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Article

European Safety Measures and Specific Legislation to Control and Eradicate Common Ragweed (*Ambrosia Artemisiifolia)*

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Abstract: Air pollution, climate change and global warming show direct linkage. **Introduction - Background:** Research in the field has proposed and demonstrated their link to increased allergenicity in plants, leading to increased allergic diseases. Allergen patterns are changing in response to climate change. Across Europe, up to 12% of the population suffers from allergic diseases (bronchial asthma and allergic rhinitis) caused by the pollen grains. The medical costs of these types of allergies are enormous and are increasing with the spread of common ragweed - *Ambrosia artemisiifolia** in Europe. In practice, more and more patients are turning to allergists. **Methods:** Based on these data, the research aims to identify safety measures and specific legislation to control and eradicate common ragweed in the countries most affected by the spread of this plant in Europe, increase in population exposure in countries affected by the presence of common ragweed and the socio-economic impact of allergic rhinitis and bronchial asthma at European level [1,2]. Our database search did not reveal any other research that has addressed this topic to date. **Results:** This research identifies specific legislation to the countries most affected by the spread of this plant pollen grains at European level, changes in allergen patterns and monitoring/safety eradication measures decided by local authorities, and data on the spread of common ragweed over the last two decades, costs per treatment, increased allergic rhinitis and bronchial asthma morbidity in the most affected areas. **Conclusions:** At European level, there are no universally valid models for eradicating this weed. Various methods can be used to limit the spread of common ragweed and its pollen production (e.g. mowing once or twice a year of overgrown land, ploughing, chemical control, public information, etc.). Local and regional cooperation should be considered essential to promote phytosanitary & safety measures and exchange of information on methods to identify and manage the spread of common ragweed. Unified legislation at European level would help all affected countries; reduce morbidity from respiratory allergic diseases and the costs of treating these diseases. **in all this paper, we will find it under the name Ambrosia artemisiifolia or common ragweed.*

Keywords: climate change; air pollutants; climatic conditions; aeroallergens; invasive plants/species; common ragweed; Ambrosia artemisiifolia; monitoring and eradication; respiratory diseases; allergic rhinitis; bronchial asthma; specific legislation; public health

1. Introduction

1.1. Background

Respiratory diseases are on the rise worldwide, both allergies and associated allergic diseases (allergic rhinitis, bronchial asthma, atopic dermatitis and food allergies) [4–8]. Pollen levels are monitored daily in many countries around the world and in Europe (pollen levels from trees, grass and common ragweed are monitored daily) [3,4], where allergic diseases are a major public health problem. The seasonality and severity of both allergic rhinitis and bronchial asthma are influenced by the growth patterns of allergen species. Common ragweed is a weed that has spread rapidly throughout the world and in many European countries is now a real danger to human health and the

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environment [5]. Climate change and outdoor air pollution increase the allergenicity of some plants (such as common ragweed) and have a direct negative effect on human health.

Global distribution - the occurrence of common ragweed *(Ambrosia Artemisiifolia)* is reported in large regions around the world: North America (Canada, USA, Mexico), South America (Brazil, Uruguay, Paraguay, Argentina, Chile), Africa (South Africa), Asia (Japan, South Korea, China), Australia and New Zealand and in different european countries (northern Portugal, parts of France (Rhône Valley region), northern and central Italy, south-eastern Europe: Hungary – considered the most affected country in Europe, Slovenia, Croatia, Serbia, Albania, south-western Russia, eastern Ukraine, parts of Romania, Montenegro, Bosnia and Herzegovina, Greece) [5].

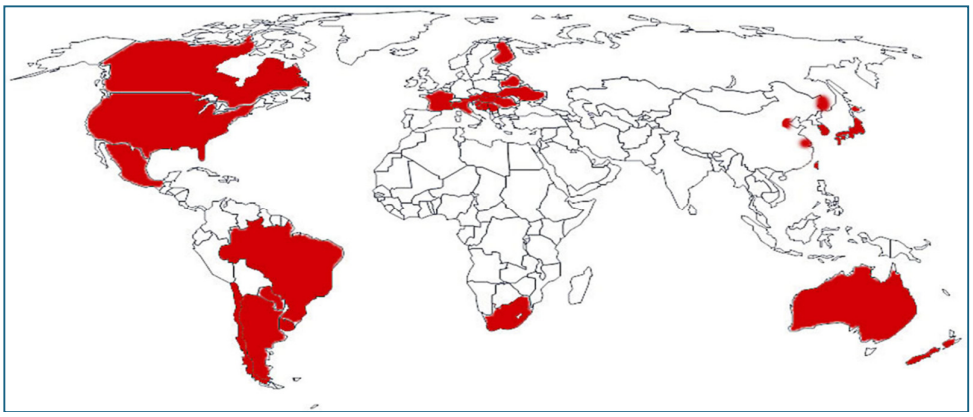

Figure 1. The Map of common ragweed *(Ambrosia Artemisiifolia)* World distribution.

Take after "Ragweed Pollen Allergy: Burden, Characteristics, and Management of an Imported Allergen Source in Europe", Sarah Cunze and colab [6].

The potential future distribution of common ragweed is highly uncertain, but the distribution is expected to shift north-eastwards and, under the influence of current climate change, to extend its potential range in Europe, with a high invasive potential in large parts of Europe: Spain, northern France, Benelux, Germany, Poland, southern Italy, parts of Russia (east of the Caspian Sea) and Turkey.

