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Opinion

The vicious cycle of biophobia

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People can express irrational fears and disgust responses towards certain wild organisms. This so-called 'biophobia' can be useful and indeed necessary in some circumstances. Biophobia can, however, also lead to excessive distress and anxiety which, in turn, can result in people avoiding interactions with nature. Here, we highlight concern that this reduction in interactions with nature might lead to progressive increases in biophobia, entrenching it more in individuals and across society. We propose the 'vicious cycle of biophobia', a concept that encapsulates how excessive aversion towards nature might emerge and grow in society. The vicious cycle of biophobia risks accelerating the extinction of experience, leading to long-term adverse consequences for the conservation of biodiversity.

Highlights

Biophobia is the aversive response, such as fear and disgust, that people can show towards some natural stimuli, settings, or situations.

Excessive biophobia can reduce people's support for pro-biodiversity policies and actions, and increase their antagonism towards nature, both of which can have enormously detrimental impacts on biodiversity conservation.

There are likely several self-reinforcing feedback loops whereby the consequences of excessive biophobia lead to increases in negative feelings towards nature through strengthened human disconnection from nature.

Researchers and policy makers should focus more attention and effort on planning how best to limit, and ideally reverse, the vicious cycle of biophobia.

Biophobia: an under-recognised dimension of human–nature relationships

The **biophilia** (see Glossary) hypothesis posits that humans have an innate affinity with the natural world [1,2]. The hypothesis is built on the assumption that humans share an evolutionary history with nature that was necessary for their survival as a species [1]. Indeed, there is good evidence to suggest that exposure to nature delivers a wide range of benefits to human health and wellbeing [3–6]. Further, at an individual human level, positive emotions towards nature can create motivations towards its protection [6,7].

Our relationship with nature, however, is more complex. Alongside biophilia, humans can also show negative feelings (e.g., fear, disgust, and aversion) towards nature, called **biophobia** [2,8]. We define biophobia as not only suffering from a severe psychological problem (e.g., anxiety, panic attacks) [9], but also broadly to refer to any negative affective attitude towards nature, such as fear and disgust [10–16]. Biophobia can take many forms, such as arachnophobia (fear of spiders), entomophobia (fear of insects), and ophidiophobia (fear of snakes) [17] (Figure 1). Some have argued that biophobia, like biophilia, has a genetic component, and it is thought to entail innate physiological responses to the elements of nature that might cause harm [2,8,18].

In contemporary societies, biophobia may be much more widespread than commonly assumed, and could be at much higher intensities than is needed to ensure an individual's survival. Both scientific and anecdotal evidence suggests that many people, especially in more urbanised and developed societies, exhibit responses of fear or disgust towards wild organisms that they will never directly encounter, or that are not particularly dangerous or harmful [10,11,13,14,16,19]. There is concern from some in the academic community that the intensity and breadth of biophobia is increasing as a result of ongoing global urbanisation, the so-called **urbanisation–disgust hypothesis** [14], and its associated loss of experiences with nature [10,13,16]. Whilst a certain level of biophobia is useful and necessary in some circumstances, excessive levels of fear and disgust towards nature can be detrimental for human health. Biophobia can cause undue stress and anxiety [20], which can then lead to avoidance of interactions with nature. This loss of interaction results in people receiving fewer of the health and wellbeing benefits that nature provides [3–6].

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Further, excessive biophobia could also reduce people's pro-biodiversity attitudes and behaviours, which can have enormous detrimental impacts on biodiversity conservation [21,22]. Despite these potentially broader implications, little attention has been paid to biophobia in the recent discourse on human–nature interactions.

The vicious cycle of biophobia

We propose a new concept that we call the 'vicious cycle of biophobia', which encapsulates how excessive biophobia might emerge and grow in society (Figure 2). We describe the mechanisms of this cycle, discuss the potential implications and mitigation measures, and suggest key knowledge gaps and recommendations for further research. We focus mainly on urbanised and high-income countries and regions, where excessive biophobia is suggested to be common [10–16,19], and because research on this phenomenon in other areas is still limited.

