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Aerobiological monitoring and mapping of *Ambrosia* plants in the province of Parma (northern Italy, southern Po valley), a useful tool for targeted preventive measures

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Abstract

Background. *Ambrosia is an annual anemophilous weed producing allergenic pollen affecting public health in European countries. In Italy, the most infested region is Lombardy where, in some areas, it is the major cause of hay fever. In the Parma district, until 2007, Ambrosia seemed to be very rare, despite an observed increase of Seasonal Pollen Index (SPI), of pollen peak value and of asthma among ragweed sensitized patients. The aims of this study were to calculate ragweed pollen season and trends from 1996 to 2015, to assess the relationships between pollen season characteristics and selected meteorological data, to map plants in the territory and to evaluate the presence of beetle Ophraella communa (Ophraella), known as an eater of Ambrosia leaves.*

Methods. *The following pollination parameters: start, end, duration, peak concentration date, peak values, SPI and the following climatic parameters: temperature, relative humidity, rainfall, were analyzed. The ragweed plants sites were mapped and the presence of Ophraella was assessed during naturalistic activities.*

Results. *Significant SPI and pollen peak value increase until 2011 were observed, but recently, 2012-2015 vs 2009-2011, a strong reduction (about 50%) of these parameters was observed. The spring average air temperature increased significantly. The results of the correlation analysis showed Ambrosia season characteristics significantly related. We identified the sites source of Ambrosia, even downtown at the confluence between Parma and Baganza rivers. Ophraella was observed for the first time in 2014.*

Conclusions. *The results showed the spread of ragweed plants over the territory and the risk of allergy increase that ragweed could cause. It remains to evaluate the role of the Ophraella in the reduction of Ambrosia pollen concentration. It is important to consider the potential risk Ophraella may represent for sunflower and other taxonomically related crop plants and other native and exotic species.*

The lack of initiatives by the Health Authorities to prevent and to contrast the spread of Ambrosia in the Parma area could cause public health consequences and an increase in health expenditures.

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Introduction

Ragweed is an annual invasive weed belonging to the *Asteraceae* family, originating from North America but later spread into Europe and Asia, causing public health related problems in many countries due to its anemophilous, very allergenic pollen (1). In Europe, its economic impact was recently estimated at several billions Euro annually, concerning effects on human and animal health, biodiversity, the environment, agriculture, horticulture, tourism, transport, building infrastructures, monitoring and control in urban areas too (1). Many European countries, characterized by continental climate, are infested by ragweed (2), which have late summer-early fall pollination. Five species of ragweed are common in Europe: *Ambrosia maritima* L. with Euri-Mediterranean native habitat, which grows in sandy soils close to the seashore causes minor allergic consequences, and *Ambrosia artemisiifolia* L., *Ambrosia tenuifolia* Sprengel, *Ambrosia coronopifolia* (*Ambrosia psilostachya*) Torr. et Gray, *Ambrosia trifida* L., originated from the American continent, locally naturalized, which grow in uncultivated fields, disused areas, railway embankments, road sides, sandy soils, and cause very important allergic consequences. In Europe foreign ragweed started expansion in the latter decades of the 19th century from Hungary (3), Austria (4), Croatia (5), some parts of France (6) and Italy (7). At present, this weed is spread mostly in Eastern Europe, in particular, in the Pannonian area and also in France, particularly in the Rhône-Alpes region, and the spreading is in progress in many countries (8, 9). The international trade and, in some case, the climatic changes are suspected to drive ragweed invasion (10). In Italy, the most infested regions by ragweed are in the Po Valley (11), especially in Lombardy, where the plant is widespread and where, in the Milano Province, 13,000 ha of crops (about 10%) were affected in 2005 (12). The species appears to be spreading toward South, with spreading rate calculated between 6 and 10 km/yr^{-1} (1). Regarding the area of Parma, in our previous study (13) we found that *Ambrosia* pollen first appeared in the early '90s, and since 1996 its presence has become regular during summer, just like the increasing trend of yearly total pollen and daily peak value. In the Parma area the plant was identified as sporadic until 2007. From 2007 up to 2011 the increasing concentrations of ragweed pollen recorded in Parma area anyway was lower than those recorded in other European and Italian areas [yearly total pollen <2,000 in Austria (4), <4,000 in Croatia (5) or <6,000 in France (14)]. Hungary showed even higher yearly total pollen, close to 20,000 (15). The ragweed pollen is transported over long distances (thousand kilometers) (16, 17) in our area too (18) and the analysis of weather charts and the calculations of back-trajectories over Parma, showed that during the peak periods the wind direction was often from North-North East, so from the most infested areas of Europe and Italy. The importance of transport of ragweed pollen over long distances has been also demonstrated in other European countries (19-21).

