

OPINION

Botanical boom: A new opportunity to promote the public appreciation of botany

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Societal Impact Statement

Plants are indispensable to life on Earth. Securing our future requires protecting plant biodiversity and the development of climate-resilient crops. Activities fostering public appreciation of plant science, and promoting plant-related professions, are therefore critical. These efforts can be hindered by plant awareness disparity, manifesting as difficulty in recognizing the presence and importance of plants. However, interest in plants as a hobby and as lifestyle elements has rapidly increased in younger demographics over the last decade. We suggest these topics should be exploited urgently by researchers and educators to increase further the reach of science communication, thereby enhancing societal awareness of botany and stimulating interest in plant-related degrees and career pathways.

Summary

Plants are the basis of life on Earth as we know it and the study of plants is essential to protect our future. Yet botany and plant science are in crisis and suffer a low uptake at the level of undergraduate degrees. Increasing science communication about exciting advances in our knowledge of plants and their importance to society may be a strategy to counteract this. Here, we comment on the recent trends in the public perception of plants and explore them using infoveillance tools. Our observations highlight that paradoxically over the last decade public interest in plant-related topics has increased considerably, with the advent of a new type of social media influencer—‘plantfluencers’. Additionally, recent studies demonstrate that the COVID-19 pandemic has boosted awareness of the therapeutic value of interacting with plants and their positive effect on human well-being. We suggest that this offers a window of opportunity to develop an appreciation of plant science among the wider public, who are reconnecting with plants in new ways. Plant-focused communities and online groups on social media platforms can facilitate engagement with new audiences. In particular, trends relating to houseplants, plant-based diets and the benefits of interacting with plants on mental health and well-being together provide an attractive springboard for science outreach and botany-focused conversations.

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Here, we discuss these trends and make recommendations for researchers and educators.

KEY WORDS

botany, education, plant awareness disparity, plant science, science communication

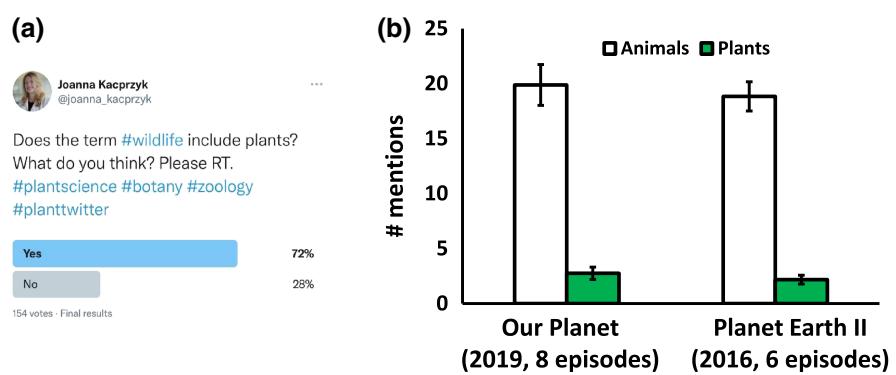
1 | CHALLENGE: THE END OF BOTANY?

Plants are both fascinating and essential organisms. They produce oxygen, maintain soil quality and provide food and habitats to other organisms. They can reduce air pollution, have medicinal properties and capture CO₂ from the atmosphere. They are all around us, can be beautiful and are deeply embedded in cultures worldwide. Yet people do not want to study plants, and indeed, the diverse roles that plants play in our everyday lives are broadly underappreciated (Jose et al., 2019). The lack of interest in the science of botany is a persistent issue (Elster, 2007; Hagay et al., 2013; Hershey, 1996; Moehlmann, 1993; Potvin & Hasni, 2014), and our own experiences as biology educators confirm it. While asking the undergraduate students about their interests, we frequently hear: ‘Anything, but plants!’. That the general public, and indeed also the broader scientific community, are often unaware of what modern botany is, and of its key achievements, has been noted as early as the 1960s (Godwin, 1968). The numbers of botany students, faculty, plant-focused courses and botany departments are declining globally (Crisci et al., 2020), with ‘The End of Botany Degree in UK’ announced in 2010 (Drea, 2011). Even among plant biologists themselves, the term ‘botany’ has lost favour, largely due to its perceived historical and taxonomical connotations (Crisci et al., 2020). Plant taxonomy and identification, a skill often associated with botanists, often lacks appropriate scientific credit and professional recognition, which is detrimental, especially to early career plant scientists (Manzano, 2021). Parallel to this trend in academia, public knowledge of plants and interest in studying plant science have declined, possibly in association with increasing urbanization and other effects of industrial and digital revolutions on society’s way of life. This decline could be one of many symptoms of ‘extinction of experience’, defined as the progressive loss of human–nature interactions (Pyle, 1993; Soga & Gaston, 2016).