Conceptual framework

Our proposed concept is based on the **fear-avoidance model**, a cognitive-behavioural theory that explains the interaction between pain-related fear and the development of persistent disability [23]. Adopting and broadening this model, we consider that: (i) biophobia is driven by exposure to negative information about nature (Pathway 1 in Figure 2), (ii) elevated biophobia leads to increased nature-avoidance behaviours (Pathway 2), (iii) these behaviours result in human disconnection from nature (Pathway 3), and (iv) the disconnection reinforces an individual's biophobia (Feedback). Although the fear-avoidance model is focused on fear as a driving force for avoidance behaviour, we chose it as the basis for the framework because negative affective attitudes towards nature, including those other than fear (such as disgust), also likely trigger similar avoidance behaviours towards it [24]. It should be noted that the vicious cycle of biophobia can be triggered and accelerated by many other external factors (see later), implying that any of the four boxes shown in the framework (Figure 2) could be the starting point of the cycle.

Pathway 1 (information leads to phobia)

There are three major ways in which people acquire negative information about nature (Figure 2). The first is by experiencing negative interactions with nature directly, which can take diverse forms (see [17] for a more detailed discussion about **negative direct human–nature interactions**). The second is information exposure through interpersonal communication such as parent–child conversations. The third is via information transfer through mass media such as newspapers, television, and websites.

Exposure to negative information about nature can increase an individual's phobic emotions towards it (Figure 2). For example, negative direct experiences of nature (e.g., aggressive behaviour by wildlife) can increase people's negative feelings and attitudes [25]. In extreme cases, these experiences (e.g., being stung by an insect or swooped on by a bird) often induce an inappropriate, exaggerated fear response, sometimes leading to negative long-term psychological consequences such as post-traumatic stress disorder [20]. Further, children frequently provided with negative information about wild animals by their parents are more likely to show fear responses toward those animals (Box 1 Figure IA) [26]. Likewise, exposure to negative information about wildlife in the popular media can affect people's risk perceptions of wildlife [27–30]. The movie 'Jaws' is a good example in this regard; its negative portrayal of sharks has led to a widespread increase in people's fear of them [31].

Of course, exposure to negative information about nature does not necessarily lead to increased biophobia in isolation. The extent to which people feel phobic emotions after being exposed to information is influenced by several interacting personal factors. For example, people with greater knowledge about nature are less likely to believe false or exaggerated negative information about

Glossary

Biophilia: a psychological tendency to be attracted to other forms of life and the natural environment.
Biophobia: feelings of negative responses to certain natural stimuli.
Expansion of negative experience: progressive increase in some kinds of negative direct interactions of people with nature.
Extinction of experience: progressive loss of daily interactions between people and nature.
Fear-avoidance model: a cognitive-behavioural model that describes how following a painful episode, some people end up in a vicious loop where hypervigilance leads to reduced activity in the longer term, which is associated with pain persistence and emotional distress.
Nature ignorance: progressive decline in the average level of knowledge of natural history among the general public.
Negative direct human–nature interactions: direct experiences of people with nature that result in adverse health outcomes.
Shifting baseline syndrome: gradual shift in the perceptions or expectations about the condition of the natural environment due to lack of past information or lack of experience of past conditions.
Urbanisation–disgust hypothesis: living in urbanised environments increases the intensity and breadth of feelings of disgust towards animals.