Aerobiological and clinical studies from various countries have documented the importance of ragweed pollen as an aeroallergen (7, 22-27). Positive results to ragweed allergens in the skin prick test (SPT) of allergic patients is more than 80% in Hungary, 30% in France, Austria and Czech Republic, 17% in Southern Switzerland (28-30). In Lombardy, in some areas, *Ambrosia* is the major cause of seasonal respiratory allergy (31). In Legnano, near Milan, the sensitization rate to ragweed of patients with pollinosis increased from 24% in 1989 to over 70% in 2008 (32). In 1989, about 45% of the ragweed sensitized patients suffered from respiratory symptoms (rhinitis, asthma). After five years, this percentage increased to

70% and finally reached 90%. In Parma we found a significant increase in the number of polysensitized patients with positive SPT to ragweed and, among these, a significant increase of asthma symptoms (33).

In Italy only the Lombardy region has been fighting *Ambrosia* spread for many years (34-37).

Recently, the beetle *Ophraella communa* (*Ophraella*), as *Ambrosia* native to North America, was accidently introduced into many countries in eastern Asia, where it is currently used as biological control agent against ragweed. At sites where the beetle was present, up to 100% of the plants were attacked with damages causing complete defoliation and death of ragweed before flowering. In 2013 this beetle was found in Europe and it is not clear the route *Ophraella* has followed. Where this occurred, it significantly reduced airborne pollen concentrations (38). Evidence has been provided that the presence of *Ophraella* may explain the lower levels of *Ambrosia* pollen recorded recently in Northern Italy (39). Unfortunately, some plant tests conducted within the EU-COST action on sustainable management of *Ambrosia artemisiifolia* (40), including taxonomically related crop plants and other native and exotic species, concluded about a potential risk by *Ophraella* for sunflowers intended for oil production, as an ornament or as animal food and for closely related endangered species.

Aims of this study were to analyze the ragweed pollen distribution in the Parma area over twenty years from 1996 to 2015, to calculate the pollen seasonal parameters, the trends of selected meteorological data and the relationships between them. Correlation between pollen season parameters and selected meteorological data was calculated. In addition, the presence of ragweed plants and of *Ophraella* on the territory of the Province of Parma was assessed.

Materials and methods

Location of the study

The study was performed in the Province of Parma (500,000 inhabitants) which lies in the Po Valley between the right side of the Po River and the Apennines (Figure 1).

Aerobiological data

Airborne pollen was sampled using a Hirst type 7-day recording volumetric spore trap, the standard equipment used for aerobiological sampling worldwide (41), according to the methods of the Italian Aerobiology Association (AIA) (42). The pollen trap was placed at 18.2 m above ground level on the meteorological tower of the Parma University in the town center, 52 m above sea level, latitude 44°48'15" North, longitude 10°19' East. We analysed pollen data collected over a 20-year period from 1996 to 2015. According to Jäger et al. (43), we examined pollination start, end, duration, date of peak, peak pollen value and Seasonal Pollen Index (SPI) as characteristics of the pollen season. The onset of the pollen season was defined as the first day when the cumulative pollen

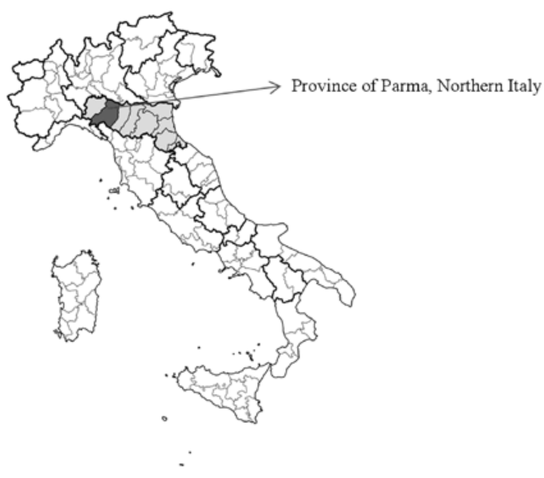


Figure 1 - Position of the monitoring sites for pollen and plants

count exceeded 1% of the annual total, not followed by more than six consecutive days with zero values. The end of the season was defined as the day upon which 95% of the annual total was reached (44). The duration of the season was calculated as the difference in days between the start date and the end date of the season. Temporal variations in pollen seasons (i.e. start date, end date and date of peak) were displayed as the number of days from January 1st (Day of the Year, DOY). Pollen concentrations were expressed as the number of pollen/m^3 and the SPI was expressed as grains (45).

