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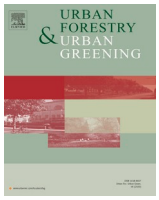

On the incidental exposure of the general public to invasive forest pests through mainstream media

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ABSTRACT

Invasive forest pests represent a major threat to ecosystems and the economy. They are often first detected in urban forests, making these environments strategic for early warning and global forest protection efforts. Although early detection is crucial to the success of eradication measures, the surveillance capacity of official authorities is limited. Citizen science can help bridge this gap—provided that citizens are aware of the stakes and

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prepared to play an active role. In this context, mainstream media may serve as a key channel to raise public awareness. We surveyed mainstream media coverage of 14 native, invasive alien non-regulated, and quarantine forest pests across 15 European countries, mostly over the 2011–2024 period. Searching for the scientific or common name of these pests in each national language returned more than 16,000 outputs. While quarantine species were mentioned less frequently than native pests, they were more likely to be mentioned in countries where they have occurred, remain present, or have been eradicated. Interestingly, we also found references to quarantine pests in countries where they were not officially reported. This last finding highlights the potential of mainstream media to attract public attention to tree pests before the surge of an outbreak—an opportunity that should be more systematically leveraged to support early detection and citizen engagement, particularly in cities where the risk of introduction and the potential for early detection is the highest.

1. Introduction

Tree planting initiatives are blooming in cities worldwide (FAO, 2018; Sousa-Silva et al. 2023). Yet, expected benefits in terms of ecosystem services are compromised by pests and diseases (Paap et al. 2017; Raum et al. 2023; Roman et al. 2021), and managing these threats may have profound consequences on people, the urban forest and forests in the surrounding environment. For instance, the detection of species regarded as quarantine pests and priority pests according to EU Regulations (EU) 2019/2072 and (EU) 2019/1702 triggers eradication measures such as the removal of every susceptible tree in circular buffers around any tree on which the pest was observed. Successful eradication is possible in case of an early detection and reporting of quarantine and pest insects to the authorities that enable a quick response (Tobin et al. 2014). This requires public awareness of pest insects and associated risks, as well as acceptance of preventive and control measures (EPPO, 2019). Whereas professionals have an appreciable knowledge of the urban forest vulnerability (Raum et al. 2024) and are presumably ready to act in case regulated pests are found, doubt remains about the preparedness of the general public (Marzano et al. 2016).

Urban forests are particularly exposed to emerging and invasive pest species. In Europe, 89% of first detections of invasive alien insect pests were made in urban areas (Branco et al. 2019), in close proximity to major harbors and airports, where the majority of the human population now lives, thus making urban trees bridge-heads for forest pest invasions (Paap et al. 2017). This is aided by the fact that cities host a much higher tree species richness than surrounding forests, offering more opportunities for exotic pests to establish (Augustinus et al. 2024; Hutt-Taylor and Ziter, 2022). The heat island effect and the presence of impervious surfaces both weakens urban trees and increases their vulnerability to insect herbivores (Tabassum et al. 2024). All these reasons justify increased vigilance toward urban trees to improve forest biosecurity at large.

The general public can play a great role in the early detection of emerging and invasive pest insects (Groot et al. 2023) along with green space managers. Invasive pests are often found by the general public before formal surveillance schemes (Epanchin-Niell and Pi, 2024; Epanchin-Niell et al. 2021), in particular via biodiversity oriented citizen science (González-Moreno et al. 2025; Roe et al. 2024). However, sharing observations online does not necessarily imply knowledge of the risk or awareness of the necessary control measures the observation may trigger. Provided that they report accurate information (Wong, 2024), traditional media may help fill this gap by informing the public about pests and related stakes, then triggering action and enhancing the reporting of invasive alien species (Koen et al., 2021; Geraldi 2019).

In this exploratory research, we asked the question: "How much do mainstream media talk about forest pests?" More specifically, we asked how frequently are forest pests mentioned in mainstream media, and whether this frequency relates to pest status. The qualitative exploration of media content was, however, beyond the scope of this study. We addressed these questions by surveying mentions of pest insects — including quarantine pests and non-quarantine pests— in national and local media at European scale. We only considered cross-country comparisons from an ecological perspective, as the same pest may have a different status in different countries.

