NEW FOUR-YEAR SCIENTIFIC ANALYSIS: SYSTEMIC PESTICIDES POSE GLOBAL THREAT TO BIODIVERSITY AND ECOSYSTEM SERVICES

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The conclusions of a new meta-analysis of the systemic pesticides neonicotinoids and fipronil confirm that they are causing significant damage to a wide range of beneficial invertebrate species and are a key factor in the decline of bees.

Concern about the impact of systemic pesticides on a variety of beneficial species has been growing for the last 20 years but the science has not been considered conclusive until now.

Undertaking a full analysis of all the available literature (800 peer reviewed reports) the Task Force on Systemic Pesticides - a group of global, independent scientists - has found clear evidence of harm, a threat to environment similar to that posed by the banned DDT and many of the organophosphate pesticides made illegal in recent years. The science has progressed to the stage where it is now sufficient to trigger regulatory action and have suggested a global phase out of the products.

Intro to neonicotinoids

Unlike other pesticides, which remain on the surface of the treated foliage, systemic pesticides are taken up by the plants vascular system and transported to all the tissues (leaves, flowers, roots and stems, as well as pollen and nectar). They are increasingly used as a prophylactic to prevent pests rather than eradicate them once a problem has occurred.

Toxicity of neonicotinoids

Pesticide	®	Use	LD50 (ng/honeybee)	Toxicity index relative to DDT
DDT	Dinocide	insecticide	27000	1
Amitraz	Apivar	insecticide / acaricide	12000	2
Coumaphos	Perizin	insecticide / acaricide	3000	9
Tau-fluvalinate	Apistan	insecticide / acaricide	2000	13.5
Methiocarb	Mesurol	insecticide	230	117
Carbofuran	Curater	insecticide	160	169
λ-cyhalothrin	Karate	insecticide	38	711
Deltamethrine	Decis	insecticide	10	2700
Thiamethoxam	Cruise	insecticide	5	5400
Fipronil	Regent	Insecticide	4.2	6475
Clothianidine	Poncho	Insecticide	4.0	6750
Imidacloprid	Gaucho	Insecticide	3.7	7297

Toxicity of insecticides to honeybees compared to DDT. The final column expresses the toxicity relative to DDT. (Source: Bonmatin, 2009)

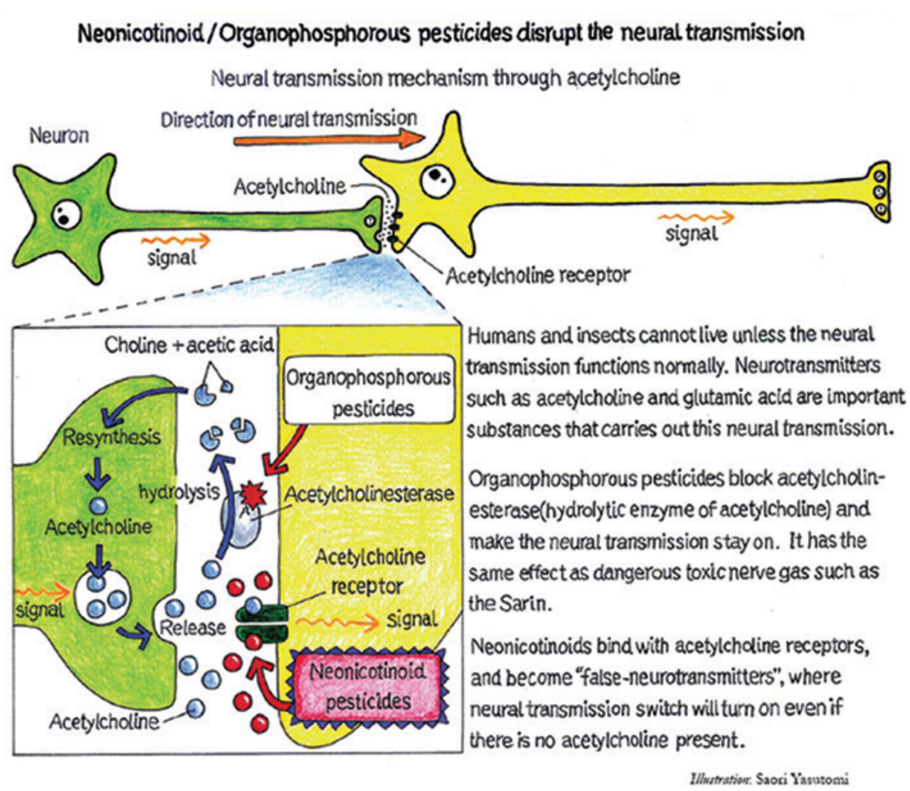
As a result of their extensive use, these substances are found in all environmental media including soil, water and air. The metabolites of neonics and fipronil (the compounds which they break down into) are often as or more toxic than the active ingredients to non-target organisms

Environmental contamination by both parent and metabolites are able to persist and build up via a number of pathways. These include dust generated during drilling of dressed seeds; build-up of concentrations after repeated application in arable soils and soil water; run-off into surface and ground waters; uptake of pesticides by non-target plants via their roots followed by translocation to the whole of the plant; dust and spray drift deposition on leaves; and wind- and animal-mediated dispersal of contaminated pollen and nectar from treated plants.