1.2. Literature review

1.2.1. Prevalence of common ragweed

The prevalence of common ragweed pollen sensitisation depends on the country and the region. There is an average prevalence of sensitization in Europe ~14%, ranging from the highest value of 54% (in Hungary, considered the most infested country in Europe) to the lowest value of 2.5% (in Finland). Romania is one of those countries in Europe where the rate of sensitization to common ragweed is high (according to the INSPIRED project) and the most widespread of these weed species is *Ambrosia Artemisiifolia* [5].

Since 2004, common ragweed has been included on the EPPO - The European Public Prosecutor's Office's List of Invasive Alien Plants (EPPO, 2021) and is regulated in several countries at the European level.

1.2.2. Safety Behavior

In Europe, at least 1 in 5 people suffer from respiratory allergy caused by common ragweed pollen grains. According to the ATOPICA (Atopic Diseases in Climate Change and Air Quality) project, this condition has become a major public health problem across Europe, which estimates that there will be a 4-fold average increase in pollen concentration in the plant by 2050 (https://www.atopica.eu/) [9].

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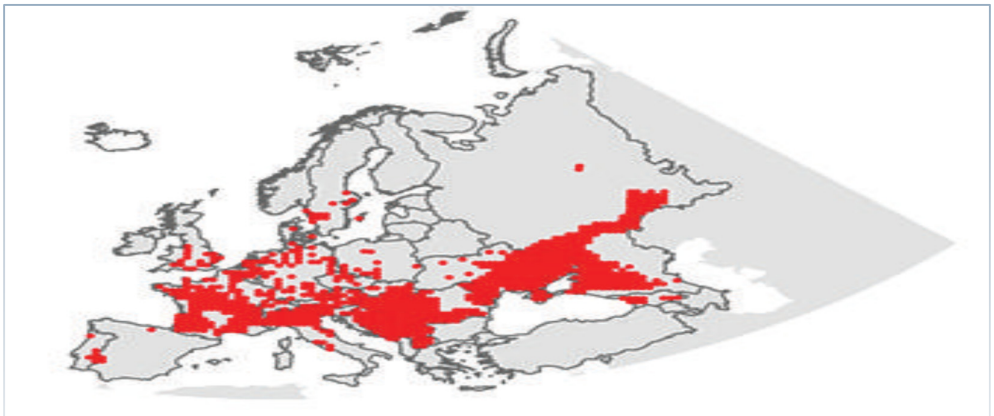

Figure 2. The Map of *Ambrosia Artemisiifolia* (common ragweed) distribution in Europe (50 km×50 km grid), based on information from over 40 national distribution maps and international databases, retrieved from *"Range Expansion of Ambrosia artemisiifolia in Europe Is Promoted by Climate Change"*, Sarah Cunze and colab., https://doi.org/10.1155/2013/610126 [7].

1.2.3. Relationship between Prevalence of common ragweed and Safety Behavior

Common ragweed has a significant negative impact on the European economy by affecting health. Climate change contributes to the burden of disease and premature death in Europe. Climate scenarios show Europe as one of the most vulnerable regions. In Europe, air pollution is considered the biggest risk to environmental health, with around 400.000 premature deaths attributed to air pollution in 2019. Air pollution is associated with allergic diseases (bronchial asthma and allergic rhinitis) [9,10].

Climate change, cultural factors, changes in agricultural practice and increased international traffic contribute to the spread of allergenic pollens such as *Ambrosia artemisiifolia* in many European countries, where they pose significant challenges for both national health systems and European authorities [8]. The man-made environment, with lifestyles in urban areas, may contribute to the increased frequency of respiratory allergies and bronchial asthma [9].

Common ragweed is spreading year after year in the European region, and it is thought that the spread is likely to be facilitated by global climate warming [11]. the pollen of the plant determines a significant health problem because it produces large amounts of highly allergenic pollen, which can disperse over long distances from its origin [11,12]. The species' temporal emergence pattern and rapid growth contribute to "the success" of its spread [13,14].

This research aims, as respiratory allergies caused by the plant pollen have become a major public health problem throughout Europe, to identify whether specific legislation exists in European countries and the monitoring/safety eradication measures of local authorities, especially in the countries most affected by the changes in allergen patterns and the spread of *Ambrosia artemisiifolia* in recent decades, with effects on human health.

2. Methods

The method used in our research was a literature – studies review, the legal provisions and applicable rules - data sources and books from the European countries most affected at the European level by the spread common ragweed.

The following search terms were used: climate change; air pollutants; climatic conditions; aeroallergens; invasive plants/species; common ragweed, *Ambrosia artemisiifolia*; monitoring and eradication; respiratory diseases; allergic rhinitis; bronchial asthma; specific legislation; public health.