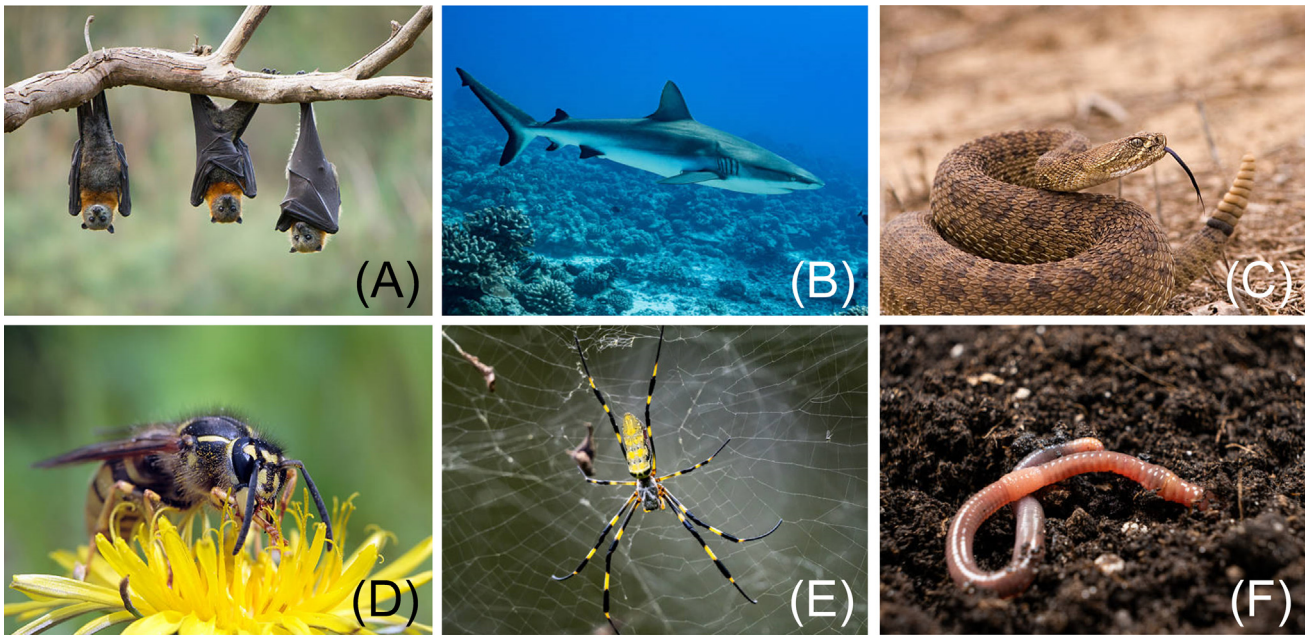

Figure 1. Forms and magnitude of biophobia. People exhibit phobic responses towards a diverse range of wild organisms, including (A) bats, (B) sharks, (C) snakes, (D) wasps, (E) spiders, and (F) worms. Images from iStock.

it in the media and thus are less likely to fear it [32]. From a practical viewpoint, it seems vitally important to determine the relative significance of personal, environmental, and social factors in shaping sensitivity to negative information about nature.

Over the last few decades, there has been a growing trend in the reported numbers of certain kinds of negative direct experiences of nature such as snake bites, shark bites, attacks by large carnivores, and invertebrate interactions [17]. This so-called **expansion of negative experience** is likely to contribute to the prevalence of negative information about nature. Indeed, whilst

Box 1. Empirical evidence supporting our proposed conceptual framework, the vicious cycle of biophobia

We present here some case studies demonstrating (i) exposure to negative information about nature increases biophobia (pathway 1 in Figure 2) (Figure IA), (ii) increased biophobia results in nature-avoidance behaviours (pathway 2 in Figure 2) (Figure IB), and (iii) disconnection from nature (loss of direct experiences of, and knowledge about, nature) leads to increased biophobia (Feedback in Figure 2) (Figure IC, D).

Pathway 1

Reider and colleagues [26] explored whether negative information about snakes and spiders from parents influences children's fear beliefs towards those organisms in the USA. They found a positive relationship between parent's negative utterances about snakes and spiders and their children's fear beliefs (Figure IA).

