Genetic Biotechnologies Put Pollinators at Risk

We, the undersigned scientists, call upon members of the International Union for Conservation of Nature (IUCN) to support a **moratorium** on the release of **organisms, products and agents obtained through genetic engineering and synthetic biology**[1] – such as gene drive organisms (GDOs) and gene-silencing molecules (e.g. RNAi-based pesticides) – into complex natural ecosystems.

Why pollinators must be protected

Pollinating insects are indispensable to biodiversity, ecosystem functioning and agricultural production.[2] Approximately 350,000 species of insects visit flowers and wild plants and participate in pollination.[3] These groups are now experiencing widespread declines,[4] for example, in richness,[5] abundance,[6] biomass[7] and extinctions.[8]

We are losing invaluable legacies from millenaries of evolution and plant-insect interactions,[9] overall genetic diversity is impoverished, entire food webs are endangered as key species[10] disappear and ecosystems might lose the fragile balance of which we know very little.

Risks from genetic biotechnologies

On top of existent pressures, new risks[11] emerge from proposals to release organisms or products obtained through genetic biotechnologies.[12] Proposals include directly modifying insect genomes and interfering with their gene expression, and genetically engineering microbial communities, amphibians, birds or trees. Despite urgent warnings from the scientific community,[13] the potential adverse impacts of such releases on pollinators, food webs and ecosystems remain poorly understood and understudied.[14]

Gene drives - engineering entire insect populations

Gene drives are genetic modifications that change the normal way traits are passed on during reproduction. They work by biasing inheritance through processes like meiosis, mitosis or cell division.[15] Gene drives are designed to spread engineered traits rapidly through populations, deliberately creating large-scale changes in wild populations and potentially transforming entire ecosystems. As Esvelt & Gemmell (2017) note, a standard, self-propagating CRISPR-based gene drive is “equivalent to creating a new, highly invasive species” capable of spreading to any viable ecosystem and “possibly causing ecological change” (p. 2).[16]

At least 82 species, including 42 insects, have been proposed for gene drive applications.[17] Once released, gene drive insects could irreversibly alter the genetic makeup of managed and wild populations. Engineered traits might spread to closely related species, including pollinators, through vertical gene flow[18] or transfer unpredictably across species via horizontal

gene transfer,[19] Studies confirm that such contamination is possible,[20] and difficult to interpret under field conditions[21] and nearly impossible to monitor effectively.[22]

RNA-based technologies – uncharted risks

Another class of interventions involve gene-silencing molecules such as double-stranded RNAs (dsRNAs), These are designed to target pests or pathogens, but gene silencing can also occur in non-target species with similar sequences, leading to adverse sub-lethal effects, including decreased feeding rates and attenuated locomotion.[23]

Agents that transfer dsRNAs through food to target pests are being tested for efficacy and commercial viability. These dsRNA “actives” may have effects on higher trophic levels, whether it be through ingestion of the target or other sources.[24]

Experimental approaches are underway to engineer gut microbiota that deliver dsRNA continuously to honey bees, aiming to confer resistance to pesticides, parasites or viruses.[25] Yet, bee-associated microbes are spread during pollination,[26] raising the risk of unintended ecological consequences. The impacts of these microbial modifications remain unknown and require more research.

Engineered microbial communities – effects impossible to predict

Microbial communities can be engineered through the addition of microbes with desirable traits or functionalities. Intensification of these kinds of approaches can have ecological effects qualitatively similar to any other kind of artificial “propagule pressure” strategy. When this strategy is combined with genetic engineering tools, risk of unintended adverse effects is enhanced.

Genetically engineered microbial communities can be used to enhance crop growth, suppress pests and degrade pollutants in soils. Once released into the environment, the DNA of these microbes could transfer across species boundaries,[27] disrupt native microbial communities and trigger cascading effects on plants, insects and other wildlife.[28] Engineered microbes may outcompete natural ones, reduce biodiversity and weaken ecosystem resilience.[29]

Although some traits are intended to be self-limiting, they may persist or spread unpredictably. Horizontal gene transfer coupled with gene drives could move engineered genes into wild microbes, creating novel traits or unforeseen ecological effects.[30] Potential impacts on the environment from the release of microbial communities, including on non-target species, such as pollinators, and unintended consequences for other ecosystems (e.g. the interconnectedness of agricultural land),[31] remain largely unstudied.

Engineered microbes might generate toxins, allergens or other harmful compounds affecting wildlife, livestock or humans. Given rapid microbial evolution and environmental variability, outcomes are inherently unpredictable[32] and monitoring, containment and mitigation would be extremely challenging, making any environmental release inherently risky.[33]

Why a moratorium Is needed

At present, no robust framework exists to guarantee that the release of genetic biotechnologies[34] and associated risk mitigation strategies would not cause ecological harm. The potential impacts of such technologies in nature—including on pollinators, ecosystems and food webs—remain largely unknown and cannot be reliably assessed with current scientific tools. Meanwhile, development and deployment of these technologies – including genetically modified organisms (GMOs) and RNAi molecules – are advancing faster than safety and risk assessment can keep pace,[35] as are other important accelerants such as artificial intelligence.[36]

Releasing these technologies into open ecosystems could cause irreversible ecological disruptions, with potentially disastrous consequences for biodiversity. In line with the UN Precautionary Principle,[37] no release should occur unless and until it can be demonstrated that there are no direct or indirect risks to pollinators, biodiversity or ecosystems.

A call for ecological integrity

Pollinating insects are already in alarming decline due to multiple stressors.[38] Adding untested genetic biotechnologies could intensify these pressures and could drive them toward extinction. We therefore call on IUCN members to support a **moratorium on the release of organisms, products and agents obtained through genetic engineering and synthetic biology** – including RNAi-based and genome editing-based pesticides and GDOs – from biosafety containment facilities into natural ecosystems.

Our generation has a responsibility to pass on resilient and life-sustaining ecosystems, which include native habitats in protected areas and in working landscapes.[39] Approaches to conservation, agriculture and public health should respect, not undermine the integrity of our ecosystems.

This statement is authored and signed by the individual scientists listed separately below. Please note that the views are those of the authors and signatories; institutional affiliations are provided for identification purposes only.

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