PROCEEDINGS OF SCIENCE

5 Years Ragweed Finder: From the Idea to the Official Reporting Tool of *Ambrosia artemisiifolia*

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Ragweed (*Ambrosia artemisiifolia*), originally native to North America, was introduced to Europe in the 19th century through contaminated seed consignments. Since then, this invasive neophyte has rapidly spread, particularly in Eastern and Central Europe. In Austria, ragweed has been established since the 1970ies and has gained significant attention due to its high allergenicity and negative impacts on crop yields. Therefore, the Ragweed Finder platform was established in 2017 to inform allergy sufferers and policymakers about ragweed distribution. This platform, available as a website and app, allows citizen-scientists to document ragweed populations. The reporting process involves completing a checklist, after which experts review the reports. Verified findings are collected and forwarded to the local authorities, who decide on further actions. Between 2017 and 2021, over 5000 reports were registered with a positivity rate of 91% resulting in the first legal regulation that deals with the control of ragweed in the federal state of Burgenland. The Ragweed Finder has since become the official reporting platform to enforce this law.

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1. Introduction

Ragweed (*Ambrosia artemisiifolia*), a member of the Asteraceae family, is a monoecious annual herb originating from North America. The plant grows up to 2.5m tall and is characterized by hairy stems, deeply pinnatifid leaves and inflorescences that consist of yellow coloured male capitula and female capitula with corolla-less flowers. [1] The introduction of this species to Europe is most likely linked to contaminated seed consignments originating from North America, in the 19th century, leading to increasing invasiveness in Austria since the 1970ies [2,3]. Since its arrival, ragweed has spread throughout the Austrian lowlands in a westward direction along rail- and motorways (Fig.1) [4].

Ragweed is officially classified as alien invasive species by the European Regulation No.1143/2014 (https://eur-lex.europa.eu/eli/reg/2014/1143/oj) and is of particular interest for pollen allergy sufferers as approximately 11% of the population in Eastern Austria are sensitized to ragweed pollen [5]. Its highly allergenic pollen does not only impact the quality-of-life, the educational and occupational performances but also imposes significant costs on the healthcare system [6]. As allergen avoidance is the primary intervention to prevent allergic symptoms [7], a citizen-science platform was launched in 2017 to collect ragweed distribution data. This platform provides pollen allergy sufferers with insights concerning ragweed populations in their surroundings and informs Austrian authorities about ragweed hot spots, so countermeasures against the spread can be planned. Since launching the platform, the "Ragweed Finder" has evolved from an initial concept to a nationally recognized reporting platform for *Ambrosia artemisiifolia*.

2. Reporting Process

Ragweed populations are reported through the "Ragweed Finder" website (https://www.ragweedfinder.at/) which is active since 2017 or via a corresponding mobile application available for Android and iOS operating systems since 2019. Independent from the data entry method, users are guided through a comprehensive multi-layered reporting process comprising three sections: (1) Recognition, (2) Report and (3) Review/React.

To ensure the proper identification of ragweed, the first section consists of a checklist with four binary (yes/no) questions concerning morphological characteristics that distinguish ragweed from other weeds (https://www.ragweedfinder.at/Checklist). These verify or exclude (1) the presence of deeply pinnatifid leaves,(2) leaves exhibiting a green-coloured abaxial surface, (3) a stem with white hairs, and (4) yellow-coloured capitula. Explanatory images are provided for each of these features. If all questions are answered positively, the reporting process advances to the next section.

When filing a report, users are required to provide the following mandatory information to complete the submission process: (1) the location of the ragweed population, (2) the date of discovery, (3) at least one photograph of the plant(s) and (4) an e-mail address. Optional supplementary information, such as habitat, population size, containment measures and any experienced allergic symptoms may also be included but are obligatory. Once the process is finalized, users receive an e-mail notification confirming the successful filing of the report.

Subsequently, a team of experts is informed about the new report that needs to be reviewed. Each report is checked by a member of the "Ragweed Finder" team to verify if the photograph(s) of the reported plant(s) are indeed showing ragweed. Users always receive feedback of the expert's decision. If the report is rejected, the process is concluded with appropriate feedback to the user. If the report is validated, the process proceeds without further user involvement. The identified ragweed population is displayed on the ragweed map (Fig.1), and the report is forwarded to the responsible Austrian federal agencies, which subsequently decide to initiate further steps to stop the spreading of this population.