The phenomenon in which students and the general public struggle to recognize both the presence and importance of plants and plant products in their everyday lives has previously been termed ‘zoochauvinism’ (Bozniak, 1994; Hershey, 1993), plant blindness (Wandersee & Schussler, 1999, 2001) and, most recently, plant awareness disparity (PAD) (Parsley, 2020). The possible causes are complex, and although their detailed discussion is beyond the scope of this perspective, innate factors in how we perceive our surroundings (Balas & Momsen, 2014), discrepancies between how we view behaviour, agency and individuality in plants and animals (Knapp, 2019) and disconnection from agricultural and natural environments (Dugan, 2016) all appear to play a significant role. Manifestations of PAD are abundant, spanning from educational settings, and curricula (Amprazis & Papadopoulou, 2018; Kaasinen, 2019; Pedrera et al., 2021), to legal terminology (Margulies et al., 2019; Wyatt, 2021). A recent legislative content analysis across 185 countries revealed that plants were clearly included in the definition of ‘wildlife’ in only 69 pieces of legislation, with 10 definitions specifically excluding them, leading to potentially troubling consequences for ecosystems and biodiversity crisis management (Wyatt, 2021). The detrimental effects of pervasive PAD have been specifically described in the context of research and policy on illegal wildlife trade, and the associated negative impacts for biodiversity conservation (Margulies et al., 2019). When we asked on the social media platform Twitter whether the term ‘wildlife’ includes plants, almost 30% of respondents answered ‘No’, despite plant biologists being overrepresented in the reach of the account belonging to Joanna Kacprzyk (a plant scientist) (Figure 1a). Together, these examples emphasize that plants are often perceived simply as the background to other living organisms by both policymakers and members of society.

Additionally, we investigated representation of plants in two critically acclaimed nature documentary series exploring various habitats and biomes: *Planet Earth II* and *Our Planet*. *Planet Earth II* drew in an

FIGURE 1 (a) Are plants wildlife? Twitter poll results (https://twitter.com/joanna_kacprzyk/status/1402611253378486272?lang=en). (b) Plants receive less attention in nature documentaries. Mean number of animal and plant mentions per episode in *Our Planet* and *Planet Earth II* documentary series. Bars are standard error of the mean. The verbal showcase of an animal or plant fitting into a taxonomic rank of phylum or lower was considered a single mention



(a)

**'Gardening Reaches an All Time High
Your 'Typical' Gardener is Younger
These Days –
And Has a LOT of Questions!'**
www.globenewswire.com April 2018

**The average Brit spends more
than £300 a year on
houseplants - and Gen Z are
the biggest fans'**
www.independent.co.uk July 2021

'Millennials really love plants'

www.businessinsider.com, April 2019

**'Why Millennials Are Suddenly So
Obsessed With Houseplants
It's much more than a social media fad.'**
www.huffpost.com September 2019

**'The Plant-Crazy Generation: Why
Millennials are Leading the Houseplant
Trend'**
www.houseplantresourcecenter.com January 2021

**'The Leafy Love Affair
Between Millennials and
Houseplants'**
www.newyorker.com April 2019

**'Getting to the Root of the
Millennial Plant Obsession'**
www.cosmopolitan.com September 2017

(b)



FIGURE 2 (a) Examples of quotes from mainstream media publications (2017–2021) highlighting the surge in interest in gardening and houseplants among younger demographics. (b) Meadows decorating UCD's campus carpark and one of Dublin parks (photos courtesy of Dr. Rainer Melzer)

average of almost 12 million UK viewers per episode (data from Broadcasters Audience Research Board, www.barb.co.uk) and Our Planet attracted over 33 million views in the first 4 weeks since its release according to Netflix, placing both series among the most popular nature documentaries produced within the last decade. Despite plants accounting for 80% of the total biomass on Earth (Bar-On et al., 2018), they were on average mentioned over seven times less frequently than animals in the analysed series (Figure 2a). An even more striking example is provided by an hour-long 1983 documentary 'Rain Forest', mentioning only one plant (bulbous acacia, *Vachellia cornigera*), compared with 25 animal species. These observations highlight how an important aspect of popular culture has neglected the importance of plants, which is especially relevant considering the measurable effect of nature documentaries, such as Planet Earth II, on species awareness in the audience (Fernández-Bellon & Kane, 2020).