Pathway 2

Deutsch and colleagues [40] explored whether people's aversion feelings (dislike, disgust, and fear) towards an endangered frog species (*Ceratophrys ornate*) influenced their reactions towards this species (kill it, let it live) when encountering it in Argentina, Brazil, and Uruguay. They found that those who had greater aversion feelings were more likely to have killed the frog species (Figure IB).

Feedback

Tomažič [54] explored whether primary school students' direct experiences of toads influenced their negative perceptions (dislike, disgust, and fear) towards these organisms in Slovenia. They found that children who had experienced toads exhibited lower levels of negative perceptions (Figure IC). Fukano and Soga [14] also explored whether people's knowledge of insects influences their disgust feelings towards these organisms in Japan. They found that those who are knowledgeable about insects showed lower disgust (Figure ID; note that we only present the results for people's disgust feelings towards lady beetles).

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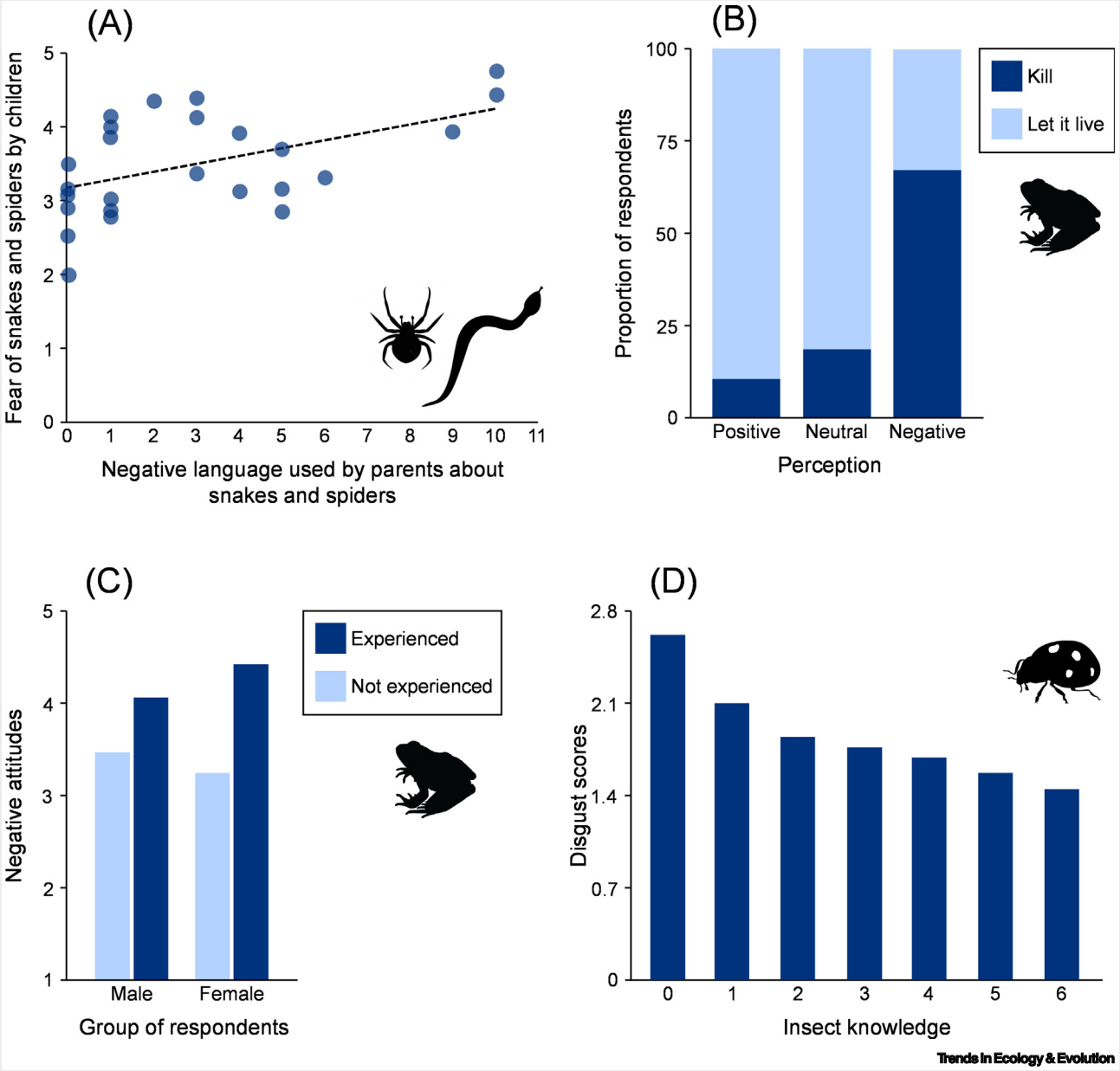