2. Forest pests in mainstream media

We focused on the pest insect species recommended for regulation as defined by Regulation (EU) 2019/1702 of 1 August 2019 as so-called quarantine pests, to which we added non-regulated species as a control (Table S1, supplementary material). Control species included both invasive alien pests, non-native to Europe but already established within European Union boundaries (henceforth, *invasive* pests) and native pests having outbreaks in recent years in several European countries (referred to as *native emerging* pests). We referred to these three categories as *candidate species* for exploration in the media.

We searched for references of candidate species (both scientific name, common name and synonyms) in three types of media in each country: newspapers, TV, radio (Table S2). For each media, we targeted the one with the largest audience (using national sources) considering the number of printed copies as a proxy of the audience of national newspapers. Where appropriate, we also considered local newspapers edited in the regions where the author's institutions are located. We considered the number of media outputs as a proxy of people's exposure to information on each pest insect. The research was conducted during the last two weeks of October 2024 (save for Sweden which we included in the survey in early April 2025), therefore aggregating media outputs up to this date. Depending on the media, it covered sources published between 1949 and 2024 (quantiles of publication year: 2011, 2016, 2019).

All data were analysed and visualized in R statistical language using functions provided by the library *tidyverse* (R Core Team, 2024; Wickham et al., 2019). We considered any mention of candidate species as promoting people awareness through exposure to candidate species. We counted the number of outputs, excluding obviously irrelevant ones referring to non-biological or unrelated contexts (e.g. homonyms or metaphorical uses) as assessed from titles andshort summaries, when available. Our interest laid in the comparison of media coverage among candidate pests, and not among countries or types of media. Therefore, we did not attempt to accommodate for potential differences in the temporal depth of media archives.

The analysis of 16,547 media outcomes across 15 European countries reveals that European residents are exposed to information content dealing with forest pests (Fig. 1). We refrained from commenting on potential differences in media coverage among countries, because these

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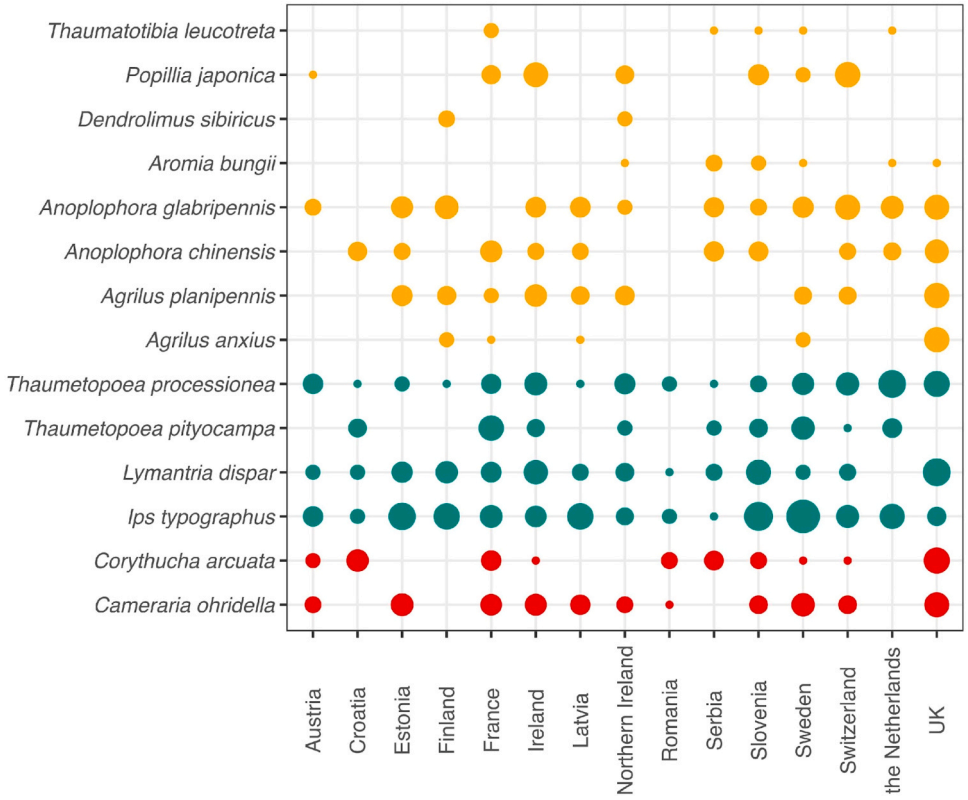