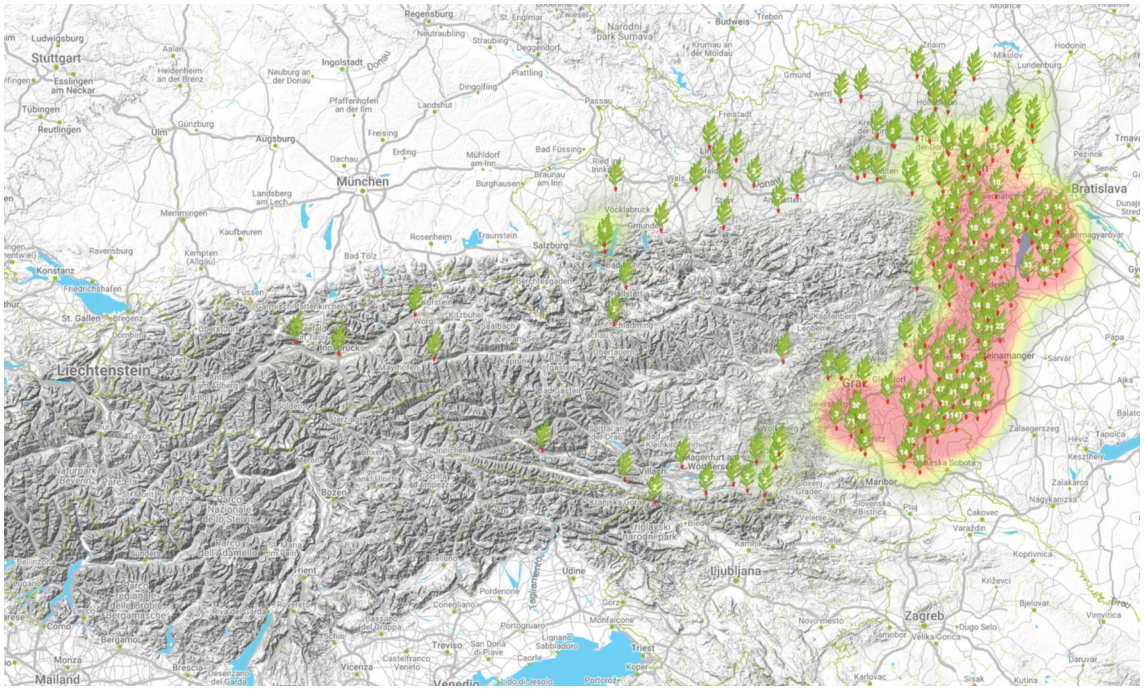

Figure 1: Validated ragweed reports from 2022

3. Results

In the year of its introduction (2017) the "Ragweed Finder" platform received 410 reports, with 324 (79%) of them being verified (Tab.1). The inclusion of the checklist in 2018 resulted in a significant increase of the verification rate and the rollout of the mobile app in 2019 led to a notably higher number of overall reports. Over the initial five years, a total of 5171 reports were filed through the system, 4681 (91%) of them were verified. Although there was a decrease in the number of reports in 2020, subsequent years showed an upward trend, resulting in a record-breaking 2431 reports (2329 verified) in 2022, increasing the overall count to 7602 reports, with 7010 (92%) of them reporting actual ragweed populations.

The majority of reports were concentrated in the eastern Austrian federal state of Burgenland (66%), followed by Lower Austria (18%) and Styria (11%). Ragweed populations were most commonly observed in fields (40%) or along roadsides (23%).

Table 1: Ragweed reports 2017 - 2022

Year	***Reports***	***Verified***	***Positivity rate***
2017	410	324	0,79
2018	635	579	0,91
2019	1643	1467	0,89
2020	931	853	0,92
2021	1552	1458	0,94
2022	2431	2329	0,96
Total	**7602**	**7010**	**0,92**

4. Conclusion

Through the provision of near real-time information on ragweed distribution in Austria, citizen-scientists have played a crucial role in capturing the attention of numerous local authorities. Consequently, all Austrian federal states, except for Carinthia, have recognized the value of the data collected by the "Ragweed Finder" platform, utilizing it to adjust their mowing strategies to contain or at least impede the spread of this neophyte [8].

Despite these developments, only one federal state in Austria established a legal framework governing the reporting and removal of ragweed. In June 2021, the federal state of Burgenland took a significant step by enacting the "Burgenländische Ragweed-Bekämpfungsgesetz" [9]. Subsequently, the "Ragweed Finder" platform has been officially designated as the reporting tool to enforce this regulation.

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