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Role of pesticides in biodiversity loss

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Abstract
Pesticides are one of the important factors affecting biodiversity, along with habitat loss and climate change. They can have toxic effects in the short term in directly exposed organisms, or long-term effects by causing changes in habitat and the food chain. Aquatic and terrestrial biodiversity can be impacted by pesticides through their direct or indirect application, such as pesticide drift, secondary poisoning, runoff into local water bodies, or groundwater contamination. Pesticides can contaminate soil, water, turf and other vegetation. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, and non-target plants. Insecticides are generally the most acutely toxic class of pesticides, but herbicides can also pose risks to non-target organisms.

Keywords: Pesticides, environment, aquatic biodiversity, terrestrial biodiversity

Introduction
Biodiversity, the 'foundation of human life' is the intricate web of life on Earth (Verma and Prakash, 2020a; Singh *et al*., 2023) [29, 25], is facing unprecedented threats in the 21st century. Among the myriad factors contributing to biodiversity loss, the role of pesticides has emerged as a significant and concerning issue. Pesticides designed to control or eliminate pests that threaten crops, have inadvertently become a double-edged sword, exacting a toll on non-target organisms and ecosystems. For instance, insecticides can negatively impact pollinators such as bees and butterflies, disrupting crucial ecological processes like pollination. Different types of synthetic pesticides have been used for crop protection for centuries. Pesticides increase the crops production; however, they also impose a serious negative impact on the environment (Arya and Dubey, 2013) [2]. Pesticides have a major effect on biodiversity, along with loss of habitat and climate change (Aborisade and Atuanya, 2023) [1].

Pesticides encompass a diverse range of chemicals used in agriculture, forestry, and public health to manage pests. In the agricultural sector alone, pesticides play a pivotal role in ensuring food security by protecting crops from insects, weeds, and diseases. They can have short-term toxic effects on directly exposed organisms, and long-term effects can result from changes to habitats and the food chain. Excess use of pesticides may lead to the destruction of biodiversity. The pesticides can disturb the natural habitat of many birds, aquatic organisms and other organisms. Alteration of natural habitats can be the one reason to convert a beautiful bird and other significant animals in endangered state (Prakash and Verma, 2016; Singh *et al*., 2023) [19, 25]. Natural habitat destruction, particularly due to human activities, has become a cause of global concern, as the anthropogenic activities and electronic wastes influence the different aspects of biodiversity and environmental ethics (Ashok, 2016; Verma, 2017; Verma and Prakash, 2020b; Prakash and Verma, 2022) [3, 26, 29, 22]. The pesticides are a concern for sustainability of environment and global stability (Masih, 2021) [15].

Pesticides are biologically toxic substances used by humans to kill pests to increase the yield of many crops and to control the spread of insects. The use of pesticides has caused serious environmental and health risks to living beings including fishes that in turn disturbs the biodiversity and sustainable development (Prakash and Verma, 2014; Chaudhary *et al*., 2021; Kumar, 2021) [18, 6, 12]. In many countries, large scale mortality of fishes has been recorded due to pesticides in water bodies as pollutants (Nikam *et al*., 2011) [16].

It is impossible to ignore the risks connected to the improper use of pesticides, as they can also, inadvertently, lessen the amount of weeds, bushes, and insects that serve as food for higher orders (Verma and Prakash, 2018) [28]. Decreases in the numbers of uncommon animal and bird species have also been connected to the use of fungicides, herbicides, and insecticides. Furthermore, as previously mentioned, frequent and prolonged use of these causes bioaccumulation (PRB, 2010; Vorkamp and Rigét, 2014) [23, 31]. According to Jayaprakash and Shettu (2013) [10], nearly 30% of all pesticides used worldwide are chlorpyrifos and its derivatives, which are often employed to control insect pests. Their average time in water is two weeks, however aquatic creatures quickly absorb them and they are very poisonous (Rand and Petrocelli, 1995) [24].

Impact of pesticides on environment

Pesticide residues can persist in the environment long after their application, accumulating in soil, water, and even the tissues of living organisms. This accumulation can lead to chronic exposure for non-target species, causing sublethal effects that may weaken populations over time (Pandey *et al*., 1980) [17]. Pesticides specially organophosphorous can alter habitat structures, making them inhospitable for certain species (Prakash and Verma, 2021) [21]. Aquatic ecosystems, in particular, are vulnerable, with runoff from agricultural fields carrying pesticides into rivers and lakes, affecting fish, amphibians, other organisms and farmers (Wafa *et al*., 2013; Kaur and Mishra, 2019; Prakash and Verma, 2020) [32, 11, 20].

How pesticides influence biodiversity

The maintenance of present-day biodiversity and ecological balance both are necessary for the existence and survival of all living beings including humans (Kumar, 2017; Verma, 2018) [12, 27]. The pesticides can disrupt soil microbial communities, essential for nutrient cycling and maintaining soil health. This disturbance can lead to long-term consequences for plant growth and ecosystem stability. Half a century ago, Rachel Carson's 'Silent Spring' clearly revealed the far-reaching environmental impact of pesticides, showing how some chemicals, organochlorines, a large group of insecticides are highly persistent in the environment (Bernardes *et al*., 2015) [4].