Fig. 1. Total number of mentions of pest species in mainstream media. Dots represent the number of media outputs mentioning each pest species in each country. We used a log-scale to compensate for the disproportionate number of media outputs referring to *Ips typographus* in Swedish media. Because the sampling effort differed among countries, differences in dot size are only meaningful when compared within countries. Orange, green and red dots represent quarantine, native emerging and invasive pests, respectively.

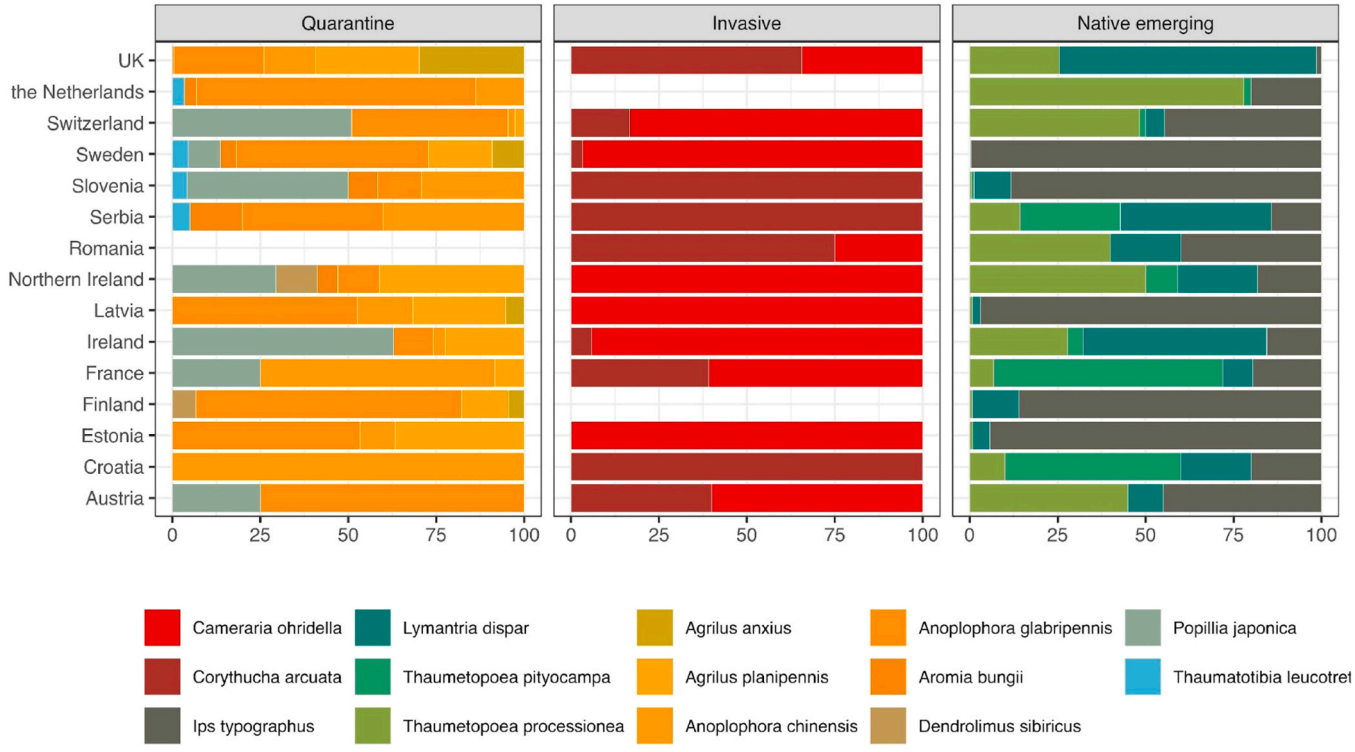

Fig. 2. Relative media coverage per pest and country (%). For each status (the three different panels) and each country (the vertical axis), the number of mentions of a specific pest (represented by different colors) was divided by the total number of occurrences of any candidate pest.