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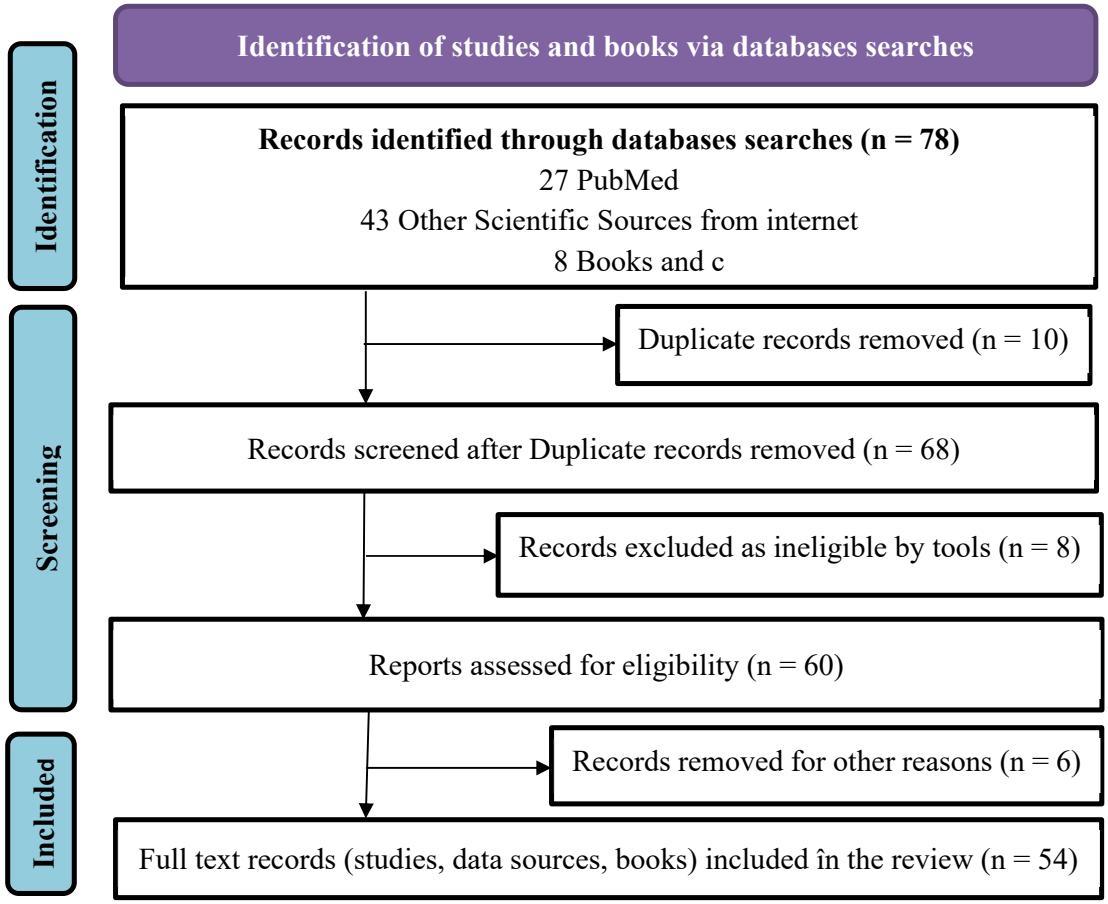

We utilised a review, searching scientific databases such as PubMed (17 studies), and Scientific sources on the internet – e.g. The European Respiratory Journal, The Intergovernmental Panel on Climate Change, The International Journal of Environmental Research and Public Health (MDPi), Cambridge University Press, Academic.edu, International Schoolary, The Jounal of Echology and SMARTER - Sustainable Management of *Ambrosia artemisiifolia* in Europe, The Weather Channel, EPPO Global Database, EIONET Portal, and the National Specific Legislation returned 78 number of results, from which texts published in the last 20 years in which an exacerbation of common ragweed pollen is thought to have occurred, were selected, containing both general information and specific, quantifiable information on local specific legislation or country-specific measures on a local and international basis, as well as on the basis of population needs.

The on-line searching returned a number of guidelines and recommendations from internationally recognised institutions or organisations such as the World Health Organisation (WHO). Duplicates studies were removed.

All studies retrieved through the search were assessed based on title, abstract and full text (where appropriate) against the inclusion criteria set for the study so that only relevant articles were admitted to the systematic review. A subset of 54 studies, data sources and books of the total search results were checked against and used the inclusion criteria.

3. Results

3.1. Data regarding annual treatment costs for treatment of bronchial asthma

Common ragweed has become one of the leading causes of seasonal allergies in Europe countries, with the plant pollen becoming a real public health problem that is increasing every year and invading more and more geographical areas, and coordinated action is needed to limit the spread of common ragweed.

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In order to understand the true extent of the impact on human health from the spread of this weed species, in particular common ragweed, we first took from an article published in the Environmental Evidence Journal the estimate of the economic costs at the European level [14,15] due to ragweed pollen allergy and the estimate of treatment costs at European level per patient per year, based on cost estimates summarised by Bullock et al. for 9 (nine) European countries.

Annual treatment costs ranged from €8,30 (for antihistamines treatment of bronchial asthma in the Czech Republic) to €8,060 (for treatment of bronchial asthma in Switzerland), with average treatment costs of €565 per patient per year. In order to calculate the socio-economic costs, the ratio of medical costs to absence from work calculated for the Rhône Valley region (18.5%) was used, and the estimated annual costs were 670 euros per patient. This estimate was more conservative than the estimate of average costs for seasonal allergic rhinitis in Europe (964 euros per patient per year) [16,17].

By weighting treatment costs and lost working time at the country level using purchasing power parity (PPP) adjusted health expenditure per capita for 2015, total economic costs were found to be around €7.4 billion (CI 5.4-8.6) billion per year in Europe.

The calculations were based on an extensive dataset of observed pollen integrals and a geospatial approach to calculate the total number of patients in Europe using a large dataset of observed sensitisation rates. The map of common ragweed sensitization rates in the European population is based on a combination of two (2) types of published studies: (a) overall sensitization rates in the general population obtained from health centres and (b) ragweed sensitization rates among sensitized patients collected from health centres [18,19].

Given the damage to public health and the high costs, there is a strong need for control measures to minimise the further spread of this species. Containment measures against invasive species are only effective at the beginning of the spread. After they are in place, measures can become extremely costly and fail to achieve the desired results. Monitoring and management measures are essential and must be applied promptly, especially in regions newly threatened by climate change.

