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Are arthropods in decline and does it matter?

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The world population continues to grow, although there are signs that the trend is slowing, and the human population may actually be facing a decline (Bricker & Ibbitson, 2019). Nonetheless, the human impact is now so large that it threatens numerous other species. Recent assessments of the state of the natural world underlines that extinctions are not the only relevant criterion to indicate that the human race harms other beings: since 1970, the populations of an estimated 10,000 species of vertebrates declined by over half (WWF, 2014). Another striking example of human influence on the living world is on bird abundance. Domesticated chicken (*Gallus gallus domesticus*) is today the world's most numerous bird with a standing population of 22.7 billion (FAO, 2018), which is an order of magnitude greater than the standing stock of the most abundant wild bird species, the red-billed quelea (*Quelea quelea*) at approximately 1.5 billion (Craig, 2010).

Not surprisingly, smaller organisms are not unaffected, either. A recent study in German protected areas (Hallmann *et al.*, 2017) analysed the trends in flying insect biomass collected by Malaise traps over 27 years, and found that overall, there has been a 75% decline in the numbers of several major insect

groups, including flies, wasps, beetles, moths and butterflies. Another long-term study in Puerto Rican rainforests (Lister & Garcia, 2018) reported biomass losses of 78%–98% in ground-foraging and canopy-dwelling arthropods. These alarming news triggered a heightened interest in arthropods in a public already sensitised to the matter by the reports of bee decline.

Subsequently, Sanchez-Bayo & Wyckhuys (2019) examined the literature to check what is the available evidence of arthropod decline. They searched papers in the Web of Science database over the last 40 years using the keywords [insect*] AND [declin*] AND [survey]. Of the original 653 publications, 73 contained data on long-term surveys that a) considered all species in a taxon (e.g. family or order), b) were made within a larger region or a country, or c) if in smaller areas, surveys spanned a period longer than 10 years. Not surprisingly, most of these datasets were from the northern temperate regions. Reports of declines are widespread, spanning from carabids in the United Kingdom (Brooks *et al.*, 2012), long-tongued bees in Denmark (Dupont *et al.*, 2011) to ladybird beetles in North America (Harmon *et al.*, 2007) and stoneflies in Central Europe (Bojkova *et al.*, 2012). Many of these studies also reported on the likely cau-

ses of population declines, with the usual culprits identified: habitat conversion, intensive use of agrochemicals, invasions and climate change. Based on these data, Sancho-Bayez & Wyckhuys warn about "the dreadful state of insect biodiversity in the world, as almost half of the species are rapidly declining and a third are being threatened with extinction" and suggest a "rethinking of current agricultural practices, in particular a serious reduction in pesticide usage and its substitution with more sustainable, ecologically-based practices, to slow or reverse current trends, allow the recovery of declining insect populations and safeguard the vital ecosystem services they provide".

This paper (finally!) generated much media interest, and at least for a few weeks, people who usually like insects dead rather than alive also took notice. Science relies on critically examining and evaluating published evidence, and several entomologists (Simmons *et al.*, 2019; Thomas *et al.*, 2019) were quick to point at flaws in the Sanchez-Bayo & Wyckhuys (2019) paper.

Debate is usually useful, although not all critical comments themselves are. Sanchez-Bayo & Wyckhuys (2019) may not have proven conclusively that arthropods are in fatal decline, but they certainly found enough evidence that this may be happening. The perspective presented by Janzen & Hallwachs (2019) from Costa Rica, where they have been doing field work for decades, reporting their overall similar impression, is also of grave concern.

To entomologists one usually does not need to explain nor to point out how fascinating and beautiful arthropods are. Entomologists are also aware how important arthropods are in the work of nature. We simply need arthropods and while the saying attributed to Einstein ("without bees, humankind may only have two years of existence left") may seem exaggerated, there is a worrying decline in bees as well as other arthropods. As Johns (2019) emphasises, we do know enough to act on conserving even arthropods, and the problem is more a political rather than a biological one. In this context, entomologists will have to engage with the public more, in many, varied and creative

ways. In other words, arthropods need humans who can convince other humans that we need arthropods more than they need us. On the small Azorean island of Terceira, I have recently attended a playful theatre presentation by a Portuguese ecologist, Rui Carvalho and his partner, Andreia Valente, trying to make children (and their parents) become less antagonistic to and more curious about spiders. From the reaction of the audience, they succeeded — and after the performance, children spent a long time looking at the live spiders available for closer inspection. The success of a recent popular book on insects (Sverdrup-Thygeson, 2019) and of Maya Leonard's entertaining "bee-trilogy" written for children (Leonard, 2016, 2017, 2018) also indicates that such is not a hopeless endeavour. It is some way from here to create a world that does not live in the "Eremocene" (Wilson, 2016; a term vastly preferable over the pompous "Anthropocene") but that is a road we must walk.

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