PAD may have dire consequences in the future. Due to a declining interest in botany as a scientific discipline, even highly skilled biologists are often unable to identify common plants (Crisci et al., 2020). Moreover, plant identification skills suffer from lack of scientific recognition (Manzano, 2021) and botanists are in danger of becoming 'the dinosaurs of biology in the 21st century' (Woodland, 2007). Insufficient uptake of botany and plant science degrees can lead to gradual decline of expertise in fields essential for food security such as plant pathology (Hird, 2012). Disregard for the importance of plants was highlighted as a factor that may hinder meeting most of the sustainable development goals, with PAD posing a critical challenge for the scientific community and policymakers alike (Amprazis & Papadopoulou, 2020). The problem of plant favouritism has also been recently described, where visually striking species draw disproportional share of scientists' attention and research efforts (Adamo et al., 2021) with a danger of this bias extending to plant conservation efforts. The urgent need for more trained botanists and increased funding for plant science institutions has been recognized by the scientific community and beyond. A prominent example is The Botany Bill ('The Botanical Sciences and Native Plant

Materials Research, Restoration, and Promotion Act'), which was recently reintroduced in both House of Representatives and the Senate (The United States 116th Congress, 2019). The objectives of the bill are threefold: (i) to increase the number of federally employed botanists; (ii) to fund research involved in habitat restoration, environmental change mitigation and invasive species management; and (iii) to promote the use of native plants on federal lands and by federal agencies. While this bill mainly highlights the demand for botanists in governmental and field roles, the need for increased expertise in academia and industry is also evident. The 'UK plant science research strategy: a green roadmap for the next 10 years', published in 2021, refers to limited expertise in the transfer of plant science technology in universities as one of the barriers limiting innovation and commercialization of plant science research in the United Kingdom (Langdale, 2021). The report traces this shortfall back to both the limited number of vocation-focused undergraduate courses in plant sciences as well as an inadequate number of PhD studentships being offered and/or accepted. The document concludes that to encourage more students to pursue a career in botany, we must emphasize why this discipline is important and the broad range of career opportunities available (Langdale, 2021).

Finally, the need to increase plant appreciation in the wider community has also been highlighted (Crisci et al., 2020; Jose et al., 2019; McDonough Mackenzie et al., 2020; Woodland, 2007). The potential impacts extend to the level of funding allocated to plant conservation efforts (Balding & Williams, 2016), plant science research and enhanced participation in plant-focused citizen science projects. To raise plant awareness and appreciation, an impressive diversity of approaches promoting botany in educational settings, as well as outside the classroom, has been proposed and developed (Crisci et al., 2020; Fančovičová & Prokop, 2011; Friesner et al., 2021; Jose et al., 2019; Levesley et al., 2012; McDonough Mackenzie et al., 2020; Moores et al., 2021; Pany et al., 2019; Thorogood, 2020; Woodland, 2007) with many demonstrating a measurable increase in botanical literacy among participants (Pinkerton et al., 2021;

Ryplova & Pokorny, 2020; Stagg & Donkin, 2013; Wells et al., 2021). The growing number of initiatives run by plant scientists, such as international Fascination of Plants Day (<https://plantday18may.org/>), PlantLoveStories (<https://www.plantlovestories.com>) or More Than Weeds (<https://morethanweeds.co.uk/>), as well as relentless work of botanical gardens around the world, also continues to promote an awareness and appreciation of plants among the general public. Here, we discuss the recent rise of 'mainstream' interest in plants as a hobby or as lifestyle elements and suggest that this trend offers a new opportunity to enhance the impact of such outreach efforts and foster a fascination with plant science among both students and the general public. We suggest that topics currently enjoying a remarkable rise in popularity, such as houseplants, plant-based diet or plants' effect on human health and well-being, can be used to capture the attention of large audiences. We also highlight the potential of social media to reach these target audiences.