Predatory and parasitic insects, crucial for natural pest control, can be adversely affected by pesticides. This can result in an increase in pest populations, triggering a cycle of intensified pesticide use. Insecticides, rodenticides and fungicides and the more toxic herbicides all threaten exposed wildlife. Some pesticides lead to direct poisoning of species and can cause major population declines which threaten rare species (Nikam *et al*., 2011) [16]. Other pesticides gradually accumulate in the food chain, something which matters particularly to vertebrates, and not least to higher order species and top predators like mammals or raptors. Nontargeted predatory mammals (e.g. dogs and foxes) and raptors often suffer 'secondary poisoning' by eating mice which have been poisoned by rodenticides. Finally, pesticides can reduce the abundance of weeds and insects which are important food sources for many species.

Threats to Aquatic Biodiversity

Runoff from agricultural fields introduces pesticides into water bodies, causing harm to aquatic life. Fish, amphibians, and other organisms may suffer from acute or chronic toxicity, disrupting food webs and ecosystem dynamics. In certain situations, such as when controlling mosquitoes, pesticides may be sprayed directly into surface water bodies or they may enter the water through runoff or soil permeability. Water tainted with pesticides is extremely dangerous for aquatic life. It may have an impact on aquatic vegetation, lower the amount of dissolved oxygen in the water, and alter fish populations' physiology and behaviour. Pesticides sprayed on land find their way into aquatic habitats through runoff, where they pose a hazardous risk to fish and other non-target animals. In addition to being poisonous by themselves, some insecticides also react negatively with stressors, such as toxic algal blooms. Synthetic pesticides are considered moderately hazardous to humans by the World Health Organization. Even at extremely low concentrations in water; synthetic pesticides may be proved harmful and biodiversity decline as a consequence of an inappropriate environmental risk assessment (Clark *et al*., 1985; Brühl and Zaller, 2019) [7, 5].

Threats to Terrestrial Biodiversity

Pesticide exposure can also cause sub-lethal effects on terrestrial plants in addition to killing non-target plants. Drifting or volatilization of phenoxy herbicides can injure nearby trees and shrubs (Dreistadt *et al*., 1994) [8]. Herbicide glyphosate increases susceptibility of plants to diseases and reduces seed quality (Locke *et al*., 1995) [14]. Even low doses of pesticides, sulfonylurea, sulphonamides and imidazolinones have a devastating impact on the productivity of nontargetcrops, natural plant communities and wildlife (Fletcher *et al*., 1993) [9]. Pollinators, essential for the reproduction of many flowering plants, face severe threats from pesticide exposure. The decline in bee populations, often attributed to neonicotinoid insecticides, has far-reaching consequences for ecosystems and agricultural productivity.

Conclusion

The role of pesticides in biodiversity loss is a multifaceted challenge that demands urgent attention. As we navigate the delicate balance between agricultural productivity and ecological preservation, finding sustainable solutions is paramount. Through a combination of scientific innovation, policy reforms, and a shift towards more ecologically conscious farming practices, we can mitigate the adverse effects of pesticides on biodiversity, preserving the intricate web of life that sustains our planet. The future of biodiversity hinges on our ability to reconcile agricultural needs with the imperative to protect the richness and diversity of life on Earth. Research and development efforts should focus on creating pesticides that are target-specific and have minimal impact on non-target organisms. Green chemistry principles can guide the design of environmentally friendly alternatives. Increasing awareness among farmers, policymakers, and the general public about the ecological consequences of pesticide use is essential. Education can lead to more informed decision-making and the implementation of sustainable agricultural practices. Governments and regulatory bodies must enact and enforce policies that promote sustainable agriculture and restrict the use of highly toxic pesticides. Incentives for farmers adopting eco-friendly practices can further drive positive change.