Figure I. (A) Relationship between parent's negative utterances about snakes/spiders and their children's fear beliefs [26]. (B) Comparison of indicated reactions (kill it or let it live) of respondents with positive, neutral, and negative perceptions towards a frog species [40]. (C) Levels of negative perceptions towards toads among primary school children according to reported direct experiences with these organisms (note: lower score means more negative perceptions) [54]. (D) Levels of disgust feelings towards lady beetles according to species identification ability [14].

the absolute number of incidents involving serious consequences for human health is not very high in many cases, these accidents are often featured prominently and sensationally in local media [33,34]. In addition, recent rapid developments in information and communication technologies have enabled news to spread faster and more widely, which has accelerated the prevalence of sensationalist – and often false – information on a global scale [35].

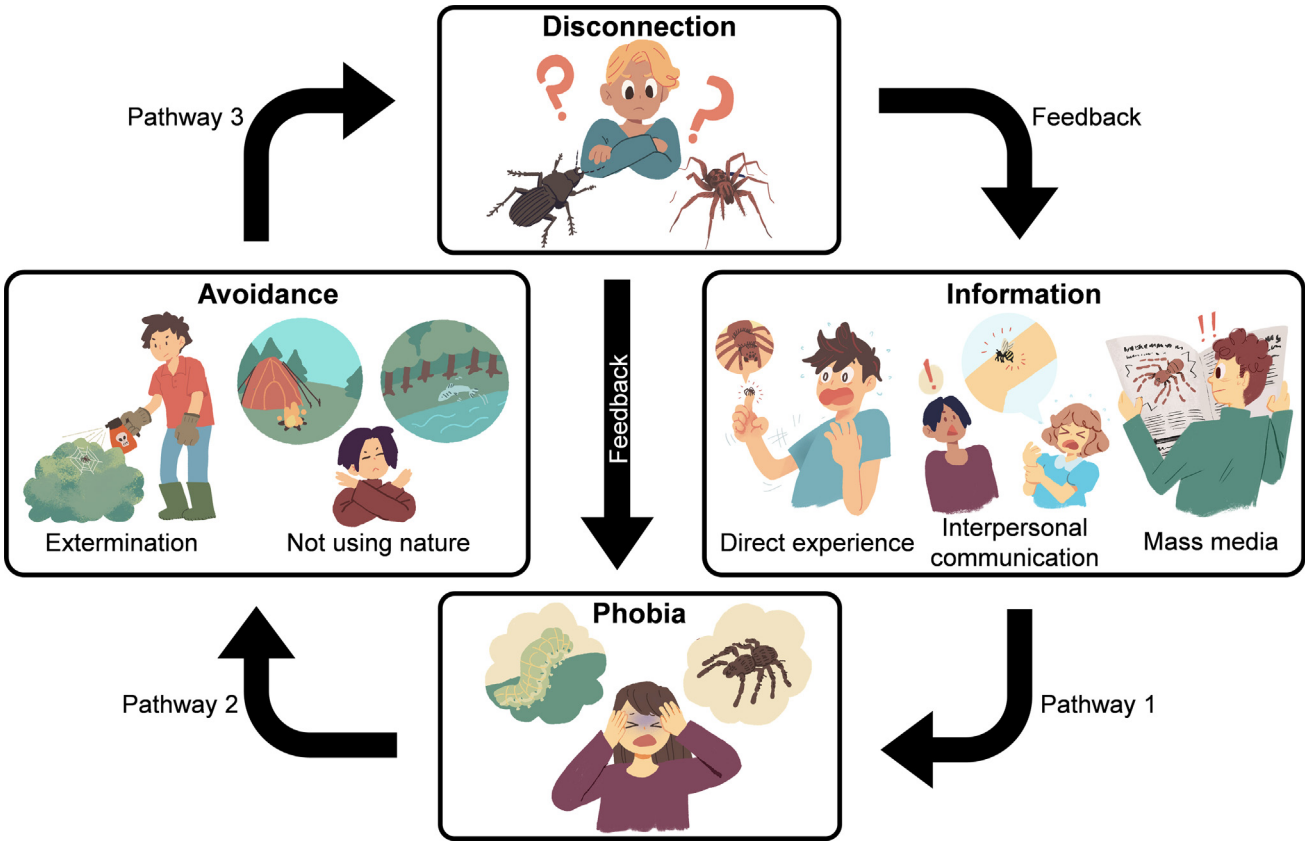

Figure 2. A conceptual framework for understanding the vicious cycle of biophobia. Increased biophobia, driven by increased exposure to negative information about nature (Pathway 1), results in nature-avoidance behaviours (Pathway 2), which might, in the long term, lead to increased disconnection from nature (Pathway 3). Disconnection from nature can decrease people's familiarity with nature (i.e., nature ignorance), which has the potential to result in increased biophobia (Feedback). Note that this schematic diagram does not necessarily represent all potential factors and processes. There are also likely many external factors that can induce and accelerate the cycle.

Pathway 2 (phobia leads to avoidance)

Feelings of fear and disgust are known to be major drivers of general avoidance behaviour [23,36]. Elevated biophobia can therefore lead to development of nature-avoidance behaviours (Figure 2). There are two major types of behaviours that enable an individual to avoid or escape from nature. The first is by avoiding natural environments that contain the organisms that the person fears (Figure 2). For example, people with high levels of biophobia are less motivated to engage in outdoor recreational activities such as camping and hiking [15]. Further, people with greater negative perceptions of wildlife are less motivated to live in locations that contain these organisms [37,38]. People with biophobia, therefore, might avoid living in areas with greater access to natural environments.