2 | OPPORTUNITIES FOR GROWTH— INCREASED INTERESTS IN PLANTS

In contrast to plant sciences in academia, an enthusiasm for plant-related hobbies and topics has flourished unexpectedly over the past 10 years, particularly among younger demographics. A recent industry commissioned UK poll of 2000 people found that 83% of 18- to 34-year-olds now describe gardening as 'cool' and 54% would choose a trip to a garden centre over a nightclub (Knight, 2021). Another poll found that British adults now spend, on average, over £300 a year on houseplants, with 18- to 24-year-olds buying them most often and owning an average of 10 different species (Hughes, 2021). This is congruent with the US data, where the 2016 National Garden Survey revealed that of the 6 million people who had taken up indoor and outdoor gardening that year, 5 million were millennials (Garden Center Magazine, 2016). This surge in plant popularity is well reflected by the rise of flora enthusiasts on social media: 'plantfluencers' and 'plantstagrammers' (Green, 2018; O'Connor, 2020). These influencers produce plant-focussed content and can reach hundreds of thousands of Instagram users (e.g., @houseplantclub [1 mln], @thesill [850 k] and @houseplantjournal [620 k followers]). Although the 'plant craze', ubiquitous among the younger age groups (Millennials and Gen Z adults), has been largely unnoticed by the scientific community, numerous mainstream media outlets, ranging from Business Insider to Cosmopolitan, enthusiastically chronicle its steadily increasing prevalence (Figure 2a). Paradoxically, the growing obsession with houseplants and the popularity of flora-related content on social networks may also have negative environmental consequences. The carbon footprint of the houseplants production chain needs to be considered (Bradley, 2021), meanwhile tourists damaging and destroying wild plants to take a 'selfie' have been reported (Gammon, 2019) and a growing demand for houseplants may lead to an increase in the smuggling of rare succulents (Dall, 2021). These examples also highlight the need for plant science outreach and education.

One of the drivers behind the soaring popularity of gardening and houseplant cultivation is certainly the growing awareness of the positive impact that these activities may have on mental health and well-being. Scientific studies have repeatedly associated interaction with plants contributing to lower levels of anxiety and stress (Hall & Knuth, 2019; Stigsdotter et al., 2010; Suyin Chalmin-Pui et al., 2021), and the connection between plants and a higher quality of life has been eagerly highlighted by numerous news outlets and mainstream media (Baker, 2020; Bovingdon, 2020). Interacting with plants is therefore increasingly considered a practice of mindfulness (Jenkins, 2020). Even toy brand LEGO® released a popular Botanical Collection comprising 'mindful' sets for building flower bouquets and bonsai trees from bioplastic components, to offer adult consumers a way to switch off and relax. Undoubtedly, this is particularly relevant in the pandemic shaken world, where lockdowns and restrictions triggered a re-examination of our home environments and further boosted the already rising interest in houseplants and gardening (Pope, 2021). With more time suddenly spent at home, people turned to testing their green fingers. Indeed, a recent analysis indicated that both indoors and outdoors greenery offer an escape and support mental health during social isolation (Dzhambov et al., 2021) and tending to plants was suggested as a coping mechanism to bring to bear comfort and psychological reassurance during the pandemic (Cordero, 2021; Rivas & Biana, 2021). The onset of COVID-19 coincided with the rapid rise of 'plant parenting' (#PlantParent [777.2 mln views on TikTok at the time of writing]). Plant parenting describes a phenomenon whereby people create an emotional bond with plants, enjoying their companionship, nurturing them and watching them grow, change and develop as living organisms (Hendrik, 2020). The beneficial psychological effects of plants are therefore likely one of the drivers behind houseplant cultivation and gardening skyrocketing in popularity.