3.2. Data regarding project "Sustainable Management of Ambrosia artemisiifolia in Europe (SMARTER)"

At the European level, countries at risk have been advised to prepare monitoring activities and a contingency plan for the monitoring, eradication and control of common ragweed, as well as to implement a national control system. The country-wide monitoring programme should be carried out in order to detect a new infestation or to delimit an infested area. Measures are recommended to eradicate newly detected populations and containment measures to prevent further spread within the country or to neighbouring countries in those areas where the pest is present, and eradication is no longer considered feasible [7].

The EU-COST FA1203 project on *"Sustainable Management of Ambrosia artemisiifolia in Europe (SMARTER)"* (https://www.cost.eu/actions/FA1203/accesed in 27.January.2024) started in February 2013. The action started with 30 participating countries signing a Memorandum of Understanding. More than 180 researchers in invasive alien species management, ecology, aerobiology, allergology and economics were registered as registered participants in this programme. Participants/Confirmed (2012) - 30 Countries: Austria, Belgium, Bosnia and Herzegovina, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Israel, Italy, Lithuania, Luxembourg, Montenegro, Netherlands, North Macedonia, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, UK [20].

COST actions have interconnected nationally-funded research projects and funded conferences, working groups and research exchanges. SMARTER aimed to initiate and develop sustainable and long-term control methods, integrate them into existing mechanical and chemical control measures, and quantify the success of these measures for both health and agriculture. The focus was on biological control methods. For this, models were developed and parameterised, starting from ragweed population dynamics to the impact of control measures on ragweed frequency and distribution and on pollen counts and allergy occurrence, each with ecological and economic components. Well-coordinated studies have been carried out across Europe. SMARTER has enabled

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various stakeholders to select optimal combinations of habitat and region-specific control methods, has acted as a catalyst for long-term research, providing an information platform and developing best practice manuals for integrated ragweed management. SMARTER has provided a forum for discussing long-term management and monitoring options and developing new innovative management solutions, such as a synergy between biological, physical and chemical control measures and vegetation management; evaluating their cost-effectiveness in terms of IAS mitigation [20].

3.3. Data regarding climatic conditions and pollen concentration

Common ragweed produces a large amount of pollen. Pollination is carried out by the wind by spreading pollen grains. A pollen concentration in the air <30 pollen grains/m³ air is sufficient to induce an allergic reaction. Very sensitive individuals may be affected by as little as 1-2 pollen grains/m³ air.

Common ragweed produces the highest amounts of pollen from mid-July onwards, depending on soil and weather conditions, with the plant reaching its peak pollination period in August-September. Under a warmer climat of recent years, the ragweed season can start earlier (May-June) or last longer (October-November). In hot, dry summers, wind spreads pollen over long distances. Common ragweed grows spontaneously and exploits disturbed landscapes (for example, fallow land, mainly along railways and roads, along streams and lakes, on the edge of forests, near rubble, on bare and poorly maintained land, but also in untended gardens and parks on building sites, in areas where excavated earth has been deposited, in cereal and sunflower crops), causing significant crop damage [21,22].

A practical finding: between the increase in pollen concentration and the onset of symptoms, there is a *"window of opportunity"*, lasting about 2 weeks, during which the treatment can be started, leading to significant improvement for patients. Thus, with minimal investment in aerobiological monitoring equipment, the population could be effectively alerted to the presence of pollen in the air. With daily pollen monitoring in place, allergy sufferers can track variations in values, especially during periods known to have the highest pollen counts [22]. Experience from different countries has revealed that infestation with common ragweed lasts for years before allergic sensitisation begins to occur in an area.

3.4. Data regarding local legislation in the European countries

In October 2019, a retrospective analysis was published in the journal Medicina[20,21] specifying that in Europe, the countries with the highest concentrations of common ragweed are Hungary, parts of Romania, Serbia, Croatia, Slovenia, Slovakia, eastern Ukraine, parts of France (Rhône Valley region), Italy (North-West Milan and South Varese), northern Portugal, Montenegro, Bosnia and Herzegovina, Greece and the South-West region of European Russia.

Table 1. The country-specific legislation and the existence of possible monitoring/ eradication measures for the buffywort are summarised in the table below.

Country	**Specific legislation** ***Ambrosia Artemisiifolia (common ragweed)***	**Other monitoring/ eradication measures** ***Ambrosia Artemisiifolia (common ragweed)***	**Possibility of spreading in the next few years of the** ***Ambrosia Artemisiifolia (common ragweed)***
France	No	Yes	Yes
Italy	No	Yes	Yes
Hungary	Yes	Yes	Yes
Romania	Yes	Yes	Yes
Germany	No	Yes	Yes
Austria	No	Yes	Yes
Armenia	No	Yes	Yes

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Croatia	No	Yes	Yes
Switzerland	Yes	Yes	Yes
Finland	No	Yes	Yes

In August 2022, another study, was published in the International Journal of Environmental Research and Public Health which reconfirmed previously published data and the countries with the highest concentrations of the plant pollen [5].

In the current analysis, carried out in 2022-2023, we evaluated local legislation in countries with the highest concentrations of common ragweed at the European level: France, Italy, Hungary, Romania, and Croatia. We also evaluated legislation in Germany, Austria, Armenia, and Switzerland. The 10th country evaluated was Finland (the country with the lowest number of people with bronchial asthma and/or allergic rhinitis triggered by common ragweed – Table 1).

3.4.1. Common ragweed in France

In France, there is no special national legislation on common ragweed, but the National Strategy to Control the Spread of this weed: territory monitoring - all monitoring stations are equipped with the same type of Hirst pollen trap; the analyses are carried out according to the procedures laid down in a CEN Technical Data Sheet 264, approved in December 2015 CEN/TS 16868 [22].

