Addressing global insect meltdown

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Citation

Samways MJ (2019) Addressing global insect meltdown. *The Ecological Citizen* **3**(Suppl A): 23–6.

Keywords

Agriculture; biodiversity; conservation; intrinsic value; sixth mass extinction

Insect diversity is enormous, with possibly 5–8 million extant species. Most of these remain undiscovered, with only just over a 1 million species described (Adler and Foottit, 2017). Many more await discovery, while many previously unknown species are being revealed through genetic studies. This huge insect variety means countless ecological interactions, from herbivory and pollination to predation and parasitism. Importantly, insects are a vital component of terrestrial food webs, meaning essential food items for many birds, small mammals, lizards and amphibians, as well as for each other.

As insects are small and often hidden among plants, in crevices, or below ground, we do not easily relate to them. It is mostly the large, benign and charismatic species, such as butterflies, dragonflies and grasshoppers, to which we relate. In short, while we value the few, we underappreciate the many. Yet it is this 'many' that not only grace the planet, but also support a vast number of life functions that we rarely see, and so do not value. This unseen majority is apparent in swifts, martins and swallows wheeling for hours, catching insect food on the wing. At any one time, there are trillions of insects circulating in the air, known as 'bioflows', creating an intrinsically important dynamic ecological tapestry, where essential nutrients for ecosystems are continually circulated (Hu *et al.*, 2016).

Current concern is not just about the decline in insect species (Sánchez-Bayo and Wyckhuys, 2019), but also their abundances (Hallmann *et al.*, 2017), through fragmentation and attrition of insect *populations* globally (Samways, 2019). Put simply, insects are not as abundant or diverse as in the recent past. Insect decline was already recognized in the 1870s (Swinton, 1880), and has become concerning since the 1950s, but today it is alarming. This could be the start of the largest global meltdown of insects – species and individuals – since the Cretaceous, 66 million years ago.

Perceptions

Many of the scientific and management tools are in place to halt, and in some locations reverse, this precipitous insect decline (Samways, 2015). The fundamental issue facing us is to improve our overall appreciation and valuation of insects, and then have the will to stop the decline (Simaika and Samways, 2018). While human-induced climate change has its deniers, global insect meltdown is shrouded in ignorance more than denial. It is now crucial that more people become aware of what is happening to insects, which, besides having intrinsic value in terms of their vast diversity and evolutionary legacy, are also essential for life as we know it, as well as for our survival (Losey and Vaughan, 2006). A third of our food crops, especially those of high nutritional value, require insect pollinators. Moreover, most flowering plants depend on insect pollinators. The global decline in insect pollinators has indeed been a shock, stimulating much needed action for recovery for all insects (Habel *et al.*, 2019). There is a growing realization that not only humans, but also much of the fabric of terrestrial life, depends on the 'services' of insects.

Reasons for insect decline

The reasons for human-driven insect decline are many and diverse. Loss of natural habitat, attrition of remaining habitat fragments, and agricultural intensification are the greatest threats to insects in most

parts of the world (Gerlach *et al.*, 2012). Natural forests, wetlands and grasslands have been converted to plantations, grazing lands and croplands, making these areas often depauperate in insects. This large-scale onslaught on environmental conditions has resulted in collateral damage to insects. There has been little appreciation that these small animals rejuvenate and till the soil, enable the survival of flowering plants, support innumerable fauna that are higher in the food chain, and, through some of them being predatory or parasitic, are an effective alternative to the use of generally harmful pesticides. Their homes in the form of indigenous microhabitats are being taken away in a matter of just a few years.

In addition, the use of heavy machinery, nitrogenous fertilizers, pesticides and overly intense grazing, as well as pollution, has further impacted insects. Many of these compounded impacts are adversely synergistic, each producing increasingly antagonistic impacts alongside the others. Additionally, climate change has emerged as an extra impact, producing, in concert with landscape fragmentation, a 'deadly anthropogenic cocktail' (Travis, 2003).