Importantly, the increased interest in plants appears to extend beyond gardening and houseplants, with the recent popularity of plant-based diets being a leading example. In 2019, the Intergovernmental Panel on Climate Change (IPCC) released a report detailing the impact that switching to a plant-based diet may have on mitigating climate change (IPCC, 2019). Model predictions suggested that altering dietary habits could lower global CO₂ emissions by millions of tonnes per year (Schiermeier, 2019). In response to both perceived health benefits and social concerns, consumer trends are shifting towards plant-based diets internationally. In a US-based online survey, 28% of respondents self-reported consuming more plant-derived protein, 24% were eating more plant-based dairy alternatives and 17% reported increased consumption of plant-based meat alternatives in 2020 compared with 2019 (International Food Information Council, 2020). Again, Gen Zs are at the forefront of this trend, with 65% finding plant-based foods appealing and 75% declaring reduced meat consumption (Hamstra, 2019). These perceived health benefits of plants have a significant impact on global markets. In 2020, the global botanicals market was valued at USD 93.6 billion with predicted growth of 6% for 2021–2026 (Business Wire, 2021). Interest in botanical or herbal ingredients in beauty and health products is rising as consumer trends increasingly focus on healthy and

sustainable lifestyles (Culliney, 2020; Radin, 2021). Finally, there is a cause for cautious optimism when appreciation of native flora is considered, especially in the United Kingdom and Ireland. The popularity of wildflower meadows is increasing as an element of both urban and countryside landscapes, as well as private gardens (Figure 2b). Albeit often driven by insect-focused actions, such as All-Ireland Pollinator Plan (2015–2020) or Plants for Pollinators (The Royal Horticultural Society, 2019), this movement holds potential to stimulate the public interest in conservation of local botanical heritage and to raise awareness of issues like invasive plant species (Walker, 2021). The warm reception of publications such as 'The Wildflowers of Ireland: A Field Guide' (originally published in 2014, updated in 2021) and other books by the author Zoë Devlin, 'the unofficial ambassador for weeds' (Manley, 2017), also illustrates this trend. It must be noted that creating wildflower meadows, especially for landscaping purposes, is often associated with use of generic wildflower seed mixtures of non-native provenance, rather than enabling spontaneous species already in the soil bank to prosper. Thereby, it may pose a risk of perturbing the distribution and abundance of native species and have negative impacts on the genetic makeup of native wildflower populations (Viney, 2021). Nevertheless, wildflower meadows enrich plant–people interactions in urban environments and can provide a springboard for discussion about native botanical diversity.

3 | GOOGLE SEARCH VOLUME ANALYSIS CONFIRMS: PLANTS ARE TRENDING

We performed an analysis of UK-based web search trends for topics such as 'Houseplant', 'Plant-based diet', 'Garden', 'Wildflower', 'Botany' and 'Plant' over the last decade (Figure 3). Google Trends™ is an open online infoveillance tool that offers a simple and immediate way to obtain data on users' web interests without complications related to privacy (Rovetta, 2021). Such data are often utilized by culturomics, a field of study analysing human culture through changes in word frequencies in digital text databases (Michel et al., 2011). Culturomics is increasingly used to explore human interactions with the natural world (Ladle et al., 2016), and a recent detailed assessment of public interest in Israeli wildflowers provides an example of culturomic study of relationship between humans and plants (Vardi et al., 2021). Excitingly, the results of our Google Trends analysis appear to recapitulate the message: Plants and plant-related topics are gaining popularity. Could this be one of first signs indicating that PAD is starting to decrease? Certainly, addressing this question is not trivial without further research, as PAD has not been measured or indeed continuously monitored at the national/societal scale, with most studies so far focused on educational settings, including groups of primary, secondary school or undergraduate students (Çil, 2015; Lindemann-Matthies, 2005; Wells et al., 2021). However, a wave of interest in a range of plant-related activities, products and industries has been clearly building over the last decade, likely with an additional impetus from the COVID-19 pandemic. Sir David Attenborough

recently reflected that 'The world has suddenly become plant conscious' ahead of the release of a BBC One documentary *The Green Planet* in January 2022. Undoubtedly, the production of a premium natural history series with plants at its centre underscores the ongoing revival of general interest in plants and is likely to accelerate it. Here, we argue that we urgently need to start using this momentum to achieve a tangible increase in the number of students pursuing degrees and professional careers in botany and to increase public appreciation of plant science.