The second avoidance behaviour involves supporting and participating in actions aimed at eliminating nature (Figure 1). For example, fear and disgust of wild animals can lead to increased willingness to kill or remove these organisms (Box 1, Figure IB) [39,40]. Elimination of nature might extend to the natural environments which the feared organisms use, such as natural vegetation in a domestic garden and urban greenspace [41]. Elimination of nature is not, however, an inevitable consequence of biophobia; people's actions towards wildlife are determined by a multitude of personal and social factors and how these interact with biophobia [42]. Research to determine

the relative contributions and interactions of biophobia and other factors in shaping people's nature-elimination behaviour would help pinpoint areas to target actions to reduce this environmental impact.

The impacts of nature-avoidance and -elimination behaviours are likely to be exacerbated and strengthened over time. Humans are a social species, we learn from others in our society and pass behaviours down through generations. By exhibiting nature-avoidance and -elimination behaviours, people could suggest (consciously or subconsciously) to others that they should fear nature and act in a similar manner. For example, children with parents who engage in nature avoidance are more likely to be afraid of wild animals [13].

Pathway 3 (avoidance leads to disconnection)

Nature avoidance that is driven by elevated fear could decrease both the opportunities and motivations of people to interact with wild organisms (including those that they do not inherently recognise as objects of fear or disgust). As a result, these behaviours can, in the long term, contribute to an ever-increasing reduction of direct experience with nature. This **extinction of experience** [43–45] results in a further disconnection from nature (Figure 2), which likely leads to increase in biophobia, which then perpetuates, reinforces, and proliferates itself more widely across society.