Botanical and entomological data

During naturalistic activities performed from 2008 to 2015, the sites with presence of ragweed plants and *Ophraella* were mapped.

Meteorological data

Daily averages of temperature (°C), relative humidity (%) and total rainfall (mm), transformed into annual or seasonal averages, were taken into consideration. The meteorological data were obtained at the same site where the pollen data were recorded.

Statistical analysis

Statistical analysis were performed using Microsoft Excel and IBM SPSS 23 software. Kolmogorov–Smirnov and Shapiro–Wilk tests were used to assess the type of distribution of pollen parameters. The tests showed that the pollen data were not normally distributed and so Spearman's "q" correlation tests (46) were used to establish whether any significant relationship existed between the different characteristics of the pollen season: start date/end date; start date/duration; start date/peak value; start date/SPI; start date/date of peak; end date/duration; end date/peak value; end date/SPI; end date/date of peak; duration/SPI; duration/peak value; duration/date of peak; SPI/date of peak; SPI/peak value; and peak value/date of peak. Simple linear regression analysis was carried out in order to investigate trends in certain characteristics of selected pollen seasons and meteorological data over time (47-49). The median, mean, standard deviation (SD), R^2 value, slope of the regression over time, standard error of the regression slope (SE), probability level (p) and number of years in the analysis (N) were calculated. Results were considered to be significant when $p<0.05$. To detect the presence of trend the Cox-Stuart test was applied.

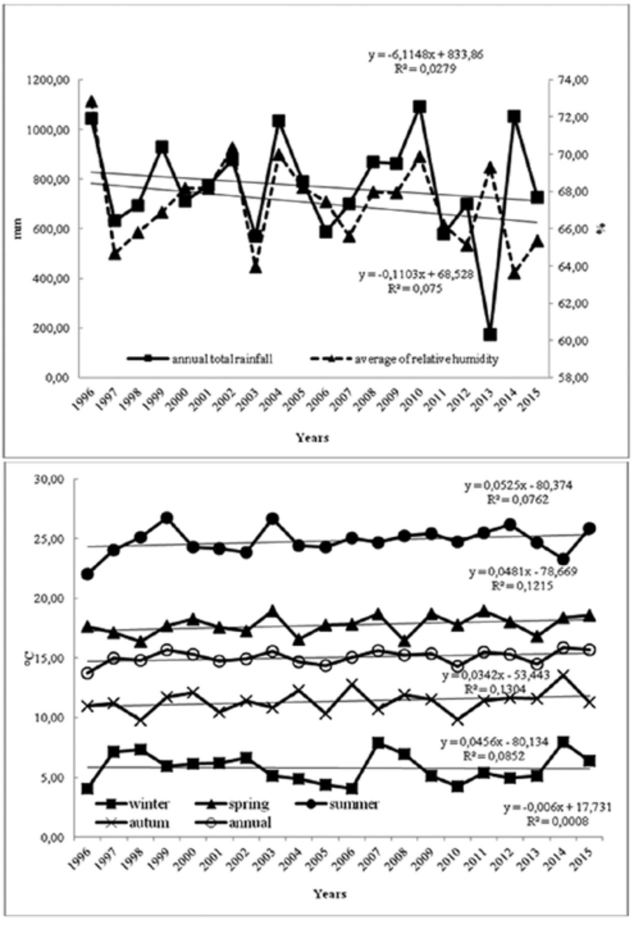
Results

Variations over time in the *Ambrosia* season of airborne pollen characteristics recorded in Parma (between 1996 and 2015) are shown in Table 1. As median, *Ambrosia* pollen appears in the air of Parma with DOY 219 and as the pollen seasons end with DOY 262. The average duration of the pollination period was 46 days (Table 1). The pollen peak value was 36 pollen grains/m^3, DOY 242. The median SPIs was 259. During the period studied, the lowest and highest amounts of variability for SPI were 6 and 793. The analysis of selected meteorological data, recorded over the same time period, showed a decrease in annual total rainfall and in annual relative humidity (Figure 2a) and a concurrent increase of annual and seasonal temperatures (Figure 2b). Only the average spring temperature increase was significant ($p<0.05$). We observed a significant increase of SPI and of the peak value until 2011 (peak value 128 p/m^3, SPI 793 during 2010) (33), but a reduction of SPI (-52.6%) and of peak value (-58,6%) 2012-2015 *vs* 2009-2011 was observed. Figure 3 shows the comparison of average pollen per day and average annual peak value concentration. The SPI (Table 1) and the numbers of days with pollen concentrations over 10 pollen grains/m^3 (Figure 4) over 20 years, significantly

