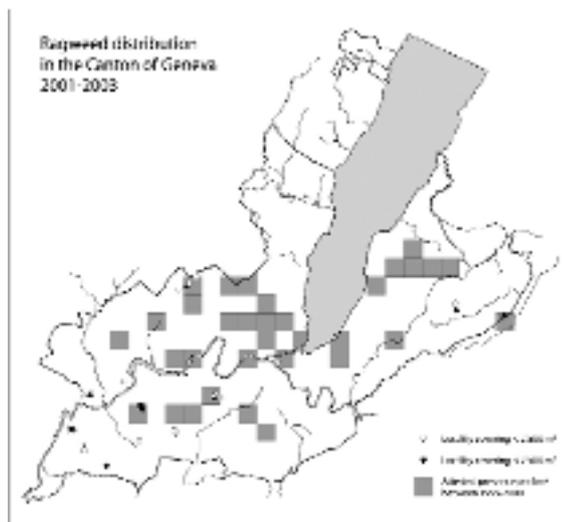
Plants

A floristic investigation of Geneva based on a kilometre square scale, conducted from 1990 to 2000, showed the presence of *A. artemisiifolia* in 33 km², representing a frequency of 11%. The mapping of ragweed plants has also been conducted yearly from 2001 to 2003. At the end of 2003, 33 locations with common ragweed were reported along or among fields, fallow lands, gardens, waste places, building yards, roads and railways with abundance ranging from just a few to 100 000 plants and covering areas of 3 m² to 5000 m² (figure 6). Eight locations were heavily infested [72]. In 2004 this mapping effort could not be updated because of lack of financial resources, but another 5 small additional localities were found by local botanists. A total of 215 000 m² are known to be already infested with ragweed, with annual plant counts estimated to vary from some 10 000 to more than a million specimens.

Ragweed epidemiology survey among Geneva allergists in 2004

The response rate among Geneva allergists in private practice was satisfactory: 18 out of 25 (72%) practitioners returned the questionnaire. Only 8 out of 18 were consulted for ragweed related allergy. The majority of the 8 practitioners have encountered 1 or 2 ragweed allergic patients during the 2004 ragweed pollinisation period. Two third of these ragweed allergic patients have been sensitised outside Switzerland, in ragweed endemic regions such as the USA, France, Italy, Austria and Hungary. The amount of ragweed allergy with evidence of sensitisation in Geneva remains still low with possibly 4 to 5 cases in 2004.

Figure 6
Common ragweed distribution in Geneva at the end of 2003.



A serious threat

Ambrosia is a major health threat. The entire sanitary network has to recognise that ragweed infestation is a serious concern in the state of Geneva and the rest of Switzerland. Ragweed pollen counts measured in Geneva increased over the last decade although low pollen indexes due to adverse weather conditions can be recorded some years. The number of colonised fields, gardens, building sites and along roads and railways is indeed increasing in Geneva, as shown by the precise cartography of the whole canton. Swiss fallow land observation net covering several cantons, has

found no ragweed invasion in the 100 observed fallow lands, suggesting again that we are still at an early stage of ragweed colonisation. This early stage of infestation is corroborated by the rarity of ragweed allergy cases due to Geneva indigenous sensitisation. Nevertheless, a few new cases related to local sensitisation have been diagnosed in Geneva in 2004. This trend will need to be confirmed over the coming years with repeated epidemiological surveys in Geneva and in other places in Switzerland.

