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Background

In recent years there has been a broad decline of many amphibian populations worldwide (Mann et al., 2009). These populations also lack data to correctly ascertain their conservation status (Baker et al., 2013). We can categorize these declines in one of three groups: over-exploitation, upland species impacted by disease, habitat modification, and introduced species, and lowland species impacted by habitat loss and modification (Mann et al., 2009). A significant contributor to habitat loss is agricultural land expansion (Mann et al., 2009). Agriculture takes up more land than any other human activity (Mann et al., 2009). Amphibian populations are often found by agriculture sites, as there are often bodies of water nearby which inadvertently makes a breeding habitat for amphibians (Mann et al., 2009). While this lessens the impact that agriculture has on habitat loss and modification, amphibians species are then exposed to numerous agricultural chemicals and runoff (Mann et al., 2009). Most temperate frog species have both their breeding and larval development stages during the same time pesticides and fertilizers are commonly applied to agriculture sites, which impacts their development (Mann et al., 2009). These chemicals are widely known to have lethal and sublethal effects (Baker et al., 2013). A review by Baker et al. found that they caused a negative effect on survival of -0.9027 and growth of -0.0737 to amphibian species (2013). Specifically, organophosphates and phosphonoglycine were shown to reduce amphibian growth (Baker et al., 2013).

Amphibian metamorphosis is dictated by thyroid hormones and can be manipulated by exposure to these hormones (Mann et al., 2009). Chemicals such as perchlorate, nonylphenol, methoxychlor, and DDE inhibit regular thyroid activity (Mann et al., 2009). On the other hand, Acetochlor appears to increase thyroid activity (Mann et al., 2009). Because of these impacts, there can either be a delay of metamorphosis or an accelerated metamorphosis, which influences adult breeding populations (Baker et al., 2013). This is very influential for species that breed using vernal pools as there is a lower chance of metamorphosis before the body of water has dried up (Mann et al., 2009). Individuals with accelerated metamorphosis are more likely to be undersized and lose 80% of their lymphocytes during the process compared to the average 40% loss in typically developing individuals (Mann et al., 2009). In turn, energy devoted to detoxifying after exposure to these chemicals reduces growth rate, leaving individuals vulnerable to predators for a longer period of time (Mann et al., 2009).

There has also been some evidence that atrazine, a herbicide, impacts sex ratios and can cause gonadal deformities (Mann et al., 2009). However, reports have been highly divided and focus on a select amount of amphibian species (Mann et al., 2009). Species is critical when considering impacts as exposure to oestrogenic chemicals delays gonadal development in some species while accelerating others (Baker et al., 2013). It is also essential to consider that carrier solvents such as ethanol and methanol can have oestrogenic properties (Mann et al., 2009). The developmental stage at which exposure to these chemicals occurs is also important, as tadpoles exposed during Niewkoop and Faber stages are impacted, while the later stages are not (Mann et al., 2009).

It has also been found that there is immune suppression after exposure to agricultural chemicals such as DDT (Mann et al., 2009). One study showed an alteration of aspects of the immune system at environmentally relevant combinations and concentrations of common agriculture chemicals(Mann et al., 2009). As many amphibian populations are in decline due to infectious diseases, it is important to ascertain the effects that these agricultural practices have on their immune systems (Mann et al., 2009). As well as the active ingredients, additives can increase toxicity by as much as 2.5 times the toxicity when exposed to just active chemicals (Mann et al., 2009). Because these additives are often not specified on the commercial package, it impacts subsequent studies of these products' toxicity (Mann et al., 2009). One study found high mortality rates in American bullfrog tadpoles after exposure to commercial permethrin, but not when exposed to pure permethrin (Mann et al., 2009). Because of the multi-faceted impacts that agricultural chemicals have on amphibian populations, my project will ascertain how various agricultural practices impact both the abundance and diversity of amphibian populations.

Works Cited

Baker, N. J., Bancroft, B. A., & Garcia, T. S. (2013). Corrigendum to A meta-analysis of the effects of pesticides and fertilizers on survival and growth of amphibians [Sci Total Environ 449 (2013) 150-156]. *Science of the Total Environment*, *454*–*455*, 639–640. https://doi.org/10.1016/j.scitotenv.2013.03.049

Mann, R. M., Hyne, R. V., Choung, C. B., & Wilson, S. P. (2009). Amphibians and agricultural chemicals: Review of the risks in a complex environment. *Environmental Pollution*, *157*(11), 2903–2927. https://doi.org/10.1016/j.envpol.2009.05.015