Table 1 - Seasonal characteristics (i.e. start date, peak date and end date, duration, peak value and SPI) and trends of *Ambrosia* pollen recorded in Parma, Northern Italy, from 1996 to 2015

1996 - 2015	*Ambrosia*							
	Median	Mean	SD	R^2	Slope	SE	*p*	N
Start date (DOY)	219	214.95	20.49	0.00	0.08	0.82	0.92	20
Peak date (DOY)	242	240.95	7.78	0.01	0.11	0.31	0.73	20
End date (DOY)	262	265.65	14.13	0.07	-0.61	0.54	0.28	20
Duration (DOY)	46	50.90	19.40	0.04	-0.64	0.76	0.41	20
Peak value (Pollen/m^3)	36	42.20	30.60	0.16	2.10	1.11	0.08	20
SPI	259	300.15	214.87	0.43	23.69	6.49	***0.00***	20

The following statistics are included: the Median, Mean, Standard Deviation (SD), R^2 value, Slope of the regression over time, Standard Error of the regression slope (SE), probability level (*p*) and number of years in the analysis (N)
Slope considered to be significant when *p*<0.05. We report in italic letters *p<0.05*, in bold letters **p< 0.01** and bold italic letters ***p< 0.001***



a)

b)

Figure 2 - Variation and trends of selected meteorological data recorded in Parma during the study period: a) annual total rainfall (mm) and average of relative humidity (%); b) annual and seasonal mean temperatures (°C).

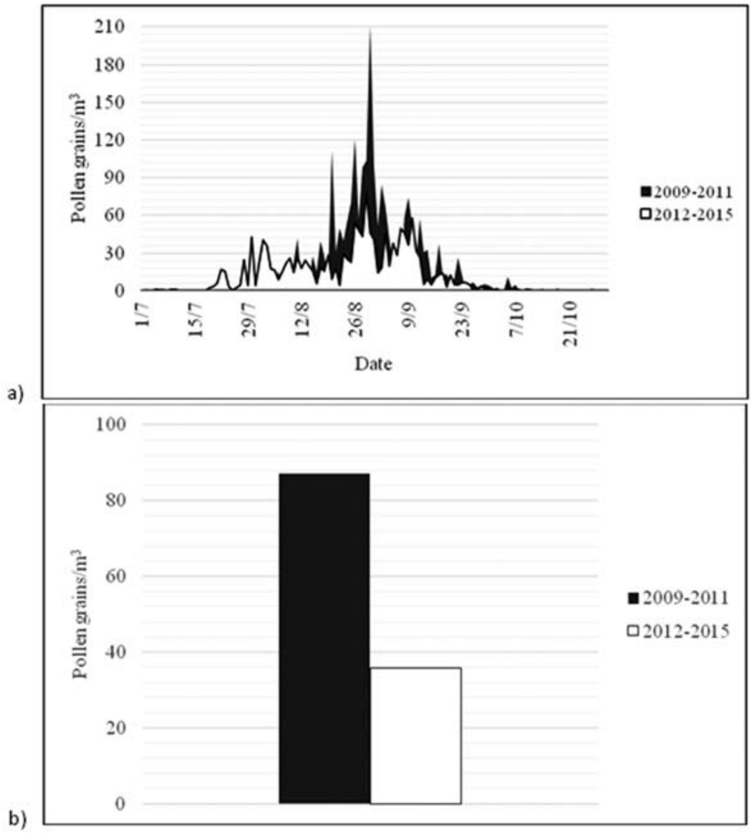


Figure 3 - Comparison of the pollen means per day (a) and peak values (b) of the period 2009-2011 *vs* 2012-2015.