Causes of ragweed progression in Europe

The wide spread progression of ragweed through south and continental Europe has several potential explanations that all seem to have a direct or indirect link with human activities. Since the accidental introduction of *Ambrosia artemisiifolia* L. and *trifida* L., from North America to France and Hungary in the second half of the 19th century, these weeds have encountered ideal conditions to develop in Europe. The growing economical development and extensive deforestation favoured the increase of industrial and urban fallow land. Both are probably important factors since ragweed grows in freshly moved grounds and along cultivated fields. In many areas the increase in ragweed colonisation is related to the development of sunflower culture. European common agriculture policies (ECAP) may have contributed to some extent to the colonisation of ragweed, as it has a tropism for fallow land. Similarly, the war that led to the fragmentation of Yugoslavia, created a situation where numerous fields were left to lie fallow and where destruction of houses led to extensive waste lands that favoured ragweed colonisation. Transport of soils contaminated with seeds for buildings or embankments, for example along the TGV railway Lyon–Marseille, is also an important cause of ragweed progression in France. The potential effect of global climate change on allergenic pollen production is still a field of investigation. There is good evidence that the climatic reheating is correlated to a mean advance of 3 weeks in the pollination periods of most winter and spring plants in Switzerland over the last 21 years of observation [75–77]. This has however not been shown for ragweed, but one can assume that similar trends might be measured in the coming decade. A recent study has demonstrated that a doubling of the CO₂ concentration in environmentally controlled greenhouses stimulated rag-

weed production by 61% [78]. Despite many uncertainties, CO₂ concentrations have already increased by 29% since pre-industrial times and are still expected to rise [79]. The climate change scenario could therefore be one of the factors favouring the spread of ragweed through Europe and Switzerland [10, 80]. Climatic changes will also favour ragweed colonisation towards the more northern and higher areas, which were initially too cold for its spread. An example is the Czech Republic where a climatic change model showed a potential for extensive ragweed proliferation in the country [81]. Traffic related air pollution is a major contributor to global warming, but may also play a role in the propagation of allergic sensitisation to pollen and therefore possibly to ragweed [82]. However, no consistent results regarding heavy traffic exposure and symptoms of allergic asthma or rhinitis have been found [83]. Ragweed infestation at an early stage has been found preferentially along the communication net such as railways and highways. The two most rapid progressing ragweed colonised areas in Switzerland are Geneva and the Ticino, which both act as main traffic entry gates into the country. Pendulum daily traffic between a ragweed infected area such as the Rhône-Alpes region and the Geneva area could generate seeds deposition on the side of the main communication ways. Agricultural machinery such as combine-harvester are now frequently rented and transported over long distances. There are several examples of farming machinery rented in the Lyon ragweed infested regions that are transported to the Geneva or Lausanne area. In fact, a farmer discovered in Geneva, in the late 90th, that one of his fields was infested by ragweed. This field had been harvested the previous year with an infested combine-harvester rent from an infested area.

Can we still do something

Despite the fact that several countries have implemented various eradication measures, ragweed continues to invade new regions. We still do not know if they really work and which one works best. There is of course the historical successful ragweed eradication campaign that started in Gaspesia in 1937. This province is still free of ragweed nowadays [84]. Nevertheless any later campaign in North America in hotter areas did not obtain a reduction in pollen loads. The main identified reasons are the lack of continuation of eradication measures and/or the lack of coordination between the various concerned administration and/or landowners.

The chance of success of fighting ragweed has to be assessed before starting an expensive campaign in Geneva and Switzerland. Switzerland is still at an early stage of ragweed invasion, which possible favours action. The “Conservatoire et Jardins botaniques de la Ville de Genève” estimated costs for the inventory, the surveillance and the coordinated action against existing ragweed locations in Geneva on approximately SFR 30000.

In view of previous international campaigns and despite the fact that success cannot be guaranteed, every attempt should be made to eradicate ragweed in Geneva and Switzerland, especially at these reasonable costs. Unfortunately, financial resources have not reached this amount in 2004.

Existing phytosanitary interventions

Many actions have been implemented to avoid progression of *Ambrosia artemisiifolia*. They usually depend on the type of infested biotope and are often combined.

Elimination strategies

The plants have to be pulled out systematically before the maturation of the fruits and ideally before flowering latest at the end of July in Geneva and the Rhône-Alpes region. This method is effective but requires several interventions and a lot of manpower in heavily infested areas. Sensitive persons should avoid this preventive eradication and others should protect themselves with gloves and masks during the flowering period. Successive cuts can also avoid flowering and fructification but they have also significant costs. The period of cutting has to be chosen very carefully to avoid seed setting of recovering plants [73]. Experiments are currently being implemented by the Federal Station of Agronomical Research of Changins on infested fields in Geneva. Overall these measures are necessary and costly. However, they are potentially insufficient if not done in coordination with and in addition to other interventions.

