Glyphosate Effection on Marine Invertebrates

Subjects: Ecology

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Glyphosate is the active ingredient of numerous commercial formulations of herbicides applied in different sectors, from agriculture to aquaculture. Due to its widespread use around the world, relatively high concentrations of glyphosate have been detected in soil and aquatic environments. The presence of glyphosate in aquatic ecosystems has aroused the attention of researchers because of its potential negative effects on living organisms, both animals and plants. Generally, data obtained in acute toxicity tests indicate that glyphosate and its commercial formulations are lethal at high concentrations (not environmentally realistic), whereas results of long-lasting experiments indicate that glyphosate can affect markedly biological responses of marine invertebrates. This review intends to summarize results of studies aimed at evaluating the effects of glyphosate (both as active ingredient and component of commercial formulations) on marine invertebrates.

Keywords: glyphosate ; marine invertebrates ; aquatic toxicology

1. Introduction

Glyphosate also known as N-(phosphonomethyl) glycine [CAS registry number 1071-83-6] is a broad-spectrum organophosphate herbicide with a non-selective, post emergence and systemic activity. It is absorbed by leaves and translocated through the phloem in all plant districts, but plants can also uptake the herbicide from roots and translocate it through the xylem. Glyphosate affects the shikimate pathways inhibiting the 5-enolpyruvyl-shikimate-3-phosphate synthase (EPSPS), an enzyme which catalyzes the penultimate step in the shikimate pathway. The inhibition lead to a decrease of the three essential aminoacids such as tyrosine, phenylalanine and tryptophan as well as a possible decrease of second metabolites such as flavonoids, lignin and phytoalexins. Besides glyphosate mainly being used in agriculture with about 1.2 million km^2 of crop land treated annually alone in the United States (U.S.), it is also applied in non-agricultural sectors such as forestry, urban, and resident weed control practices, in the control of aquatic weeds and along railroads.

1.1. Occurrence of glyphosate in aquatic environments

Despite the high affinity of glyphosate for soil particles and its consequent low mobility, it has been detected in a wide spectrum of water bodies. Indeed, glyphosate can reach surface waters through either runoff and soil leaching or - more rarely - a direct application into water (for example, to control aquatic weeds). In groundwater, herbicide can occur due to karst phenomena, as reported in intensive agricultural areas, but it rarely reaches high levels in groundwater because it remains bind to soil particles. Concentrations of glyphosate in water can vary along seasons and depends on rainfalls intensities, making it detectable not only in soil, but also in wastewater treatment plants, agricultural areas surface water, groundwater, rivers and seawater.

2. The Eects of Glyphosate to Marine Invertebrates

Most of the studies that have been performed to evaluate the toxic effects of glyphosate to non-target marine invertebrates are mainly related to mollusks. Different species of marine mollusks, such as *Crassostrea gigas, Crassostrea virginica, Mytilus galloprovincialis, Ruditapes philippinarum, Ruditapes decussatus, Perna perna, Haliotis tuberculata,* have been used as model organisms to assess the effects of glyphosate and its commercial formulations on different levels of animal biological organization, from gametes to organism.

To the best of our knowledge, information concerning the effects of glyphosate or its commercial formulations to other marine invertebrates are limited to few taxonomic groups, such as Crustacea, Echinoderms, Corals, and Polychaetes.

3. Conclusions and Perspectives

Although information concerning the levels of glyphosate in the marine environment is limited, the results of the studies that have been summarized in this review clearly indicate that this substance can cause undesirable effects on marine organisms, at different levels of biological organization. The growing interest in the potential risk posed by glyphosate to human health has also played an important role in the development of ecotoxicological studies aimed at understanding the negative effects of such substance to non-target organisms. Considering that the use of this herbicide is still permitted in many countries, further studies are necessary for a more in-depth assessment of the risk that glyphosate and its commercial formulations can pose to non-target marine organisms. In this context, it is important to highlight that data obtained in acute toxicity tests (few hours) indicate that glyphosate and its commercial formulations are generally lethal at high concentrations, that are not environmentally realistic. Conversely, information obtained following more prolonged exposure (several weeks) suggest that glyphosate can markedly affect biological responses of marine invertebrates. Consequently, efforts should be addressed at evaluating chronic or sub-chronic effects of such substances to other species of marine invertebrates.