4 | ACTION: PLANT LOVERS AND HOW TO FIND THEM

Can we bring botany from peril to prosperity? Perhaps there has never been a better time to try. There is a sharp contrast between low uptake of botany degrees and career pathways, and the rapidly growing popularity of plant-related leisure activities and lifestyle elements. We suggest that this increasing interest in plant-related topics has opened a window of opportunity to raise societal awareness and appreciation of plant science. In particular, the fact that younger demographic groups seek interactions with plants offers a chance to build on this trend and promote botany as a career choice. What actions can we take to achieve this? Firstly, targeted outreach efforts, aimed at attracting groups already showing interest in plants or plant-related topics, should ensure that this interest continues and is broadened to plant science. There are different approaches that can be employed to reach these audiences, to include interactions through social media, particularly relevant now during COVID-19 pandemic. Plant-focused community groups (both public and private) on Facebook often gather thousands of members: for example, UK Houseplant Addicts (13 k members), UK houseplant swap and sell (36 k), Irish Gardening (45 k members) and Ireland Plant Identification Forum (9 k members). Similarly, Instagram and Twitter, more popular among younger cohorts (Greenwood et al., 2016), enable users to effectively reach desired audiences via careful use of appropriate hashtags: for example, #plantsofinstagram (12.9 mln posts of Instagram) and #plantsmakepeoplehappy (9.4 mln posts). Finding (prospective) plant lovers could be also mediated via local gardening centres, houseplant stores or gardening/flower shows. For example, the 'UCD Evolution of Land Plants Garden' demonstrates how plants colonized land over 500 million years (Elliott-Kingston et al., 2021) and won the concept award and a gold medal during Bloom in the Park, the biggest garden and lifestyle festival in Ireland (>100 k visitors each year), and as a result received coverage in mainstream media such as the Irish Times and Irish Independent (Independent.ie, 2016; Purcell, 2016). Likewise, connecting with relevant audiences may be facilitated via events focused on promoting plant-based diets and sustainable living, such as vegan fairs/food markets, or increasingly popular environmental festivals. In conclusion, there are many successful strategies for instilling fascination with plants and plant science among different public groups (Moscoe & Hanes, 2019) and we suggest that now, thanks to increasing interest in plant-related topics,