Persistence in soils, waterways and non-target plants is variable but can be long; for example, the half-lives of neonicotinoids in soils can exceed 1,000 days. Similarly, they can persist in woody plants for periods exceeding 1 year. This increases their toxicity effects and makes them more damaging to non-target species. Breakdown results in toxic metabolites, though concentrations of these in the environment are rarely measured (Bonmatin et al. 2014).

Breakdown of the effect on species

Neonicotinoids and fipronil operate by disrupting neural transmission in the central nervous system of organisms. Neonicotinoids bind to the nicotinic acetylcholine receptor, whereas fipronil inhibits the GABA receptor. Both pesticides produce lethal and a wide range of sublethal adverse impacts on invertebrates but also some vertebrates (Simon-Delso et al. 2014; Gibbons et al. 2014)



Most notable is the very high affinity with which neonicotinoid insecticides agonistically bind to the nicotinic acetylcholine receptor (nAChR) such that even low-dose exposure over extended periods of time can culminate into substantial effects. Even long term exposure at low, non-lethal levels can be harmful.

Infograph analysis of the current data available for the effects of neonicotinoids on a range of taxonomic groups. Showing the route and potential of exposure; the eco-toxicological effects on the individuals, populations and communities; and what ecosystem services are impacted.

The analysis found that the most affected groups of species were terrestrial invertebrates such as earthworms which are exposed at high levels via soil and plants, medium levels via surface water and leaching from plants and low levels via air. Both individuals and populations can be adversely affected at even low levels and by acute exposure. This makes them highly vulnerable to the levels of neonics associated with agricultural use.

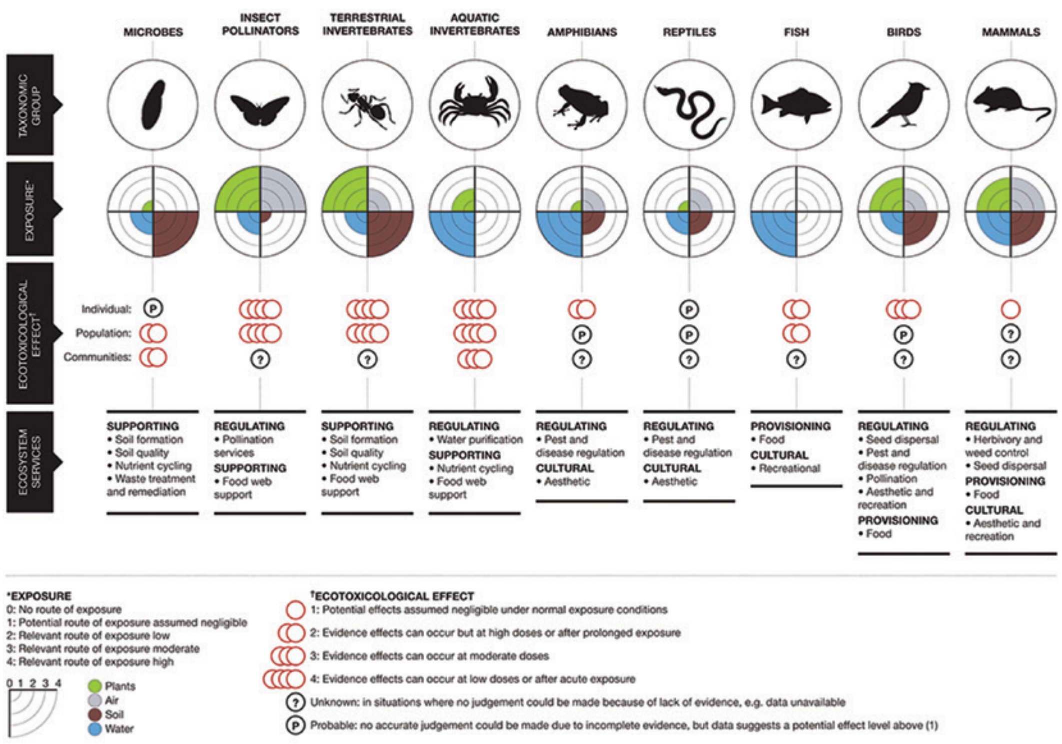
The next most affected group is insect pollinators such as bees and butterflies which are exposed to high contamination through air and plants and medium exposure levels through water. Honeybees have been at the forefront of concern about neonics and fipronil to date and limited actions have been taken, for example by the EU Commission, but manufacturers of these neurotoxicants have refuted any claims of harm.