The measurement of health impacts related to exposure to the plant pollen can be performed in different ways according to the protocols used in each country: in France, a *"clinical index"* calculated throughout the ragweed season is used with the help of a network of physicians; in recent years, in the Rhône-Alpes Region of France, an area which common ragweed heavily infests and where the local population is exposed to significant amounts of the plant's pollen, the *"annual pollen index"* and the *"clinical index"* have increased in most French stations in infested areas [23].

Following its expertise, ANSES (Agence Nationale de Sécurité Sanitaire de l'alimentation, de l'environnement et du travail) found that the management of common ragweed monitoring, control and eradication still faces some regulatory obstacles (e.g. limited enforcement power of local municipalities, especially on private land) and recommendations were issued: (a) *for the prevention and control of common ragweed:* immediate introduction of specific, locally coordinated regulations in frontline areas and in areas still relatively unaffected by the presence of the plant, including the appointment of an advisor responsible for the implementation of control measures on the ground; involvement of the construction and public works sector, alongside the agricultural sector, to raise awareness of the existing risk and promote the adoption of best practices (cleaning of machinery, management of contaminated land, etc.) to reduce the spread of the plant and protect the health of the general population as well as exposed workers; (b) *for surveillance of common ragweed:* extend and intensify monitoring of the plant and its pollen at national level; modernise the plant pollen monitoring system - by linking it to models that can predict its dispersal throughout metropolitan France; (c) *for information on common ragweed:* raising awareness among health professionals and allergic or potentially allergic people in areas where the plant is present and in areas where it is likely to develop; promoting information exchange between regions through the development of '*sentinel*' networks of physicians and patients [22,23].

3.4.2. Common ragweed in Italy

In Italy, there is currently neither a legal and organisational framework at national level not specific legislation on the monitoring and eradication of common ragweed. Depending on the extent of the problem in different regions, regional and local authorities have different policies. In Italy, the most infested region is the Lombardy Region where, in some areas, the plant pollen is the leading cause of hay fever. The peak day is reached in August (36 p/m^3). There is no specific legislation on common ragweed in the Lombardy Region either, but only an initiative by local authorities to prevent and reduce the spread of the plant, which could have consequences for public health and annual treatment costs [24–26].

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The measures adopted in Italy to monitor, prevent the spread of common ragweed and reduce its pollen in the Lombardy Region (measures that included the actions of Local Health Authorities in managing the problem) aimed at developing and improving the management strategy (a set of primary prevention actions): epidemiological studies - which demonstrated the increasing prevalence of common ragweed allergy, confirming the aggressive allergic behaviour of the plant pollen (~40% of these patients with common ragweed allergic suffered from bronchial asthma); assessment of direct health costs in these patients; studies on methods to limit the spread of common ragweed (in collaboration with the COST-SMARTER team); informing and educating the public authorities and the local population; control in the territory (aerobiological monitoring, surveillance and monitoring of the infested area and town planning) [44,45].

3.4.3. Common ragweed in Hungary

Hungary, the country currently most affected at the European level by the presence of this weed, has a legal and organisational framework, addressing the monitoring and eradication aspects of the plant. However, in Hungary, there is no uniform data collection at the national level, so it is impossible to correlate the health impact across the country (i.e. data on new ragweed sensitisations or prevalence of ragweed allergy in the population) and the increased level of the weed [29,30].

The 19 monitoring stations of the Hungarian Aerobiological Network, spread unevenly across the country, showed an increase in the level of common ragweed pollen in the air through the average pollen data collected. In the Southern part of Hungary (including the Northern part of Serbia and Montenegro), common ragweed pollen concentrations during the peak season are higher than in any area in the rest of Europe [29,30].

An analysis of the development of common ragweed in the context of human activity indicates that social land use policies after the collapse of the Soviet Union (early 1990s) may have influenced the establishment and spread of this plant in Eastern Europe. The influence of human activity - locally, regionally or globally - seems to be associated with the spread and negative impact of this invasive plant species on human health in Eastern Europe, particularly in Hungary [29,30].

Hungary and Ukraine have made numerous attempts to limit infestations of this plant. The large number of people suffering from the plant pollen allergy in Hungary (~2.5 million people) led to the development of a normative document regulating how citizens can fight against the spread of this plant and the obligations they have [30,31]. A temporal examination of pollen trends in Szeged, Hungary, indicates that most of the pollen is transported from a medium or local distance and peaks from August to September. In the central part of the country, the average temperature is lower and in late summer and autumn, the humidity increases, which explains reduced plant growth and pollen exposure [29–32].

In summer, the wind blows from the west, from Hungary. Measures adopted in Hungary against the spread of common ragweed*:* Government Decision No. 1230/2012 (VII.6.) on weed control: in order to reduce public exposure to the plant's pollen, simpler and more efficient procedures were developed to locate areas covered by ragweed and penalties were imposed; incorporation of remote sensing into the detection procedure of infected areas and into the official detection system; cooperation between Hungary and neighbouring countries (in particular Austria and Croatia) on the cross border information system on ragweed development and pollen spread; more reliable assessment of plant pollen distribution at national level; more efficient operation of the warning system and its further development to make it possible to use it for international purposes; organisation of continuous control of ragweed under the auspices of local authorities; training on crop production, technological knowledge, control and prevention of ragweed for farmers; monitoring the development of the plant along railways, roads, highways [29–32].