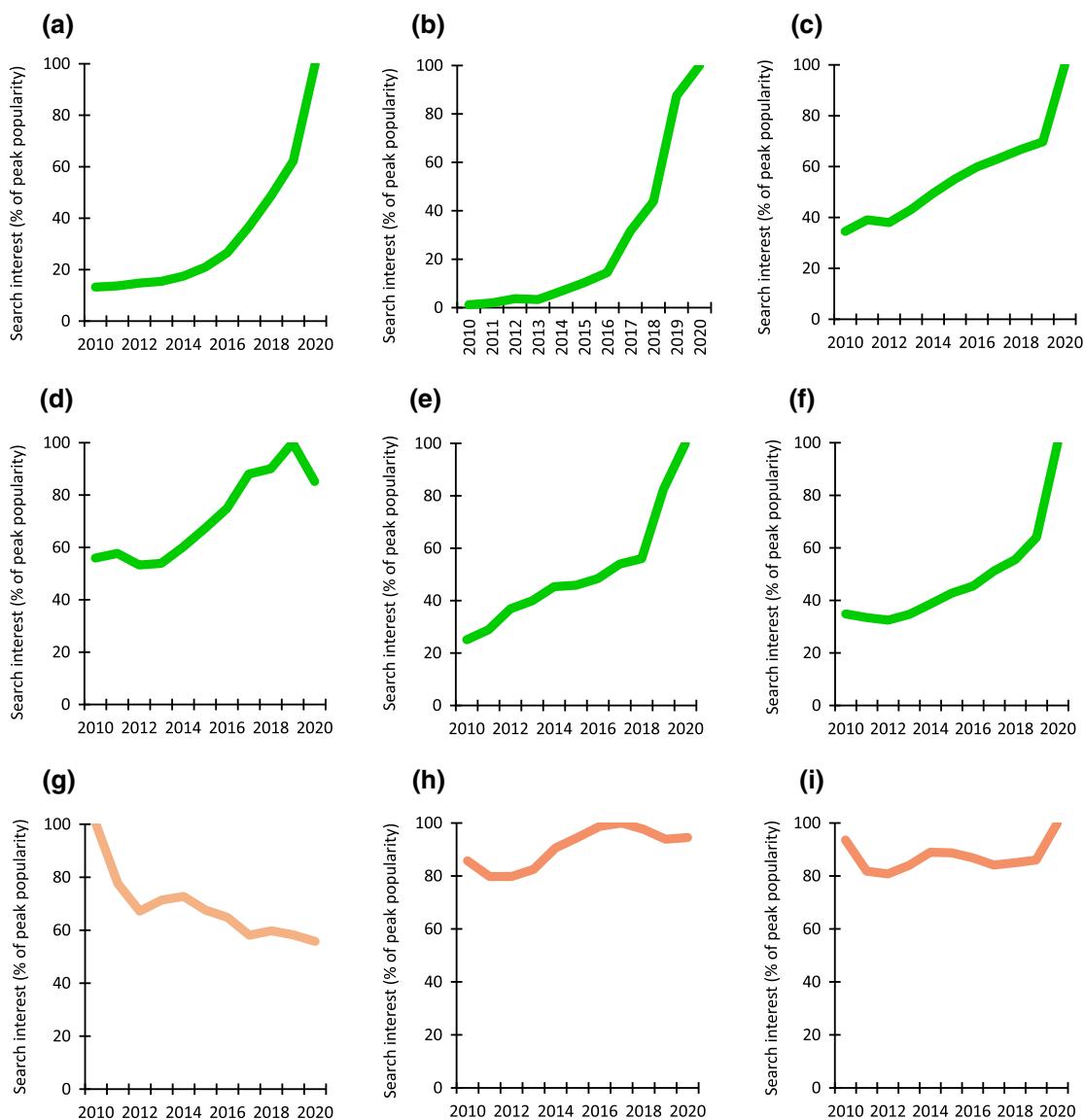


FIGURE 3 Google search trends analysis. Relative annual mean search volumes were calculated based on the search data extracted from Google Trends for each topic (<https://www.google.com/trends>). The values represent search interest relative to the peak annual popularity for the topic (100%) in the United Kingdom between 2010 and 2020. Trends, but not values, can be compared between the panels. Plant-related topics show general increase in popularity over the last decade (a–f) as opposed to examined topics unrelated to botany showing a steady, or even declining, relative popularity (g–i). (a) Houseplant; (b) plant-based diet; (c) garden; (d) botany (field of study); (e) wildflower; (f) plant; (g) zoology (field of study); (h) cell (biology); (i) animal

we can ensure that these strategies reach particularly responsive target audiences and consequently their success rate is multiplied.

The efforts promoting plant research, if directed, may be more likely than ever to fall on fertile ground, especially if we design them to specifically spark the interest of target groups. The topics currently rising in popularity, such as houseplants, benefits of interacting with plants for human health and well-being or plant-based diets, and the importance of plants in the battle against climate change, are likely to attract attention and hence can be used as a springboard for promoting plant science. For example, an outreach action helping to answer the question ‘How to keep your houseplant healthy?’ could be a starting point to a conversation on plant stress physiology and

pathology. Secondly, analysis of current trends indicates that when botany and plant biology degrees are advertised and promoted, references to parts of the degree covering areas such as plants as a tool to fight climate change; the role of plants in human nutrition, beauty and health industries; houseplants/ornamental plant care, breeding and evolution; and other topics of growing popularity are likely to attract attention of young adults. Further increasing the match between teaching curricula and these interests is also worth consideration, and indeed, similar approaches were successful in the past: including how highlighting the more applied aspects of plant biology helped to increase the number of botany majors almost fourfold at Department of Botany and Microbiology at the University of Oklahoma

(Uno, 2007). These recommendations could complement strategies developed to (i) improve the association of plant science with specific career paths and (ii) increase the numbers and diversity of students applying for vocational, undergraduate and postgraduate programmes (Langdale, 2021). Collectively, we contend that the increasingly green public of 2022 represent an ideal audience for engagement with plant science.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

AUTHOR CONTRIBUTIONS

JK conceived an original idea for the article, further developed by all authors (RB, OS, SC, RC, AK, PMC and JK). RB, OS and JK drafted the initial version of the manuscript. SC examined plant and animal mentions in the nature documentaries presented in Figure 1, and RC performed Google Trend analysis presented in Figure 3. All authors (RB, OS, SC, RC, AK, PMC and JK) contributed to the article and approved the submitted version.

DATA AVAILABILITY STATEMENT

Detailed analyses of plant and animal mentions per episode of *Our Planet* and *Planet Earth II* series, as well as raw search data extracted from www.trends.google.com, are available from the corresponding author upon request.

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