In reviewing all the available literature rather than simply comparing one report with another, the WIA has found that field-realistic concentrations of neonics adversely affect individual navigation, learning, food collection, longevity, resistance to disease and fecundity of bees. For bumblebees, irrefutable colony-level effects have been found, with exposed colonies growing more slowly and producing significantly fewer queens. Both individuals and populations can be adversely affected by low or acute exposure making them highly vulnerable.

Then aquatic invertebrates such as freshwater snails and water fleas which are vulnerable to low and acute exposure and can be affected at the individual, population and community levels.

While vertebrate animals are generally less susceptible, bird populations are at risk from eating crop seeds treated with systemic insecticides, and reptile numbers have declined due to depletion of their insect prey. Microbes were found to be affected after high levels of or prolonged exposure. Samples taken in water from around the world have been found to exceed ecotoxicological limits on a regular basis.

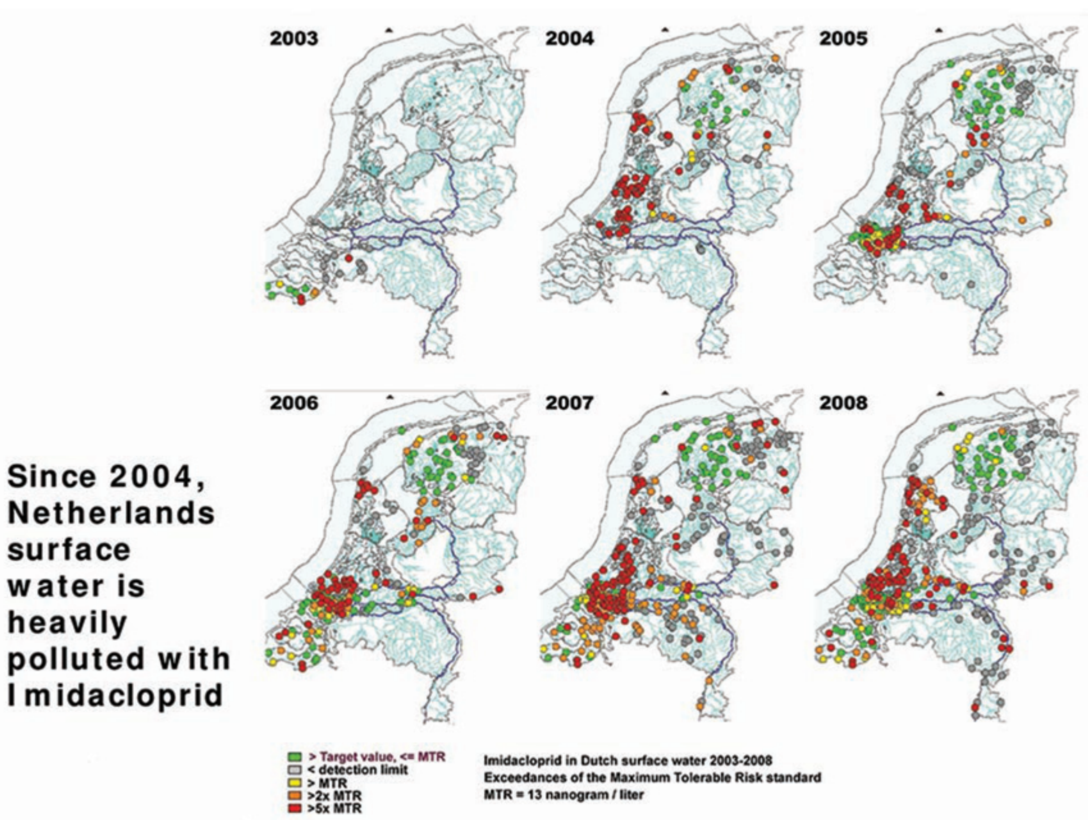
In addition to contaminating non-target species through direct exposure (e.g. insects consuming nectar from treated plants), the chemicals are also found in varying concentrations outside intentionally treated areas. The water solubility of neonics mean that they leach and run-off easily and have been found to contaminate much wider areas leading to both chronic and acute exposure of organisms, including in riparian zones, estuarine and coastal marine systems.



Current Use

Neonicotinoids have become the most widely used group of insecticides globally, with a global market share now estimated at around 40% and sales of over US $2.63 billion in 2011. This combination of persistence (over months or years) and solubility in water has led to large-scale contamination of, and the potential for build-up in, soils and sediments (ppb-ppm range), waterways (ground and surface waters in the ppt-ppb range) and treated and non-treated vegetation (ppb-ppm range). Screening of these matrices for pesticides and their metabolites has not been done in a systematic and appropriate way in order to identify both the long-term exposure to low concentrations and the short-term erratic exposure to high concentrations.

