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Intensive Agribusiness is Causing a Global Decline in Insect Populations

With serious consequences for humans and the rest of nature.

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As the son of an agricultural worker in NE Scotland, agricultural areas were always full of wonder and excitement for me. Places of clean, clear rivers where gigantic fish leapt enthusiastically for flies; home to mind boggling mass migrations of flying insects with their natural insect predators greedily in tow; places where light from a bedroom window could quickly attract 100 beautiful green lacewings, each staring implacably in with iridescent eyes to see what can be had.

When I see the barren industrial zones that agricultural areas in the UK and other economically developed nations have now become, my principle feeling is sadness, and some anger. Anger that this decimation can be treated with essentially a shrug of the shoulders by farmers, farm workers, politicians, the agri-industrialists that supply the weapons of destruction, and the general public alike. As a professional ecologist and academic I will explain here how intensive farming, principally through its incredibly abusive relationship with insects, is destroying not only the many beneficial insects such as pollinators that we depend up on but also the many larger, more charismatic animals such as birds and mammals that are visible to the public.

My focus here is on agriculture and insects. Why are insects so important to us and the natural world? The main reason why is that they are *extremely* abundant and diverse. Research done during the 1980s put the mass of insects in the United States at around 100 kg per hectare; comparable to the environmental abundance of bacteria and fungi. To put that in perspective, you could sum the mass of humans, birds and non-human mammals and it would still only be around 1/15 the mass of insects in the same area.

Figures for species richness are similarly impressive. Excluding fungi, algae and microbes (for which data is often poor) just over half the species on earth are insects and of those around half are plant-eating insects. Vertebrates (fish, amphibians, reptiles, birds, mammals) by comparison make up a paltry 4% of species. All this has two major implications. The first you will have heard about: insects are important to us humans. In their role as pollinators, decomposers of nature's waste materials and as natural regulators of pests, insects keep us in food and living in a relatively constant and healthy environment.

The second implication is perhaps less obvious: they are an incredibly important source of food for other animals. Their great species richness means that insects feature at the bottom of almost all food webs; a gigantic pot of food provisioned by mother nature to keep the feathered and furry animals higher up the food web with a full stomach. Mess with the abundance of insects and you are messing with the foundations of life itself. But that is

exactly what humans are doing. Insect abundance right across the globe is dropping and it is dropping fast.

We have in fact known that insects are in trouble for some time but the recent publicity surrounding global insect decline appears to have coalesced round a piece of research done by a German team and published in 2017. Sampling flying insects across numerous German conservation sites, the team showed that numbers of flying insects had dropped by an incredible 75% in the 27 years since 1990. An influential review on global insect decline and a flurry of media interest has ensued. To my mind, what is interesting about these recent articles is the explicitness with which they point the finger at intensive agriculture and, in particular, pesticide use. Entomologists (insect scientists) have a well-concealed but very cosy relationship with agriculture and the agrochemical industry in particular. The British Royal Entomological Society, for example, which claims to be an organisation devoted to insect conservation, regularly invites agrochem scientists to its meetings to give presentations. I attended my final meeting of this organisation a few years back at a conference dedicated to insect decline where an agrochem rep gave a presentation that amounted essentially to displaying a catalogue of new insect pest control products his company were offering. So you can bet that if entomologists are pointing the finger at intensive agriculture they are really worried: their default position is to keep their mouth shut.

Agriculture impacts nature so profoundly by virtue of its scale. England, for example, is around 70% agricultural land by area with about half of that area dedicated to growing crops (arable) and the other half pasture for the rearing of animals. England is more or less all agricultural land and natural habitat is restricted to patches here and there. We scoff at countries like Indonesia clearing its forests for palm oil plantations at the expense of orangutans but the truth is that most economically developed nations cleared their natural environment a long, long time ago. By comparison, most economically developing nations have treated their natural environment with kid gloves. All this is to say that, in economically developed nations, if nature declines across agricultural land, it declines everywhere: the nature of agricultural areas is essentially the nature of the nation.

To get back to insects, agriculture leads a three pronged attack on these creatures. First line of attack is direct through spraying of ever more potent insecticides against insect crop pests. Using the UK as an example, the weight of pesticide applied in the UK has in fact halved since 1990, however this statistics is deceptive. The area treated has doubled, as has the number of applications per area. And crucially, the potency of pesticides has increased dramatically, particularly with the introduction of the ultra-potent neonicotinoids in the 1990s (all statistics here). Dave Goulson at the University of Sussex and colleagues calculate that the number of honeybee lethal doses applied to the 4.6 million hectares of arable land in the UK has increase roughly sixfold since 1990. And recall that these pesticides don't just wipe out the problem insect pests that attack the crop; they kill almost all insects that happen to be living or resting in the crop. In essence, over and over, year after year, farmers kill pretty much every insect across just under half the land area of their nation. Can we reasonably expect to have a healthy insect fauna in nations where this intensity of spraying is so common place?