Increasing human demands and incursions are also adding pressure on freshwater ecologies, whether through over-abstraction of water, or pollution of rivers, lakes, and other water bodies with pesticides, nitrogenous compounds and heavy metals (Darwall *et al.*, 2012). In and around towns and cities, there are two other impacts adversely affecting insects: artificial lighting, which disorients and affects the survival of night-flying insects such as moths (Longcore *et al.*, 2015), and roadkill from increased traffic density and speed (Martin *et al.*, 2018). Except in rare cases, these impacts are proving to be extremely challenging to address.

How to help insects

Firstly, we need to assess how insect species and their populations are faring. While such assessments require scientific validation, citizen science is now playing a vitally important role by providing more eyes and hands to record changes in insect populations. In some areas, this extra help is physically improving conditions for insects through habitat restoration. Citizen science for young learners is also a great opportunity, not least because they are receptive to actions that improve their own future (Saunders *et al.*, 2018).

A move away from agricultural intensification to *ecological* intensification (where all natural ecological integrity and ecosystem function and resilience is maintained) is now crucial (Garibaldi *et al.*, 2019). This approach views insect and other diversity of life forms as requiring space. Yet this is not any space, but rather quality space in terms of allowing for a greater proportion of natural or semi-wild habitat relative to areas of production. Providing abundant protected areas of natural habitat, contiguous with cultivated lands, thus plays a major role in this approach. Also important are networks of conservation corridors (Figure 1; Samways and Pryke, 2016). At the smaller spatial scale, improvements for insect life can be fostered by planting insect-friendly strips of vegetation between crop rows (Figure 2). This practice is associated with the approach known as 'integrated pest management', where there is maximal use of natural enemies for injurious insects and thus less reliance on pesticides. Natural or semi-natural vegetation can also provide refuges and nectar resources for these natural enemies, as well as for pollinators (Winter *et al.*, 2018). This shift to a more sensitive ecological approach also necessitates a shift in human perception and values, to take on board a sustainable future for biodiversity and agriculture, beyond immediate commercial profitability.

In an urban environment, greenspace in the form of urban parks and eco-friendly gardens is playing a major role in insect protection (Guenat *et al.*, 2019). However, the issue of artificial lighting of urban areas is still a great challenge. There are some technical ways to reduce the impacts of light pollution, such as moving away from white to a softer light (Somers-Yeats *et al.*, 2013) and reducing roadkill

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Figure 1. Large, remnant, high-quality conservation corridors, such as this one among plantation blocks, play a major role in conserving insects in a changing world.

through improvement in the structure and naturalness of roadside vegetation (Skórka *et al.*, 2013) and implementation of insect flight deflectors for their protection (Skórka *et al.*, 2015). However, globally there is limited motivation for implementing such actions, given so many other social perspectives and priorities among urban planners.

River protection ideally must consider the whole catchment, and must also include conservation of the riparian corridor, as many aquatic insects require both good water conditions and a healthy river margin (Dalzochio *et al.*, 2018). Ponds are also playing a major role in insect conservation, especially when they are well-vegetated, unpolluted, and functionally well connected (Hill *et al.*, 2018).

The future

Global climate change will be less severe on insect populations when options are available for insects to move across the landscape, as they did before industrialization and widespread habitat fragmentation. This means that we must always consider ways to improve functional connectivity across the landscape, especially for maintaining high levels of intact populations and their dynamics across the landscape. Inevitably, we will see distinct insect winners and losers in this rapidly changing world, depending on the traits of species on the one hand, and the extent and degree of the challenges that they face on the other. While we are losing species and populations, some insect species are already genetically adapting to the new conditions. What is now required is raising awareness about the plight of insects and their importance to the natural functioning of the planet, and providing them with as many opportunities for survival as possible. ■

Figure 2. At a small spatial scale, inter-rows between crop lines (here vines) provide essential stepping stone habitats for insects across the landscape.

References

Adler PH and Foottit RG (2017) Introduction. In: Foottit RG and Adler PH, eds. *Insect Biodiversity: Science and society*, Volume 1 (2nd edition). Wiley Blackwell, Hoboken, NJ, USA: 1–7.

Dalzochio MS, Périco E, Renner S and Sahlén G (2018) Effect of tree plantations on the functional composition of Odonata species in the highlands of southern Brazil. *Hydrobiologia* **808**: 283–300.