However, where environmental samples have been screened, they were commonly found to contain mixtures of pesticides, including neonicotinoids or fipronil (with their toxic metabolites). In addition, samples taken in ground and surface waters have been found to exceed limits based on regulatory ecological threshold values set in different countries in North America and Europe.



The combination of prophylactic use, persistence, mobility, systemic properties and chronic toxicity is predicted to result in substantial impacts on biodiversity and ecosystem functioning. The body of evidence reviewed in this Worldwide Integrated Assessment indicates that the present scale of use of neonicotinoids and fipronil is not a sustainable pest management approach and compromises the actions of numerous stakeholders in maintaining and supporting biodiversity and subsequently the ecological functions and services the diverse organisms perform.

In modern agricultural settings, it is increasingly clear that insecticide treatments with neonicotinoids and fipronil—and most prominently its prophylactic applications—are incompatible with the original mindset that led to the development of the principles of integrated pest management (IPM).

Although IPM approaches have always included insecticide tools, there are other approaches that can be effectively incorporated with IPM giving chemicals the position of the last resort in the chain of preferred options that need be applied first. Note that the current practice of seed treatment is the opposite: it applies chemicals as the first applied option instead of the last resort.

Continued use can only accelerate global decline of important invertebrates and risk reduction in levels of diversity security and stability of ecosystem services.

Current legislation

Neonicotinoids have been subjected to various restrictions since their initial registration. In 1999, France banned imidacloprid as a seed dressing for sunflowers and in 2004 for corn after one-third of honeybees died after its use. Germany and Italy followed suit in 2008 with clothianidin.

The European Food Safety Authority (EFSA) issued reports in 2013 confirming that three of the five neonicotinoids approved for use in the European Commission (thiamethoxam, clothianidin and imidacloprid) present acute risks to honey bee survival.

A "high acute risk" to honey bees was identified from exposure via dust drip for authorised uses in cereals, cotton, maize and oilseed rape. A "high acute risk" was also identified for exposure to the residues in nectar and/or pollen for authorised uses in cotton, oilseed rape and sunflowers. The EFSA also identified other risks and major data gaps in the studies previously undertaken such as the effect on other pollinators such as bumblebees.

The European Commission, based on the findings of the EFSA, then restricted the sale and use of neonicotinoid insecticides, specifically products containing clothianidin, imidacloprid and thiamethoxam. This restriction entered into force on December 1, 2013 and will be reviewed within two years. The restriction applies to the use of neonicotinoids for seed treatment, soil application (granules) and foliar treatment on plants and cereals (with the exception of winter cereals) that are attractive to bees.

The Precautionary Principle "When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm" - Enshrined in the EU Commission Directive 1107/2009.

The European Commission did not invoke the Precautionary Principle when implementing the temporary suspension on neonicotinoids. The response was based on a sound, robust analysis of the science which led to a measured response. Had the precautionary principle been considered, all uses of neonicotinoids would have been withdrawn due to the number of unknown risks that EFSA discovered during their analysis.

Going forward

The adequacy of the regulatory process in multiple countries for pesticide approval must be closely considered and be cognizant of past errors. For example, other organochloride insecticides such as DDT were used all over the world before their persistence, bioaccumulation and disruptive impacts on ecosystem functioning were recognised, and they were subsequently banned in most countries.

Organophosphates have been largely withdrawn because of belated realisation that they posed great risks to human and wildlife health. The systemic insecticides, neonicotinoids and fipronil, represent a new chapter in the apparent shortcomings of the regulatory pesticide review and approval process that do not fully consider the risks posed by large-scale applications of broad-spectrum insecticides.

There is an urgent need to reduce the use of these chemicals and to switch to sustainable methods of food production and pest control that do not further reduce global biodiversity and that do not undermine the ecosystem services upon which we all depend.

The authors strongly suggest that regulatory agencies apply more precautionary principles and further tighten regulations on neonicotinoids and fipronil and start planning for a global phase-out or at least start formulating plans for a strong reduction of the global scale of use.

References

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Task Force On Systemic Pesticides

The Task Force on Systemic Pesticides is the response of the scientific community to concern around the impact of systemic pesticides on biodiversity and ecosystems. Its intention is to provide the definitive view of science to inform more rapid and improved decision-making.
It advises two IUCN Commissions, the Commission on Ecosystem Management and the Species Survival Commission. Its work has been noted by the Subsidiary Body on Scientific, Technical and Technological Advice under the Convention on Biodiversity (CBD) and was brought to the attention of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) - on which four members of the Task Force serve - in the context of the fast-track thematic assessment of pollinators, pollination and food production.