increased despite the great reduction observed in the last few years. No significant trends in season characteristics related in timing of pollen season (start, end, duration), but only in SPI, was observed (Table 1). There were also a large number of significant Spearman's rank correlations between different pollen season characteristics (Table 2). Significant negative correlations between end dates and SPI, end dates and the peak value or start and duration, peak value and duration were observed (respectively ρ= -0.541, ρ= -0.463, ρ= -0.589 and ρ= -0.447). There was also a significant negative correlation between duration and SPI (ρ= -0.552). Significant positive correlations between end and duration (ρ=0.506), and SPI and peak value (ρ=0.820) were observed. There were also significant positive correlations between SPI and spring (ρ=0.582) and summer temperature (ρ=0.490). In addition, a positive correlation between relative humidity and the day of peak (ρ= 0.538) and a negative correlation between annual average temperature and the day of peak (ρ= -0.508) were observed.

On the ground we identified numerous sites with ragweed plants: *Ambrosia artemisiifolia* (42), *Ambrosia coronopifolia* (37) and *Ambrosia trifida* (5) (Table 3), even downtown, specially, at the confluence of the Parma river with the Baganza river. *Ambrosia* was observed up 660 m above sea level. 56.8% of the sites with *Ambrosia coronopifolia* were located in hilly areas South of Via Emilia and 27.1% in Parma

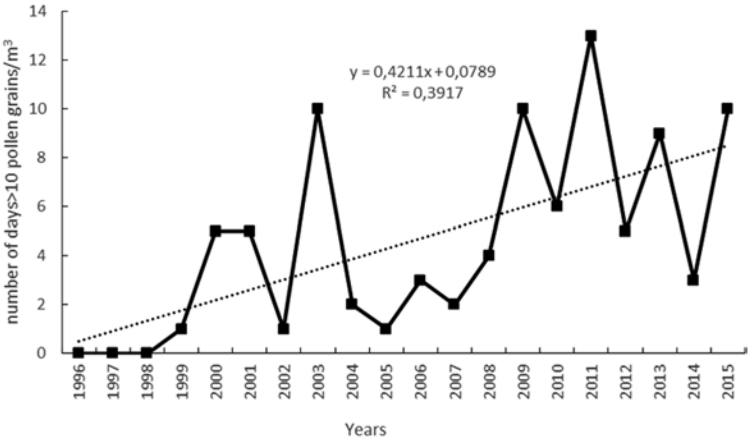


Figure 4 – Numbers of days per year with pollen concentration over 10 pollen grains/m^3, N=10, r=1, $p<0.01$

downtown; 39.1% sites with *Ambrosia artemisiifolia* were located in hilly areas South of Via Emilia and 22% in Parma downtown. *Ambrosia trifida* was observed North of Via Emilia (Figure 5). In Vignale, beetle *Ophraella* was observed for the first time in 2014 (Figure 6 a, b, c). In 14.5% of the sites involved with *Ambrosia,* presence of the beetles was observed (19% of sites with *Ambrosia coronopifolia*, 12.2% of sites with *Ambrosia artemisiifolia* and 0% of sites with *Ambrosia trifida*).

Discussion and Conclusions

Observations conducted in the early 1990s showed that *Ambrosia* pollen appeared sporadically in the air of Parma, but - since 1996 - there has been a significant increase in pollen as well as a corresponding growth in the number of patients with positive SPT to *Ambrosia* pollen allergens, and - among these - a significant increase of asthma (33). It is important to underline that allergic reactions significantly reduce the quality of life, interfere with both attendance and performance at school and work (50). The allergic diseases (rhinitis, hay fever, asthma, and atopic dermatitis), associated with exposure to aeroallergens, determine both substantial health effects and large economic costs (50, 51). The aims of this study were to quantify the regional pollen spectrum of *Ambrosia* observed over a 20-year period, the trends, and to evaluate the relationships between them and meteorological data. An additional goal was to map the ragweed plants in the area and to evaluate the presence of the beetle *Ophraella,* an eater of *Ambrosia* leaves which, inexplicably, has never been observed North of the Via Emilia. The results confirm the well-documented expansion of these invasive alien species in Northern Italy (26, 52) and the increasing trend of exposure data of previous study, despite the reduction in airborne pollen observed in the last few years. Concentrations in Parma are lower than in the province of Milan (Lombardy), where yearly total pollen is approx. 5,000, but higher than many other areas, e.g. Central Italy where yearly value is lower than 100 (data from R.I.M.A.®, Italian Monitoring Network in Aerobiology of the Italian Association of Aerobiology, AIA), anyway capable of determining sensitization and symptoms in allergic individuals (33). The significant negative correlation