3.4.4. Common ragweed in Romania

In Romania, there is currently a legal and organisational framework addressing aspects of common ragweed monitoring and eradication. In the last 25 years, the distribution of allergy has changed in all regions of Romania, being initially reported in the North-West, West, South, and

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South-East areas of Romania. Recent studies confirm the presence of this species also in the Romanian Plain [33,34,37]. Anthropic influence, topography (latitude) and climatic factors have allowed the spread of this species in our country. The plants have found the weather conditions (winds, intense rainfall, high average temperatures) ideal for their expansion. Today, this weed is widespread in almost all areas of the country (except the high hills and mountainous areas), preferring sandy, less fertile, slightly alkaline soils [29]. Common ragweed grows intensely on acid sandy soil, being a highly adaptive plant, with maximum germination and propagation in regions with average temperatures around 30°C in summer, as in the southern regions of Romania. [33,34,37]

Romania is neighbouring Hungary at the western border of the country, which leads to the spread of common ragweed species in Romania, especially in the North-West region. In 2014, in Timiș County (located in the western region of Romania, close to Hungary), with an increased incidence of allergic reactions, local authorities issued local legislation on the fight against ragweed [27,28].

Of Romania's working population (9,000,000 people), ~482,000 people are allergic to common ragweed pollen (according to data published on the Ministry of Health website) [29,34,36]. Romania adopted only prophylactic measures to limit the spread of ragweed pollen in 2018 across the country:

2017: the *"Beware of ragweed"* campaign was launched by the Romanian Society of Allergy and Clinical Immunology, informing the public, local and central authorities about the risk of the plant's spread and its effects on the health of the urban population.

2018: Law no. 62/2018 on the fight against common ragweed and the methodological rules for applying the law are approved and published in the Official Gazette of Romania.

2018: Government Decision no. 707, Art. 3 para. (1) on combating ragweed: The responsibility for identifying land infested with ragweed lies with the local public administration authorities (municipal, town and city halls), which must annually inspect the land within their administrative-territorial radius, identify the owners or holders of land, the managers of public roads, railways, watercourses, lakes, irrigation systems and fish ponds, as well as the beneficiaries of construction works where outbreaks of infestation have been identified, and to submit them in a timely manner. Common ragweed should be destroyed from the time of emergence until the first flowers appear by June 30, each year.

Limiting spread is possible by repeated mechanical cutting on public and private land. The survey and identification of land infested with ragweed species will be started in spring after the emergence of ragweed. In case of recurrence of infestation outbreaks, it is recommended to carry out repeated control work throughout the year, avoiding the appearance of inflorescences. The disease could be avoided if ragweed were removed.

2018: Law no. 62, Art. 5 and Government Decision No 707, Art. 4 para. (1): The first control is carried out between 1-15 July each year. Owners who have not applied control measures are sanctioned with *"Warning"*. The second control is carried out between 16 and 31 July each year, targeting owners or holders of land, managers of public roads, railways, watercourses, lakes, irrigation systems and fish ponds, beneficiaries of construction works who have not applied weed control works even after receiving the warning sanction. Individuals are fined from 750 RON to 5,000 RON. Legal persons are fined from 5,000 RON to 20,000 RON.

July 2020: Law no. 129/2020 amending Law no. 62/2018 on combating ragweed was published. The amendment concerns the establishment/updating of the procedure for the destruction of common ragweed, the measures to be taken to limit the area of spread of this invasive species and the methods for its removal and eradication by the Ministry of Agriculture and Rural Development and the Ministry of the Environment, Water and Forests, which carry out annual information and awareness-raising campaigns in the media, online and in written form, especially during the ragweed growing season. A new contravention is introduced: failure to comply with the provisions of the warning by owners or holders of land, beneficiaries of construction works, managers of public roads, railways, watercourses, lakes, irrigation systems and fish ponds and is punishable by a fine of between 1,000 RON and 5,000 RON for individuals and a fine of between 10,000 RON and 20,000 RON for legal entities.

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Verification and detection of non-compliance by owners or holders of land, beneficiaries of construction works, managers of public roads, railways, watercourses, lakes, irrigation systems and fish ponds, as well as the application of sanctions are carried out by the local public administration authorities in whose territorial area the control is carried out, by personnel authorised by the mayor, by local police officers or by commissioners of the National Environmental Guard. The local public administration authorities, which also have the power to sanction non-compliance with the provisions of this law, shall fulfil their obligations[34,36,37]

3.4.5. Common ragweed in Germany

In Germany, there is currently neither a legal and organisational framework nor special legislation at the national level on weed issues within the country. There is no legal obligation to register, monitor or eradicate this plant pollen in Germany. Without these, common ragweed is expected to spread in Germany over the following decades. Regional and local authorities have different policies depending on the spread in each federal state.

Compared to the rest of Europe, common ragweed is considered rare in Germany, although the number of populations of these plants has increased since 2000. Extensive populations are found in south-eastern Brandenburg (Niederlausitz), where common ragweed mainly populates agricultural areas and roadsides (high concentrations of the plant allergens are found in the air). Roadsides are problematic (common ragweed eradication methods cannot be applied with satisfactory results and control of the plant's development is insufficient). Central Germany and higher altitude areas are almost free of the plant (due to the non-adaptation of the plants to the climatic conditions in these areas) [38,39].

Measures taken in Germany against common ragweed: active control programmes (ongoing) and voluntary efforts in some federal states are leading to complete and successful reduction of ragweed spread. Few federal states (Bavaria, Berlin and Baden-Württemberg) carry out eradication campaigns, with subsequent monitoring of success and, in these states, prevention of weed spread;[38] The German Interdisciplinary Working Group (WGI) on Control of Ragweed recommends control, monitoring, prevention of the spread and importation of the plant (WGI consists of experts - botanists, ecologists, plant protection workers, allergists, aerobiologists, etc. and is organised at national level, with some participation from neighbouring German-speaking countries - e.g. Switzerland, Luxembourg, Austria, the Netherlands); public awareness campaigns (started in 2005, still ongoing); participation of allergists, through voluntary actions, in local campaigns: "*Make sure you recognise ragweed", "Remove ragweed when you see it", "Report large or small ragweed populations to the authorities"* ¬ www.ambrosia info.de [38,39].