There is growing concern that the extinction of experience is expanding as a result of ongoing global urbanisation, loss of biodiversity, and the greater uptake of sedentary pastimes such as watching television, playing computer games, and online activities [44–48]. This concern is amplified when considering that the extinction of experience can have a wide range of adverse impacts on both human health and biodiversity conservation [6,44]. Whilst discussion of the extinction of experience has so far centred largely on how to promote people's positive emotions towards nature (i.e., biophilia) [44,47,49,50], it is also important to understand how biophobia contributes to the development of this phenomenon.

Feedback (disconnection leads to information leads to phobia)

One of the key consequences of the extinction of experience is loss of familiarity with nature (e.g., species identification ability) [14,51–53]. The loss of people's familiarity with nature, so-called **nature ignorance** [6], has the potential to result in increased biophobia in several ways (Figure 2). First, since people are generally afraid of the unknown, those who are not familiar with wild organisms are likely to show phobic responses towards them (Box 1, Figure IC,D)

Box 2. Pathways through which increased biophobia can affect biodiversity conservation

Elevated biophobia can negatively affect biodiversity conservation in several ways. First, increased biophobia can decrease the willingness of people to coexist with wild animals, particularly those regarded as dangerous or harmful (e.g., wolves, bears, large cats) [37]. This can decrease people's acceptance of policies and actions that aim to conserve and restore these organisms (e.g., reintroduction) [22]. Second, it is known that those who exhibit biophobia tend to undervalue the benefits wild organisms provide to society (e.g., pollination services provided by wasps) [21]. Given that perceptions of ecosystem services are known to be an important predictor of people's willingness to support conservation [67,68], decreased understanding of the value of nature can reduce their motivation to conserve and restore it. Third, nature-elimination behaviours due to increased biophobia can negatively impact biodiversity more directly. For example, the coronavirus disease 2019 (COVID-19) pandemic has led to an increase in fear towards bats as a result of their role as vectors or reservoirs for strains of coronaviruses [69,70]. Intentional killing of bats and disturbance of bat colonies, including of species on the International Union for Conservation of Nature (IUCN) Red List, have increased worldwide since the pandemic [69,70]. Fourth, increased nature-avoidance behaviours likely accelerate the ongoing loss of positive direct interactions between people and nature (i.e., the extinction of experience) [44]. Positive experiences of nature, especially at an early age, can play an important role in generating and reinforcing people's favourable beliefs, perceptions, and attitudes towards it (early nature experience hypothesis) [6]. Extinction of experience can therefore have the potential to decrease people's support for policies and actions that aim to conserve biodiversity.

[14,54,55]. Second, people who are not knowledgeable about nature can sometimes exhibit inappropriate behaviours that lead to an increased likelihood of negative direct experiences with nature [17,56]. This can contribute to the development of negative information about nature. Third, people who lack relevant knowledge of natural history, and real experiences of nature, may be more likely to believe, and share, sensationalist and false information about wild organisms, which may in turn result in the spread of inaccurate negative information about nature (cf., [32]). Fourth, it is likely that people who are not knowledgeable about nature are not able to easily distinguish harmful from nonharmful organisms, thereby broadening the range of species about which they feel fearful [14]. These four pathways imply that there is a feedback loop by which increases in fear or disgust feelings towards nature can result in increased and entrenched biophobia.

We acknowledge that some assumptions in our conceptual model are simplifications of what is undoubtedly a complicated relationship between humans and nature. There may be circumstances where increases in biophobia lead to decreases in exposure to negative information about nature. For example, engagement in nature-avoidance behaviours might inevitably reduce negative interactions with wild organisms. This can thus decrease people's exposure to negative information about nature. Indeed, with the proliferation of sophisticated media programs about nature reaching many millions of people worldwide, there may be a romanticisation of nature that neglects the realities of interacting with it directly. More empirical research is required to understand how the feedback loops involved in our conceptual framework operate and interact with each other.