Darwall W, Seddon M, Clausnitzer V and Cumberlidge, N (2012) Freshwater invertebrate life. In: Collen B, Böhm M, Kemp R and Baillie JE, eds. *Spineless: Status and trends of the world's invertebrates*. Zoological Society of London, London, UK: 26–33.

Garibaldi LA, Pérez-Méndez N, Garratt MP *et al.* (2019) Policies for ecological intensification of crop production. *Trends in Ecology & Evolution* **34**: 154–66.

Gerlach J, Hoffman Black S, Hochkirch A *et al.* (2012) Terrestrial invertebrate life. In: Collen B, Böhm M, Kemp R and Baillie JE, eds. *Spineless: Status and trends of the world's invertebrates*. Zoological Society of London, London, UK: 46–57.

Guenat S, Kunin WE, Dougill AJ and Dallimer M (2019) Effects of urbanisation and management practices on pollinators in tropical Africa. *Journal of Applied Ecology* **56**: 214–24.

Habel JC, Samways MJ and Schmitt T (2019) Mitigating the precipitous decline of terrestrial European insects: Requirements for a new strategy. *Biodiversity and Conservation* **28**: 1343–60.

Hallmann CA, Sorg M, Jongejans E *et al.* (2017) More than 75 percent decline over 27 years in total flying insect biomass in protected areas. *PLoS ONE* **12**: e0185809.

Hill MJ, Hassall C, Oertli B *et al.* (2018) New policy directions for global pond conservation. *Conservation Letters* **11**: e12447.

Hu G, Lim KS, Horvitz N *et al.* (2016) Mass seasonal bioflows of high-flying insect migrants. *Science* **354**: 1584–87.

Longcore T, Aldern HL, Eggers JF *et al.* (2015) Tuning the white light spectrum of light emitting diode lamps to reduce attraction of nocturnal arthropods. *Philosophical Transactions of the Royal Society B-Biological Sciences* **370**: 20140125.

Losey JE and Vaughan M (2006) The economic value of ecological services provided by insects. *BioScience* **56**: 311–23.

Martin AE, Graham SL, Henry M *et al.* (2018) Flying insect abundance declines with increasing road traffic. *Insect Conservation and Diversity* **11**: 608–13.

Samways MJ (2015) Future-proofing insect diversity. *Current Opinion in Insect Science* **12**: 71–8.

Samways MJ (2019) *Insect Conservation: A global synthesis*. CABI, Wallingford, UK.

Samways MJ and Pryke JS (2016) Large-scale ecological networks do work in an ecologically complex biodiversity hotspot. *Ambio* **45**: 161–72.

Sánchez-Bayo F and Wyckhuys KA (2019) Worldwide decline of the entomofauna: A review of its drivers. *Biological Conservation* **232**: 8–27.

Saunders ME, Roger E, Geary WL *et al.* (2018) Citizen science in schools: Engaging students in research on urban habitat for pollinators. *Austral Ecology* **43**: 635–42.

Simaika JP and Samways MJ (2018) Insect conservation psychology. *Journal of Insect Conservation* **22**: 635–42.

Skórka P, Lenda M, Moroń D *et al.* (2013) Factors affecting road mortality and the suitability of road verges for butterflies. *Biological Conservation* **159**: 148–57.

Skórka P, Lenda M, Moroń D *et al.* (2015) Biodiversity collision blackspots in Poland: Separation causality from stochasticity in roadkills of butterflies. *Biological Conservation* **187**: 154–63.

Somers-Yeates R, Hodgson D, McGregor PK *et al.* (2013) Shedding light on moths: shorter wavelengths attract noctuids more than geometrids. *Biology Letters* **9**: 20130376.

Swinton AH (1880) *Insect Variety: Its propagation and distribution*. Cassell, Petter Galpin & Co, London, UK.

Travis JM (2003) Climate change and habitat destruction: a deadly anthropogenic cocktail. *Proceedings of the Royal Society B-Biological Sciences* **270**: 467–73.

Winter S, Bauer T, Strauss P *et al.* (2018) Effects of vegetation management intensity on biodiversity and ecosystem services in vineyards: A meta-analysis. *Journal of Applied Ecology* **55**: 2484–95.