Table 2 - The results of Spearman's rank correlation test between different parameters of the pollen season

Seasonal and meteorological data	Start	End	Duration	Peak value	SPI	Day of Peak	Winter mean temperature	Spring mean temperature	Summer mean temperature	Autumn mean temperature	Relative humidity average	Annual total rainfall	Annual mean temperature
Start	-	ns	-0.589**	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
End	ns	-	0.506*	-0.463*	-0.541*	ns	ns	ns	ns	ns	ns	ns	ns
Duration	-0.589**	0.506*	-	-0.447*	-0.552*	ns	ns	ns	ns	ns	ns	ns	ns
Peak value	ns	-0.463*	-0.447*	-	0.820***	ns	ns	ns	ns	ns	ns	ns	ns
SPI	ns	-0.541*	-0.552*	0.820***	-	ns	ns	0.582**	0.490*	ns	ns	ns	ns
Day of peak	ns	ns	ns	ns	ns	-	ns	ns	ns	ns	0.538*	ns	-0.508*
Winter mean temperature	ns	ns	ns	ns	ns	ns	-	ns	ns	ns	-0.499*	ns	0.517*
Spring mean temperature	ns	ns	ns	ns	0.582**	ns	ns	-	ns	ns	-0.456*	ns	0.621**
Summer mean temperature	ns	ns	ns	ns	0.490*	ns	ns	ns	-	ns	ns	ns	0.481*
Autumn mean temperature	ns	ns	ns	ns	ns	ns	ns	ns	ns	-	ns	ns	ns
Relative humidity	ns	ns	ns	ns	ns	0.538*	-0.499*	-0.456*	ns	ns	-	ns	-0.764***
Annual total rainfall	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	-	ns
Annual mean temperature	ns	ns	ns	ns	ns	-0.508*	0.517*	0.621**	0.481*	ns	-0.764***	ns	-

*p<0.05, ** p<0.01, ***p<0.001, ns: not significant

between duration and SPI suggests that a high level of the *Ambrosia* pollen season is shorter. However, the values indicate a phenomenon which was evolving at least until the appearance of *Ophraella*. In the Parma area the increase in concentrations of ragweed pollen grains can probably be related also to the progressive disuse of industrial areas (53), with consequent spread of *Ambrosia* plants. The construction of the High Speed Rail Line had a high impact on the area close to the city, with enormous amounts of soil moved and, consequently, with the accumulation of many derelict buildings and uncultivated land (54). The results presented here provide an essential baseline for determining exposure of the population to allergenic pollen and can help in understanding the incidence of pollinosis to *Ambrosia* in Parma. However, with the increase in the concentrations of ragweed pollen and the likely increasing sensitization in the allergic population, it would be important to improve monitoring and forecasts systems of pollen distribution (55). It is necessary to develop the territory mapping to control ragweed spreading across the area of Parma, and to understand how widespread the populations of ragweed plants are. At present, it is important to keep under observation the relationship between seasonal pollen parameters and meteorological trends by following over time the evolution of the data through local (56) and wide scale aerobiological monitoring. Moreover, it is equally important to assess the role of *Ophraella* in the reduction of pollen concentration observed in the last few years, keeping in mind that it does not only eat the leaves of *Ambrosia* but it can also eat the leaves of sunflowers used for oil production or as ornament or as animal food and of other taxonomically related crop plants and of other native and exotic species.

In the future, in our region, we could observe the increase of ragweed allergy related to plants spread over the territory.

Table 3 - Sites observed in 2014 and 2015, in the Province of Parma, with presence of both *Ambrosia* plants and the beetle *Ophraella communa* (in brackets)

	Altitude above sea level	*A. artemisiifolia*	*A. cononopifolia*	*A. trifida*
Berceto	285-450	2		
Bore	653	1		
Borgo Val di Taro	660	1		
Collecchio	81-115	3 (1)	4 (1)	
Colorno	32	2		
Corniglio	385		1	
Felino	220	1	1	
Fidenza	53-100	3		2
Fontanellato	42	1	1	
Fornovo di Taro	150		1	
Lesignano de' Bagni	220		1	
Medesano	95-126	3 (2)	2 (2)	
Mezzani	26-30	3	1	
Montechiarugolo	125		1	
Noceto	75		1	
Palanzano	360		1	
Parma	34-145	9 (1)	10 (1)	
Polesine Parmense	33	1		
Roccabianca	31-35	2	1	
Sala Baganza	175-275	2 (1)	3 (1)	
Sissa	30	1		
Solignano	150-175	3	1	
Soragna	42-48			3
Sorbolo	35		1	
Traversetolo	135-150	1	2 (1)	
Trecasali	38		1	
Varano de' Melegari	165-220		3 (1)	
Zibello	35	2		
Total		41 (5)	37 (7)	5