Herbicides

Based on the French experience since 1985, various herbicides can be used combined with physical elimination strategies. Chemical weed-killing represents an ecological and health risk and should be used with caution and adequately regulated. Herbicides may be used in agricultural fields only. Ongoing experiments on herbicide are currently being implemented in the infested fields and meadows in Geneva by the Federal Station of Agronomical Research of Changins. None of the tested herbicides have proved a complete efficacy. In sunflower fields, for instance, there is no really efficient product [73].

Prevention measures

Several measures can prevent ragweed infestation in at risk surfaces or in treated surfaces. Textile membranes or re-vegetation have advantages and disadvantages. To avoid and control ragweed infestation, bare surfaces must be covered and regularly inspected.

What is done and where

Experiences from France

The enormous potential of dispersion is the strength of this invasive neophyte species. The analysis of the ragweed invasion in the Rhône-Alpes region since 30 years bears concern, despite several eradication campaigns. The lack of coordination between the various administrative offices, the absence of concerted actions including all the infested areas of a region, and the too short duration of these campaigns are responsible for the lack of success. The neighbouring areas of the Rhône-Alpes valley channel like Switzerland and other French regions (Auvergne, Provence-Côte d'Azur) are now reaching levels of ragweed pollen close to the threshold of alert. In the Rhône-Alpes area CHF 250'000 are spent yearly only to spread information. Practical documentation on the ragweed fight and pollen counts for various areas within the Rhône-Alpes region are available and downloadable from the internet: www.ambrosie.info.

Experiences from Italy

The case of northern Italy is exemplary, because almost nothing was done despite numerous warnings to fight ragweed in an early stage of the invasion. After 10 to 15 years the passivity of the authorities has resulted in the fact that ragweed is found almost everywhere. The consequences

in terms of public health and costs are very important. For example, in the very heavily infested area of Busto Arsizio, 12% of the population is allergic. Here the pollen concentration often exceeds 200 pollen/m³ during the flowering season and reaches for several days 700 pollen/m³. The state hospital of Milano 1 spent approximately 1'390'000 Euro to treat the ambrosia allergic people in 2002 [26]. Moreover, the chances of ragweed eradication at this stage of the invasion are compromised, in particular for economical reasons.

Experiences from Canada

The historical successful eradication campaign launched in 1938 was based on systematic pull-out of the ragweed plant with the help of school-children in Gaspesia [84]. There are several geographic reasons that may explain that success that still prevail today. Gaspesia is located on the shore of the Atlantic ocean, which limits the spreading of the weed, and is situated at the septentrional limit of the ragweed distribution. The same type of campaign has nevertheless failed in 1950 in other parts of Canada and in particular in Montreal. In Quebec the direct cost of ambrosia (health and prevention) reaches an equivalent of CHF 49 millions. The campaign against the spread of ragweed in Quebec has been re-evaluated since 1990. It demonstrated that repeated yearly cam-

paigns implementing mowing the weed at 2 cm or hand weeding at the second fortnight in July are effective. The seed production reduces and the

pollen production can be reduced by 88%, thereby insuring a relative relief for people allergic to ragweed pollen [85, 86].

Proposed measures in Switzerland

The National pollen network (MeteoSwiss), has made possible to announce the presence of ragweed pollen in Switzerland and in particular in Geneva since 1993, at an early stage of invasion. The ground control of the canton of Geneva has corroborated these findings by detecting an increase in the number of spots, mainly in freshly moved fields and along streets and railway lines. Early measures have been taken since 2001. In Geneva most ragweed plants have been pulled out one or several times and herbicides have been used in the agricultural invaded surfaces. Ragweed is now well known by farmers and may be regularly controlled mechanically or by herbicides. The Geneva Ambrosia Group has been officially recognised by the *State Council of Geneva* (Conseil d'Etat de Genève) on April 21, 2004. Further measures need to be supervised at the federal level [87]. A multidisciplinary net will therefore soon be launched by the *Swiss federal Office of Public Health* (SFOPH = OFSP = BAG) in collaboration with Allergy health specialists from Swiss Universities and private practice, the *Swiss Agency for Environment, Forest and Landscape* (SAEFL = OFEFP = BUWAL), the *Federal Office for Agriculture* (FOA = OFAG = BLW), and road and rail maintenance services. This national group will have to statue on the best measures to be taken in the light of the