3.4.6. Common ragweed in Austria

In Austria, there is a lack of a clear legal and organisational framework at the national level to address all aspects of invasive plant species, including common ragweed.

The plant was first detected in Innsbruck (1883). From the 1960s until the 1990s, common ragweed started to invade agricultural fields (sugar beet, maize, sunflower). In Austria, fields in the East and South-East are invaded by the plant pollen, with heavily infested regions (from the South-Eastern and Eastern federal states to the Western federal states). The degree of infestation along roadsides and significant highways increases in the eastern federal states. In Upper Austria, many roads are infested. In Lower Austria, the motorway network has been totally infested for more than ten years, with the plant increasing in density and spreading in recent years. Crops most likely contaminate ragweed: sunflower, pumpkin oil, red beans, maize, soya, cereals, potatoes, sugar beet, and vegetables [46].

The measures adopted in Austria are occasionally preventive actions. Surveys or monitoring programmes - run by individual governmental and non-governmental organisations (lack of funding in the past resulted in programmes not being carried out consistently and implementation of management strategies not reaching all relevant target groups and end-users).

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Austrian Federal Plant Protection Act: State laws and regulations implement phytosanitary measures at the federal level. Local police decrees are also used to ensure the health of residents. The use of herbicides against common ragweed is limited or in some cases not allowed, and non-chemical control measures must be established. Cutting *Ambrosia atemisiifolia* is a preferred tool in sensitive environments (e.g. on roadsides, the spread of the plant has been favoured by inadequate cutting regimes). Cutting experiments under controlled conditions have shown high regeneration power after cutting - measured as the number of shoots/biomass or regrowing inflorescences [47,48]. Seed survival and longevity in soil are crucial for long-term control efficacy.

Essl et al. state that global warming will enhance the invasive success of common ragweed in Austria, based on the close relationship between plant distribution and temperature in a generalized linear model [46–50].

3.4.7. Common ragweed in Armenia

In Armenia, there is currently no legal and organisational framework or specific national legislation on common ragweed. According to the GISS-E2-R temperature and forcing dataset, this plant in Armenia has a great potential to spread also until 2080, when it will occupy all of Central and Northeastern Armenia and some territories in the South of the country.

In order to forecast the future distribution of the plant pollen in Armenia, species distribution models were used, which are widely used international tools for such problems. All bioclimatic models show further spreading trends in Armenia, and it is indicated to prevent or at least slow down the spread, taking into account the important allergic reaction caused by its pollen. Common ragweed is expected to continue to spread and become even more dangerous to both agricultural and natural ecosystems and the biodiversity of Armenia [50].

3.4.8. Common ragweed in Croatia

Under favourable field and weather conditions, common ragweed sprouting has usually been observed as early as mid-March. However, germination and peak of this plant emergence in mainland Croatia most likely occur in April and May. Croatia has a high abundance of common ragweed and it causes major health problems for allergic people [43].

The Institute of Public Health (IPH) at 17 monitoring stations in Croatia monitor pollen concentrations in the air. IPH is the coordinator of the pollen forecast for Croatia. Data are collected from the monitoring stations and reproduced daily (or twice a week) as unique information on the website and mobile app. IPH participates in educating citizens, pre-school and school children through the "*European Mobility Week*" activities on the identification and importance of common ragweed removal.

Each pollen season is followed by numerous articles, TV reports, talk shows and radio spots about allergenic plants. In collaboration with the Municipal Health Office issuing an educational brochure about common ragweed, the Institute organises actions to remove this allergenic plant every year in the city [43–45].

3.4.9. Common ragweed in Switzerland

In Switzerland, there is currently a legal and organisational framework, and special national legislation on the monitoring and eradicating of this plant. According to published data, the abundance of this weed remains apparently stable in Switzerland. In this country, common ragweed is listed in the Plant Protection Ordinance as a dangerous weed, and there is an obligation for strict control of this plant (eradication). Control is the responsibility of the cantons. The number of small outbreaks in home gardens has decreased by 80-90% in recent years, and the number of notices to city services and individuals has decreased in parallel. However, the situation in army exercise fields and other disturbed areas remains worrying [40].

The Swiss National Law (Plant Protection Ordinance) was introduced by the Federal Office for Agriculture (Systematische Rechtssammlung: SR 916.20 "*Verordnung über Pflanzenschutz*" (PSV),

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"Ordonnance sur la protection des végétaux", *"Ordinanza sulla protezione dei vege*tali" (OPV)) as early as 2006.

Aim of the law: control of existing populations of common ragweed and prevention of spread. Summary of the law: it is not allowed to keep/breed, propagate and distribute common ragweed. There is a general obligation to report, to the cantonal authorities, locations where ragweed plants are found (outbreaks) and to control ragweed in these locations. Information about the law can be found on the website, and meetings for farmers are mandatory. Functions of the Local Health Authorities - advice and collaboration with the mayor, information and awareness raising - enforcement of the legislation [40].

3.4.10. Common ragweed in Finland

Northern countries are very little or not at all affected by the spread of this plant. The Finnish Nature Conservation Act (1096/1996 as amended by 492/1997, 144/1999, 371/1999, 553/2004, 1069/2004, 506/2005 and 591/2005) was developed to meet Finland's conservation needs and obligations under EU legislation, in particular the EU Birds and Habitats Directives and the International Convention on Biological Diversity.