Second line of attack is herbicide spraying. Again using the UK as an example, the area of arable treated with the most commonly used herbicide, glyphosate (Roundup), has increased roughly 9-fold since 1990 to a staggering 2,634,573 hectares treatment area in

2016. As a boy I remember the surface of cereal fields and fields margins would be awash with a diversity of wild plants, with game birds scurrying among the crops to pick insects from them. Now go down on your knees and look across the surface of a cereal field and there is nothing but sandy soil and crop; a relative desert, and diversity in field margins is now largely restricted to grasses and a small number of dominant wild plants such as cow parsley. Recalling that almost half of all insects depend on wild plants for food, again, there is no way we can expect to have a healthy population of insects and the animals that eat them when almost half the land of nations is treated in this way.

The last line of attack on insects by intensive agriculture is intensification of pasture management. Traditionally, grass pastures were managed non-intensively, with low levels of chemical fertilisation, a low density of grazing animals, and prolonged periods of rest between grazing bouts. All this combined to make grass pasture an important habitat for plant and insect biodiversity with a high diversity of wild plants on which insects could feed. Now grass pasture can be viewed essentially as a high throughput system for the production of meat and milk. Huge quantities of chemical fertilisers are applied with the result that only a small number of dominant plant species can thrive, the length of time in between feeding bouts has been dramatically reduced, and many wet pastures have been drained as part of the intensification process. Now farmer's pastures support nothing but grass and the large animals that graze on it. Like arable fields, they are a no go area for wild plants, the insects that feed on them, and the larger wild animals that feed on the insects in turn. Bearing in mind that grass pasture covers just under half of economically developed nations like England, this is a terrible blow to insects and nature in general.

So intensive agriculture is decimating insects and nature in general. What have we, the public, gotten in return? In a word: yield. Yield per area of arable and pasture have increased considerably in the last few decades. Proponents of high-intensity agriculture call this phenomenon 'The Green Revolution'. When I talk to academic supporters of conventional agriculture they are always keen to tell me that this has led to cheaper food and greater food security. This is something of a mantra among such academics: they repeat it over and over again in conservation until they feel they have conveyed the message sufficiently forcefully. But the reality for the average citizen in many nations is far from so simple. Particularly in rapidly developing nations, this increased availability of food has led to a move away from healthy traditional diets to diets higher in fattening animal products and sugar with a resultant increase in obesity an ill health. In the UK no one can deny the ready availability of candy and junk food even to the poorest, but a recent report by the Food Foundation indicates that healthy food, the fruit and vegetables that we should be eating, remain out of reach for as many as 4 million of the UK's least well off. As for food security, the ability of countries such as the UK to feed itself has been declining for many years. The UK produces roughly 60% of its own food with the rest imported. Food self-sufficiency in many economically developed nations has been subordinated to what is considered to be the more important function of international trade. The result is that any modifications to international trade leads to food insecurity and panic buying. In the UK the prospect of altered trade relations with the EU (Brexit) has lead to widespread fear of food shortages and panic buying. Only the staunchest supporters of intensive agriculture could claim that countries such as the UK are food secure. And with the worldwide rise of right wing zealots in positions of power, who knows what disturbances to international trade and food security lie ahead?

In the UK, the response of the ruling Conservative Party to the issues discussed in this

article is a new Agriculture Bill. This promises to incentivise environmental improvements to farmland and if this leads to improved pasture management for nature then it is to be welcomed. However the bill barely mentions pesticide and herbicide spraying, suggesting that these key destroyers of the farmland environment for nature will remain untouched, which, to my mind, makes something of a mockery of the whole thing.

The solution to overuse of pesticide is simple. All crops have a threshold beyond which insect pest damage results in significant economic losses. These thresholds are typically expressed as number of insect pests per plant or head in the case of cereal. It would not take more than a small team of government scientists to produce yearly or dynamic within-year thresholds for the main crops grown in the UK. All that would then remain is for farmers to regularly sample their crop for pests to determine if threshold have been crossed, when spraying would then be allowed. This would, however, require legislation to restrict pesticide availability to farmers and some effort on the part of farmers. Farmers many years ago would regularly be seen among their crops examining plants but this 'artisan' aspect of farming in the UK seems to be all but gone. Modern farming appears to require skills in logistics and staff management rather than a knowledge of plant pathology and pest population dynamics. Herbicides could be treated similarly. A few weeds in a field won't cause much loss and weed thresholds could be similarly applied. But as the current government won't even mention pesticides and herbicides in their Agriculture Bill, these very reasonable solutions seems a very distant prospect.

Personally, I would like to see a mass mobilisation of citizens in defence of nature and against intensive farming in a way we are beginning to see in response to the problem of global warming. But waving placards in parliament square will achieve nothing regardless of how many people turn up. Our representatives in Westminster, Hollyrood, the Welsh and Northern Irish Assemblies, and in political assemblies all over the world only understand money and economics and only when activists begin to impact 'the bottom line' of nations will they sit up and take notice.

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