failures and successes of other countries and create an adequate monitoring system. To eradicate ragweed specific federal legislation is needed regarding the importation of bird grains, since 70% of them are contaminated by ragweed seeds. Farmers should be encouraged to announce systematically a ragweed infestation to the adequate phytosanitary authority. Small surfaces or low intensity infestation should be treated by pulling-up plants and when the surface is too large or the density too high it is best to combine successive cuts and chemical treatments. The use of herbicides should be regulated at the federal level depending on the type of infested field and the stage of growth of the ragweed plant. Information about the different ragweed eradication methods should be spread out in all national Swiss languages and on the same level as in France. The surveillance of ragweed locations of infestation in Geneva, has confirmed its continuous presence since 2001. The seed bank is elevated to very elevated in the ground of heavily invaded areas. This will allow germination for many coming years. The pursuit of anti ragweed measures and prevention strategies are therefore necessary to avoid or limit the formation of new seeds and further propagation of the ragweed infestation.

Predictive models

In North America or in the French Rhône-Alpes region, it seems unrealistic to try to eradicate ragweed at short or medium term. Aerobiologists have therefore implemented forecasting models based on the probabilistic distribution of pollen curves [7]. Except for large and rapid fluctuation of pollen counts, this model allows a good estimate of the exposure risk two days in advance [88]. Moreover, the start and the duration of the

pollen season can be forecasted with statistical models: one by summing the temperatures and the other by using a multiple regression based on monthly meteorological parameters. These models are successfully implemented in the Lyon area since 2000 by allergists and patients who can anticipate the risk of ragweed exposure and take preventive treatment [89].

Conclusion

A low grade but rapidly expanding ragweed invasion has now started in some locations around Geneva, in the Ticino and in other parts of Switzerland. Farmers are already well informed of the situation and adequate measures should be taken. There is more concern about industrial, urban and natural sites of ragweed invasion because the public is insufficiently informed. Federal

sanitary authorities will have to coordinate costly global measures encompassing regulation, prevention, elimination strategies and education. Acting now, at reasonable costs may avoid an allergic epidemic similar to the one in the neighbouring French Rhône-Alpes region, where 12% of the population is allergic to ragweed. This window of opportunity should not be missed and every effort

should be made to stop the ragweed invasion before it becomes a public health or agricultural problem. This is also one of the main recommendations from the World Health Organization concerning the future of allergies [90].

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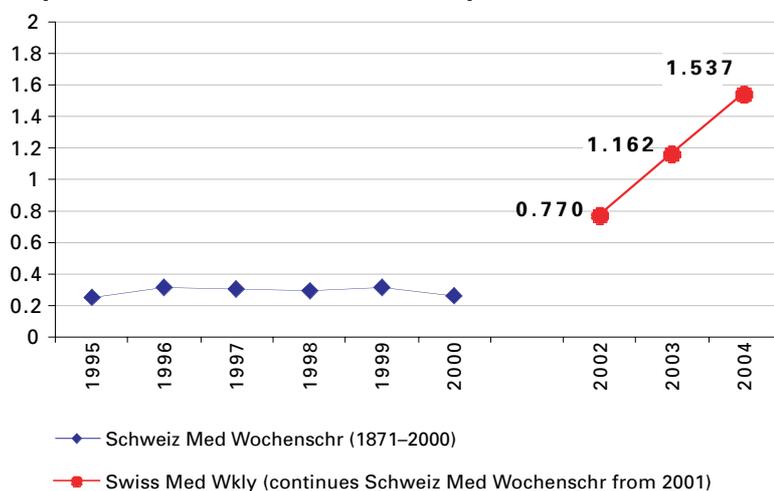
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