References

1. Aborisade WT, Atuanya EI. Ecotoxicological studies of pesticide formulations on soil sentinel's microflora (*Nitrosomonas* and *Nitrobacter* spp.) and mesofauna (*Ephyriodrilus* spp.). Int. J Biol Innov. 2023;5(1):01-13.
2. Arya S, Dubey RK. Studies on citrus crop insect–pest management with adhesive cage under integrated pest management programme. Int. J Innov Res Sci Eng Technol. 2013;2(12):8088-8091.
3. Ashok KV. Biodiversity: Its different levels and values. Int J Environ Sci. 2016;7(2):143-145.
4. Bernardes MFF, Pazin M, Pereira LC, Dorta DJ. Impact of pesticides on environmental and human health. In: Andreazza AC, Scola G, editors. Toxicology Studies. Rijeka: Intech Open; c2015. p. 8.
5. Brühl CA, Zaller JG. Biodiversity Decline as a Consequence of an Inappropriate Environmental Risk Assessment of Pesticides. Front Environ Sci. 2019;7:177.
6. Chaudhary VK, Arya S, Singh P. Effects of Pesticides on Biodiversity and Climate Change. Int. J Environ Sci. 2021;11(2):95-99.
7. Clark JR, James R M, Patrick J M. Douglas and C M James. Ecotoxicol Environ Saf. 1985;10:382-390.
8. Dreistadt SH, Clark JK, Flint ML. Pests of landscape trees and shrubs. An integrated pest management guide. University of California Division of Agriculture and Natural Resources. Publication No. 3359; c1994.
9. Fletcher JS, Pfleeger TG, Ratsch HC. Potential environmental risks associated with the new sulfonylurea herbicides. Environ Sci Technol. 1993;27:2250-2252.
10. Jayaprakash C, Shettu N. Changes in the hematology of the freshwater fish, *Channa punctatus* (Bloch) exposed to the toxicity of deltamethrin. J Chem Pharm Res. 2013;5(6):178-183.
11. Kaur G, Mishra BKP. Histopathological changes in Liver of fish *Channa punctatus* exposed to sub-lethal concentration of Hybrid Pesticide. Int. J Biol Innov. 2019;1(2):83-86.
12. Kumar AV. Necessity of Ecological Balance for Widespread Biodiversity. Indian J Biol. 2017;4(2):158-160.
13. Kumar AV. Influence of climate change on balanced ecosystem, biodiversity and sustainable development: An overview. Int. J Biol Innov. 2021;3(2):331-337.
14. Locke D, Landivar JA, Moseley D. The effects of rate and timing of glyphosate applications on defoliation efficiency, regrowth inhibition, lint yield, fiber quality and seed quality. Proc Beltwide Cotton Conf. 1995;2:1088-1090.
15. Masih SC. Impact of Monocrotophos pesticide on serum biochemical profile in freshwater fish, Cirrhinus mrigala (Hamilton, 1822). Int. J Biol Innov. 2021;3(2):402-406.
16. Nikam SM, Shejule KB, Patil RB. Study of acute toxicity of Metasystox on the freshwater fish, Nemacheilus botia, from Kedrai dam in Maharashtra, India. Biol Med. 2011;3(4):13-17.
17. Pandey PK, Singh NK, Chaudhary BP. Effect of organophosphorus insecticide, malathion on the hematology of *Channa punctatus*. Proc. 6th Ind. Sc. Cong. 1980;11:213.
18. Prakash S, Verma AK. Effect of Organophosphorus pesticides (Chlorpyrifos) on the hematology of *Heteropneustes fossilis* (Bloch). Int. J Fauna Biol Stud. 2014;1(5):95-98.
19. Prakash S, Verma AK. Marital fidelity and congregation of Indian sarus crane, Grus antigone antigone in and around Alwara lake of district Kaushambi (Uttar Pradesh), India. Int. J Biol Res. 2016;4(1):10-13.
20. Prakash S, Verma AK. Effect of organophosphorus pesticides on biomolecules of freshwater fish, *Heteropneustes fossilis* (Bloch). Indian J Biol. 2020;7(2):65-69.
21. Prakash S, Verma AK. Toxic effect of Organophosphorous pesticide, Phorate on the Biochemical Parameters and Recovery Response of Freshwater Snake Headed Fish, *Channa punctatus*. Bull Pure Appl Sci-Zool. 2021;40A(2):291-297.
22. Prakash S, Verma AK. Anthropogenic activities and Biodiversity threats. Int J Biol Innov. 2022;4(1):94-103.
23. PRB. Pesticides reduce biodiversity (June, Pesticides News). 2010;88:4-7.
24. Rand GM, Petrocelli SR. Fundamentals of aquatic toxicology. Hemisphere Publishing Corporation; c1995. p. 666.
25. Singh R, Verma AK, Prakash S. The web of life: Role of pollution in biodiversity decline. Int. J Fauna Biol Stud. 2023;10(3):49-52.
26. Verma AK. Environmental Ethics: Need to Rethink. Int J Environ Sci. 2017;8(1):7-9.
27. Verma AK. Ecological Balance: An Indispensable Need for Human Survival. J Exp Zool India. 2018;21(1):407-409.
28. Verma AK, Prakash S. Haematotoxicity of Phorate, an Organophosphorous pesticide on a Freshwater Fish, *Channa punctatus* (Bloch). Int. J Agric Sci. 2018;9(2):117-120.
29. Verma AK, Prakash S. Status of Animal Phyla in different Kingdom Systems of Biological Classification. Int. J Biol Innov. 2020;2(2):149-154.
30. Verma AK, Prakash S. E-wastes and their impact on environment and public health. Int. J Appl Res. 2020;6(9):164-168.
31. Vorkamp K, Rigét FF. A review of new and current-use contaminants in the Arctic environment: Evidence of long-range transport and indications of bioaccumulation. Chemosphere. 2014;111:379-395.
32. Wafa T, Nadia K, Amel N, Ikbal C, Insaf T, Asma K, *et al*. Oxidative stress, hematological and biochemical alterations in farmers exposed to pesticides. J Environ Sci Health Part B. 2013;48:1058-1069.