Reversing the cycle

We have so far discussed the risk that the vicious cycle of biophobia poses to human health and biodiversity conservation in the long term (see Box 2). Yet, if the cycle could be reversed, we might instead benefit from increases in human health and improvements to biodiversity conservation. In this vein, there are likely two key strategies to limit and possibly reverse the vicious cycle of biophobia. We focus on strategies and actions that can be used to promote widespread societal shifts rather than those aimed at meeting the needs of specific groups of people. Therefore, we do not discuss interventions that are normally adopted in clinical settings as a tool for the treatment of specific kinds of phobia [9].

Increase people's knowledge about nature through educational and outreach programs

This would reduce the likelihood that people believe, and share, inaccurate information about nature. It might also help to counteract the prevalence of inaccurate or sensationalist information about nature. There are various ways to increase knowledge about nature, such as implementing nature education in schools, zoos, and museums [19,57,58], improving collaboration between journalists and researchers [59], and developing online education and recreational channels to communicate scientific knowledge about nature [60].

Provide direct experiences of wild organisms

Direct positive contact with nature can contribute to reducing people's negative perceptions of wild organisms. For example, even brief and infrequent positive interactions with nature, such as one-day field trips or urban gardening, can mitigate phobic-like reactions to animals such as snakes, wasps, and earthworms [16,61,62]. Importantly, providing direct experiences of nature can also help increase people's knowledge and motivation to use it [13,14,16].

Of course, the feasibility and effectiveness of these two strategies will vary according to the situation and individual. For example, research suggests that biophobic responses can differ between animal species for those with increased knowledge about nature [14]. There are no

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'silver bullet' solutions to limit the vicious cycle of biophobia, and careful consideration is required when choosing strategies.

Concluding remarks

Ongoing global urbanisation and biodiversity loss, and the resultant expansion in human disconnection from nature, risk increasing people's biophobia (see Outstanding questions). Ultimately, this will result in a gradual decline in people's tolerance, and an increase in antagonism, towards nature, implying a **shifting baseline syndrome** [63]. The prevalence of this 'inappropriate' biophobia in society could be detrimental to human health and biodiversity conservation. There is an ever increasing and urgent need to undertake ambitious conservation and restoration programs in the face of continued worldwide environmental destruction [64–66]. We argue that a fundamental part of environmental conservation is the need to focus more attention and effort on understanding the vicious cycle of biophobia and to plan how best to limit or, better still, reverse it. Part of this, we believe, is to communicate to a broad audience – including policy makers, conservationists, education professionals, journalists, and the public – the significance and consequences of this phenomenon.

Outstanding questions

What are the best methods for measuring people's biophobia?

To what extent are people's negative feelings towards nature increasing?

Under what conditions is biophobia likely to grow more rapidly?

How do levels of biophobia vary between people?

What are the relative contributions of genetic and environmental factors in shaping an individual's biophobia?

How commonly or differently manifested is biophobia across societies, and how specific is it?

How are people's biophilia and biophobia related to each other?

What are the differences between the species that can evoke a phobic-like reaction and those that generate a favourable feeling?

To what extent does biophobia influence people's behaviour towards nature?

How do fear and disgust differ in their influences on people's attitudes and behaviours towards nature?

What are the best approaches for reducing the prevalence of biophobia?

How will preventing the ongoing loss of human–nature interactions contribute to reduced biophobia?

How will conservation and restoration programs in urban areas influence the prevalence of biophobia?

What measures are needed to promote public motivation to protect kinds of wildlife that can evoke biophobia, and how do such interventions differ from those aimed at enhancing interest in more attractive species?

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Declaration of interests

No interests are declared.

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