The Nature Conservation Act provides for detailed regulations on information and public participation during the preparation of various protection programmes. The Act aims to preserve the diversity of nature in Finland by ensuring the favourable conservation status of different types of natural habitats and native species is maintained or restored.

The Act introduced a programme to protect areas of valuable landscape in areas where human activity has shaped the landscape to a great extent over centuries. These areas are selected mainly for their aesthetic value, and any development that would change the characteristic features of their landscape will not be allowed [51].

4. Discussion

4.1. Analysis of data collected

Predicting the potential spread of a highly allergenic pest such as common ragweed can be a useful tool for developing protective measures such as monitoring and eradication in threatened areas. Control measures should also be applied in threatened areas where this plant is not yet established. The predicted increase of the area (large areas of Europe are potentially threatened by an invasion of this species, especially in the context of climate change) and the predicted range shift towards the North-East (in Northern Europe, common ragweed is now absent) are in line with the hypothesis that the invasive potential of common ragweed in Central and Northern Europe is influenced by climate warming.

The future projection over the whole of Europe shows a conservative estimate. In North-Western Europe (France and Germany) the potential distribution of common ragweed may be underestimated, and both countries do not have specific legislation at national level, but are taking measures on monitoring and eradication of the weed. In Italy, the most infested region is the Lombardy Region; there is neither a legal and organisational framework at national level not specific legislation on monitoring and eradication of the weed. Depending on the extent of the different regions, regional and local authorities have different policies that they apply. In Switzerland, the abundance of this weed remains apparently stable at present; here there is a legal and organisational framework, a specific national legislation on monitoring and eradication of the weed.

The southern part of Hungary, the northern part of Serbia-Montenegro, the north-western part of Romania and the south-western part of Ukraine show, during the peak season, much higher common ragweed pollen concentrations than in any other area of Europe. The countries are neighbouring and have 'ideal' weather conditions for the spread of the plant - high average temperatures (climatic warming), rainfall and strong winds. Hungary, the country most affected by the spread of this weed, and Romania have specific legislation passed at national level and are countries where measures are being attempted to monitor and eradicate the weed.

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In Croatia & Armenia there is a high abundance of the weed, which causes major health problems for allergic people, and there is no specific national legislation on monitoring and eradication of the weed, and common ragweed has a high potential to spread until 2080, when it is expected to occupy the whole North-East, Central and some Southern territories în Armenia.

Regarding the likely spread of common ragweed in Europe, which is mainly sustained and distributed by anthropogenic influence - human activities, the results suggest that we will face serious threats to human health, as there are already costs of several million euros per year allocated in the different countries affected due to *Ambrosia artemisiifolia* allergies (e.g. 110 million C per year in Hungary), and in other countries, such as Switzerland, the cost for treatment of bronchial asthma reaches 8060 euros per year per person.

4.2. Strengths and Limitations

The strengths of this research include the fact that it is based on a review of the literature, the legal and organisational framework at European level and research on specific legislation on the monitoring and eradication of common ragweed, a weed that is a major public health problem throughout Europe.

This research is part of a more in-depth study in Romania, which started from the idea of a possible involuntary exposure to the pollen of the plant, for a long period of the year (March - November), of the population in countries affected by the spread of common ragweed, leading over time to the impairment of human health through allergic respiratory diseases of a growing group of people and to an exponential increase in the costs for the treatment of these diseases. What we wanted to study was the willingness of authorities in affected countries to monitor and eradicate the plant through national measures, information about costs per treatment, increased allergic rhinitis and bronchial asthma morbidity in the most affected areas.

The main limitation of our study is that we were not able to carry out a more in-depth analysis of the implementation of the specific legislation in force or the measures declared at the level of each country analysed and an analysis of the impact on the protection of human health, following the monitoring, limitation or even eradication of common ragweed, as well as a decrease in the costs allocated to the treatment of allergic respiratory diseases.

5. Conclusions

At European level, there are no universally valid models for eradicating this weed. Different methods applied in the EU countries may be useful to limit the spread of A artemisiifolia and its pollen production (e.g. mowing once or twice a year of overgrown land, ploughing, chemical control, public information, etc.).

Monitoring *Ambrosia artemisiifolia* - staff of organisations monitoring common ragweed species at national level (National Plant Protection Organisation (NPPO), botanists, agronomists, farmers, municipal and road and railway authorities, landowners) should be trained to recognise the plant at all stages of its life cycle, even when it is present as a small population [19].

Eradication of *Ambrosia artemisiifolia* - any weed eradication program (in the case of newly detected populations) would be based on delimitation of the infested area and application of measures (eradication as well as prevention of further spread of the pest); the feasibility of eradicating common ragweed always depends on the size and proper delimitation of the infested area, population density, accumulated seed and accessibility of the site, and eradication may only be feasible in the early stages of the infestation [19].

Regional cooperation at European level on common ragweed should be considered essential to promote phytosanitary measures and the exchange of information on identification and management methods; the recommendation is that countries communicate with each other and especially with their neighbours, exchange views on the best monitoring programme for common ragweed at country level and implement measures aimed at eradicating the plant to achieve the regional objective of preventing further spread of the pest.

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For the effective implementation of monitoring and control of the spread of *Ambrosia artemisiifolia* at national level, cooperation between the relevant public bodies [e.g. National Plant Protection Organisation (NPPO), Ministry of Environment, Water and Forestry, Ministry of Transport, Ministry of Agriculture and Rural Development, etc].

In addition, a more consistent mapping of common ragweed in Europe could be carried out by gathering all national information. There is a need for long-term and widely applicable options for the sustainable management of common ragweed, as well as for the coordination of institutions involved in research and management of the plant across Europe.

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