At present, in our area, the situation is very similar to what occurred in Lombardy at the end of the last century (7). Local health authorities and public entities delegated to the control of the territory should work to coordinate monitoring and management, based on the experiences of Lombardy in order to fight the *Ambrosia* pollen and plants spreading. In the absence of legislative and managerial initiatives by the Institutions and the local Health Authorities to understand, to prevent and to reduce *Ambrosia* plants spread, serious consequences on public health should be expected and, in addition, also an increase of direct and indirect sanitary costs.

The public health authorities should organize dedicated teams, as the Lombardy Health Authorities have already done, for targeted preventive measures. In fact, the Lombard Department of Health has prepared guidelines (57) for many years, for the prevention of ragweed pollen spread, entrusted to the Prevention Departments of the Local Health Authorities and Municipalities, adopting

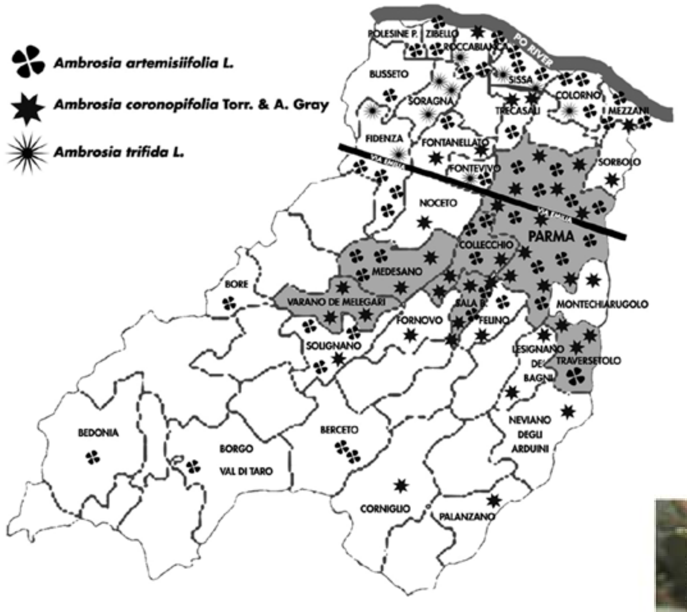


Figure 5 – Province of Parma. Sites observed from 2014 with Ambrosia plants (different species). The beetle Ophraella communa was observed in the municipalities of Collecchio, Medesano, Parma, Sala Baganza, Traversetolo and Varano de Melegari (areas marked in gray).

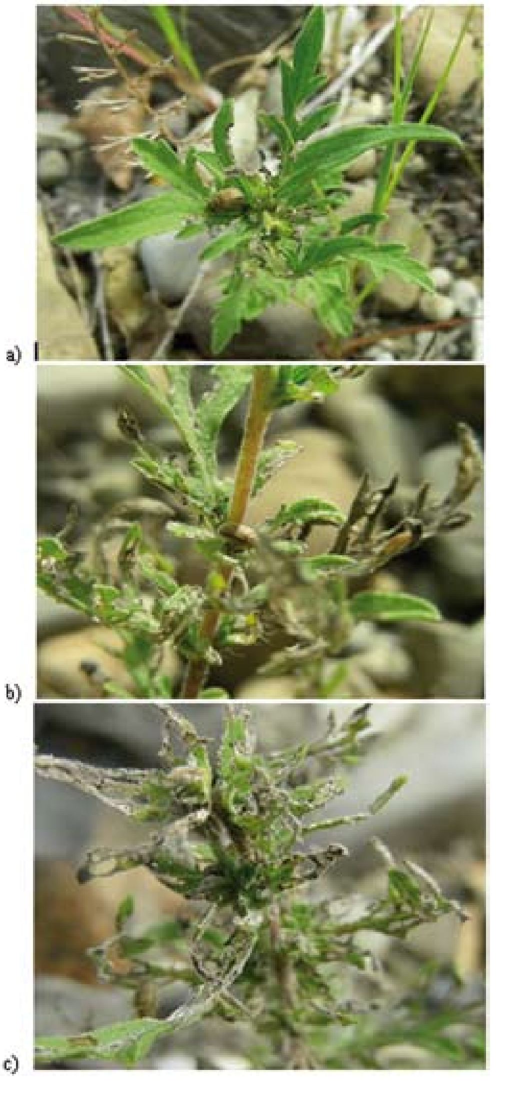


Figure 6 - a) The beetle Ophraella communa in action on Ambrosia coronopifolia Torr. & Gray (left river-bed of the Enza river in Vignale of Traversetolo, Summer 2014); b) and c) ragweed plant with leaves badly worn.