differences could have arisen from methodological aspects of the study (e.g., uneven accessibility to primary data). However, differences among pests are insightful.

Despite their greater potential harm to forests, quarantine species (that are expected not to be present in Europe) received less attention than native emerging pestsor invasive species that have been introduced to Europe in the recent years or decades, have established and expanded and are now out of control. The European spruce bark beetle, *Ips typographus* (Coleoptera: Curculionidae), was the pest that received the most attention (n = 14,413 outputs), followed by the spongy moth (*Lymantria dispar*, Lepidoptera: Lymantridae; n = 477) and the oak processionary moth (*Thaumetopoea processionea,* Lepidoptera: Notodontidae; n = 465). These three species are major outbreaking forest pests native to Europe. The disproportionate interest for *I. typographus* may be due to the economic impact and recent Europe-wide outbreaks of this pest (Hlásny et al., 2021). Unlike other native pests, its management often consists of measures such as salvage logging. *Thaumetopea processionea* is mostly cited in reference to its urticating character and the harm it causes to humans, pets and cattle. Among quarantine species, Asian longhorn beetles (*Anoplophora glabripennis,* Coleoptera, Cerambycidae and *Anoplophora chinensis,* Coleoptera, Cerambycidae; n = 341), the Japanese beetle *Popillia japonica*, Coleoptera: Scarabaeidae; n = 159) and the Emerald Ash Borer (*Agrilus planipennis*, Coleoptera: Buprestidae; n = 131) received the most attention (Fig. 2). Surprisingly, Siberian silk moth *Dendrolimus sibiricus* (Lepidoptera: Lasiocampidae) was only found to be mentioned in media in Finland and Northern Ireland (Fig. 1), yet, neither of these two countries are bordering the current range of this pest in Europe. The corresponding articles referred to the consequences of climate change on Russian forests (*The Belfast Telegraph*, Ireland) or changes in EU legislation impacting the Russian forestry sector (*Helsingin sanomat*, Finland). None of the quarantine pests included in the survey was mentioned in Romania, despite the fact that Romanian media mentioned other candidate species present in the country.

Media coverage of invasive species is often low and shortlasting (Geraldi et al., 2019). Still, the fact that pest-related issues in mainstream media are partially covered is encouraging in several regards. First, considering that the primary goal of a media is to be read, watched out or listened to, it is primarily indicative of a general interest for pest-related issues. Second, several studies reported that receiving information on the environment and associated threats to human and non-human organisms has the potential to trigger pro-environmental behaviors (Hong et al. 2019; Meng et al. 2023; Awan et al. 2022; Holbert et al. 2003; Liao, 2025). Finally, it is increasingly well established that the general public may play a significant role in the early detection of non-native invasive and quarantine pest, thus complementing surveillance schemes (Epanchin-Niell and Pi, 2024; Epanchin-Niell et al. 2021; González-Moreno et al. 2025). These considerations and our results thus converge towards the idea that the European population could be partially prepared to play an active role in monitoring forest pests. However, a more formal test of this hypothesis will require an in depth analysis of the framing of the information conveyed by media, *i.e.*, a more qualitative approach.

3. What determines media coverage?

An intuitive expectation would be that quarantine pests — by definition not expected to be found in European countries — only attract media attention after their detection triggers eradication measures. Following this idea, we would expect that quarantine pests are mentioned in media only after they are introduced to a particular country, and that the probability of media occurrence and the number of media outcomes referring to quarantine pests would be higher in countries where they were detected and possibly eradicated.

To test this hypothesis, we interrogated the EPPO global database (https://gd.eppo.int/) in April 2025, searching for occurrence data for selected quarantine pests in each country. We defined pest status as present (P), absent (A), or eradicated (E). Eradication implies that the species has been observed and that appropriate measures were taken. Although this would result in an absence status, we subsequently merged presence and eradicated statuses into a single category (P/E). When no record was found in the EPPO database, we considered the species to be absent. We additionally searched for the date of the first report of each quarantine pest in the EPPO database. Although *Ips typographus* and *Thaumetopoea processionea* are native to Europe, they are regulated pests in the British islands. We included first reports of these two species in the UK and Ireland in the analysis. We also added information on *Corythucha arcuata* (Hemiptera: Tingidae), as the spread

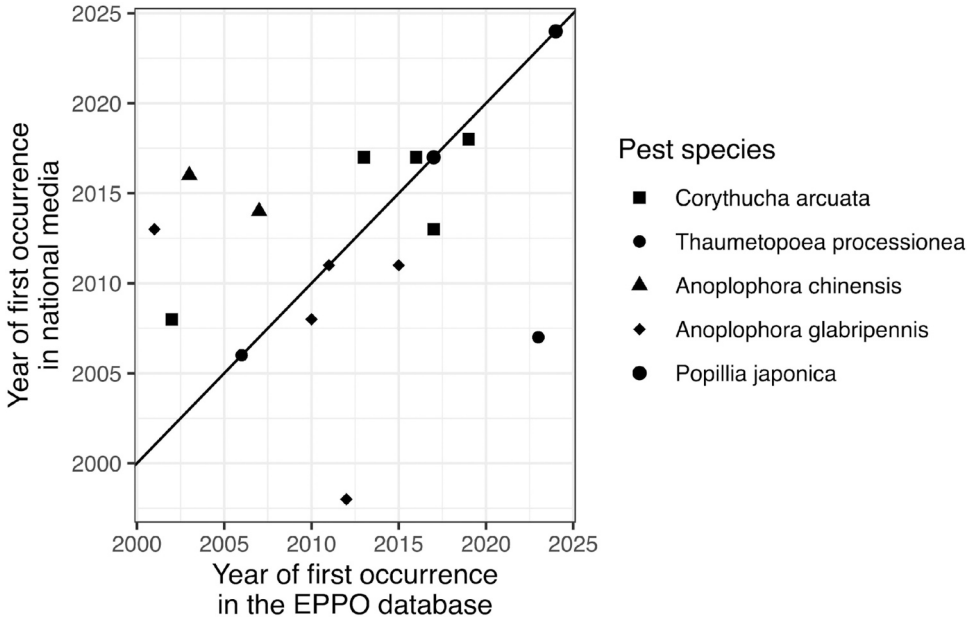

Fig. 3. Relationship between the year of first occurrence of a quarantine pest in a country according to the EPPO database and the year of first mention in national media. The central line corresponds to the y = x relationship, indicating that references to pest insects in national media occur in the same year as in the EPPO database. Source: https://gd.eppo.int/, search on April 22nd, 2025.

of this species since its introduction to Europe has been well documented (Csóka et al. 2020).

We modeled the number of mentions of a candidate species in mainstream media as a function of current pest occurrence status (present/absent) using generalized mixed-effect models (GLMM) in a two-step approach. We first modeled the probability of a candidate species being mentioned in the media using a GLM with a binomial error distribution, where the binomial data were coded as "yes" (the pest was reported at least once in a given medium and country) or "no" (no report). Then, we modeled the number of articles related to a given pest among sources that had reported information on the pest at least once in a given medium and country. In this case, we used a GLMM with a Poisson error distribution. In each GLMM, we declared candidate species, medium and country as crossed random factors. We ran models with the function glmmTMB in the library glmmTMB (Brooks et al. 2017) and checked for an appropriate residual distribution with functions provided in the package DHARMa (Hartig, 2016).