a multidisciplinary approach. The goals were: studies of territorial expansion of the plant, containment activities of the spread of the plants on the territory, allergy epidemiology, restraint of sanitary costs, conferences of consensus on the ragweed allergies prevention guide, education and empowerment of the population. In addition to pollen, following the recent results of the European project HIALINE (Health Impacts of Airborne Allergen Information Network) (58-60), in the near future, it will be important to focus also on ragweed airborne allergen content (i.e. amb a1). This will lead to understand and better define the risk of exposure to airborne *Ambrosia* allergens in order to protect allergic patients and the entire population.

As in any environment where biological particles can pose a risk either to human health or to the integrity of materials, microbiological monitoring is a fundamental activity for the management of the problem (61-69), also for the prevention and control of *Ambrosia* allergy, monitoring concerning pollen, allergen and plants represents a useful tool for targeted preventive measures.

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Riassunto

Il monitoraggio aerobiologico e la mappatura delle piante di Ambrosia in provincia di Parma (nord Italia, a sud del fiume Po), un utile strumento per misure preventive mirate

Introduzione. L'*Ambrosia* è una pianta annuale, infestante, a impollinazione anemofila che produce grande quantità di polline allergenico. In Italia la regione maggiormente infestata è la Lombardia dove in alcune aree, *Ambrosia* rappresenta la principale causa di pollinosi. In provincia di Parma, fino al 2007 il ritrovamento della pianta era occasionale, nonostante l'incremento dell'Indice Pollinico Stagionale (SPI), dei valori di picco pollinico e dell'asma tra i pazienti sensibilizzati ad essa. Scopo dello studio è stato quello di calcolare, nel periodo 1996-2015, la stagionalità pollinica e le sue tendenze, correlandole ad alcuni valori meteoclimatici, mappare la diffusione delle piante nel territorio e osservare la presenza di *Ophraella communa (Ophraella),* insetto conosciuto come divoratore di foglie di *Ambrosia.*

Metodi. Sono stati analizzati i seguenti parametri di pollinazione: inizio, fine, durata, data del picco di concentrazione, valori di picco, SPI e i seguenti parametri climatici: temperature, umidità e precipitazioni totali. Nel corso di attività naturalistiche sono stati mappati siti con *Ambrosia* e determinata la presenza di *Ophraella.*

Risultati. Fino al 2011 sono aumentati significativamente SPI e valore di picco pollinico che nel corso degli anni successivi si sono ridotti circa del 50% (2012-2015 vs 2009-2011). Durante il periodo considerato si è osservata una correlazione tra andamento delle temperature medie primaverili (che sono aumentate significativamente) ed estive con lo SPI. Diversi parametri della stagionalità di *Ambrosia* sono risultati correlati in modo significativo. Sono stati identificati siti con *Ambrosia* in tutta la provincia, anche all'interno della città, alla confluenza dei torrenti Parma e Baganza. Nel 2014 è stata osservata per la prima volta *Ophraella.*

Conclusioni. La diffusione delle piante di *Ambrosia*, osservata negli ultimi anni, potrebbe provocare l'incremento del rischio dell'allergia all' *Ambrosia.* La presenza del coleottero potrebbe essere messa in relazione con la concomitante diminuzione delle concentrazioni del polline di *Ambrosia.* Tuttavia, resta da valutare il ruolo di *Ophraella* nella riduzione della concentrazione pollinica registrata nel contempo, considerando anche il potenziale rischio determinato dal coleottero nei confronti delle coltivazioni di girasole o di altre specie esotiche o native tassonomicamente correlate. La mancanza di iniziative di prevenzione/contrasto della diffusione di *Ambrosia* sul territorio, da parte delle autorità competenti, potrebbe determinare conseguenze importanti di salute pubblica con aumento dei costi sanitari.

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