The probability of reporting information on tree pests and the number of media releases referring to a tree pest were both influenced by the pest status in the EPPO database, but did not depend on whether they are native, invasive, or regulated as quarantine pests (Table S3). The probability of reporting and the number of occurrences in media were, on average, larger when the pest was present in a European country or had been present and then eradicated (model coefficient estimate $\pm$ SE: 1.24 $\pm$ 0.36 and 1.42 $\pm$ 0.29, respectively). However, we found no particular relationship between the year of first occurrence in the EPPO database and the year of first mention in national media (Spearman correlation test: $\rho = 0.41$; $P = 0.117$; Fig. 3): in six instances media coverage occurred after the first introduction was reported to EPPO, in six instances, the opposite occurred, and in four occurrences, mention in the media and the EPPO database occurred in the same year. Notably, *Dendrolimus sibiricus*, *Agrilus planipennis* and *Agrilus anxius* were mentioned in some media, whereas they had never been observed within EU boundaries.

Our exploratory study highlights on the one hand the potential role of generalist media in raising awareness about pest-related issues, which can potentially foster pro-environmental behaviors and enhance the probability of detection and report of quarantine pests by the public. On the other hand, the very same data also reveals a maybe more worrisome trend of media being reactive, rather than proactive.

Nevertheless, these results should be interpreted with appropriate caution. First, whereas it is known that media play a role in shaping public opinion, it is also well established that informing and raising awareness is not enough to trigger action and enhance reporting of invasive alien species (Haley et al., 2023; but see Koen and Newton, 2021; Toomey, 2023). Second, media coverage may not reflect the attention or comprehension of the public in matters that are being covered. The mere availability of information does not necessarily imply it is received by its target audience. Moreover, the same information may be received in many different ways, depending on the worldviews, religion or political beliefs of the receiver (Toomey, 2023). Several among the factors ultimately influencing people's actions following the exposure to a piece of information (including information framing, media credibility, personal norms of people in the audience; Clarke et al. 2020; Liao, 2025) were out of reach in the present study.

Although further insights would be gained by analysing the framing (Chong and Drukman, 2007) of media outcomes and surveying public knowledge of and attitude towards forest pest insects and their environmental, social and economical implications, we hope that our study serves as a baseline to improve the sharing of information about pest insects among scientists, stakeholders, media, and ultimately citizens. In particular, we call for broader background coverage of plant-health issues, as this could increase public awareness, vigilance, and preparedness in the event of new introductions, while also helping explain the environmental, social, and economic justifications for the often drastic measures required to eradicate quarantine pests.

CRediT authorship contribution statement

Benno AUGUSTINUS: Writing – review & editing, Investigation, Conceptualization. **Bastien CASTAGNEYROL:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Zina DEVETAK:** Writing – review & editing, Investigation. **Tugba DOGAB:** Writing – review & editing, Investigation. **Tiia DRENKHAN-MAATEN:** Writing – review & editing, Investigation. **Renata GAGIĆ-SERDAR:** Writing – review & editing, Investigation. **Maarten DE GROOT:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Conceptualization. **Eva GROZNIK:** Writing – review & editing, Investigation. **Milici GRUBAC:** Writing – review & editing, Investigation. **Andrija JUKIC:** Writing – review & editing, Investigation. **Milena LAKICEVIC:** Writing – review & editing, Investigation. **Liva LEGZDINA:** Writing – review & editing, Investigation. **Miia MANTTARI:** Writing – review & editing, Investigation. **Lazar PAVLOVIC:** Writing – review & editing, Investigation. **Nikola PERENDIJA:** Writing – review & editing, Investigation. **Leopold POLJAKOVIĆ-PAJNIK:** Writing – review & editing, Investigation. **Florentine SPAANS:** Writing – review & editing, Investigation. **Dragos TOMA:** Writing – review & editing, Investigation. **Maude TOÏGO:** Writing – review & editing, Investigation. **Johanna WITZEL:** Writing – review & editing, Investigation, Funding acquisition.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Bastien Castagneyrol reports financial support was provided by COST Action Urban Tree Guard - Safeguarding European urban trees and forests through improved biosecurity, CA20132. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ufug.2026.129403.

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