How Can We Better Understand Ecosystem Scale Effects of Neuroactive Chemicals?

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Introduction

Very Little Known of the Effects of Neuroactive Chemicals on Ecological Interactions Crucial to Ecosystem Functioning

Measured Environmental Concentrations Typically Below Lethal Concentrations, However Sublethal Effects Largely Unknown

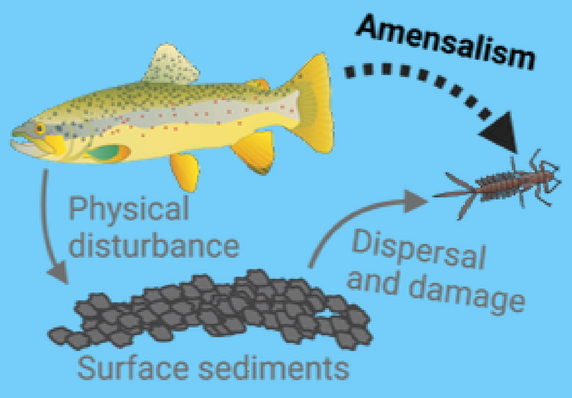
Large Compound Mixtures with Numerous Target Receptors and Mechanisms of Action, Vast Potential to Impact Organisms

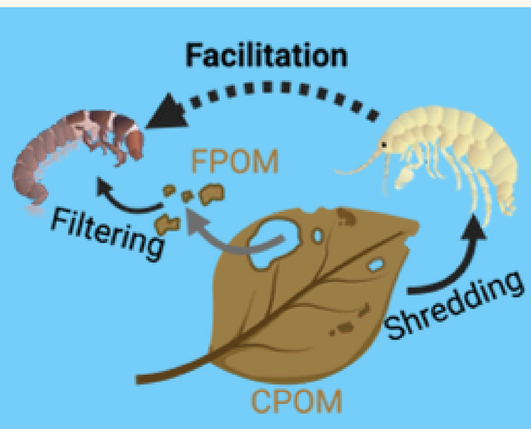
Aims

Two Key Aims Focusing on Freshwater Macroinvertebrate Communities Fundamental to Ecosystem Function

1 Better Understand how Neuroactive Chemicals May Alter Ecological Interactions and the Complex Networks these Interactions Form

2 To Determine if Changes to Ecological Networks Imposed by Neuroactive Chemicals Cause Alterations to Ecosystem Functioning





Anticonvulsants e.g. Carbamazepine

Pesticides e.g. Chlorpyrifos

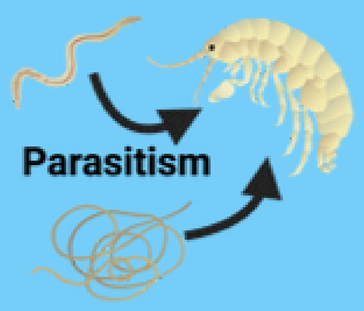
Antidepressants e.g. Venlafaxine

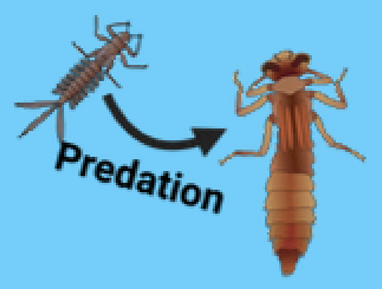
Mechanism of Action

Inhibition of Voltage-Gated Ion Channels & Altered NT Release

Inhibition of ACh Neurotransmitter

Inhibition of Presynaptic Reuptake of Serotonin & Increased Receptor Stimulation





Known Impacts from Previous Research

Reduced Swim Mobility & Speed[1]

Reduced Predator Activity Reduced Antipredator Activity[2]

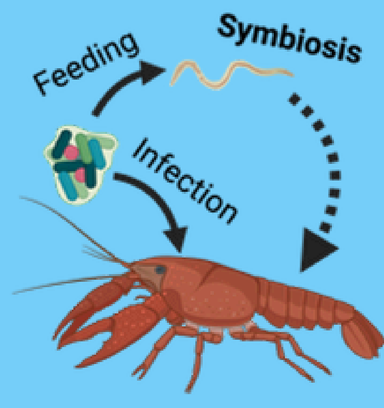
Delayed Predator Response & Escape Rates (Adults) Reduced Growth & Survival (Juveniles)[3]

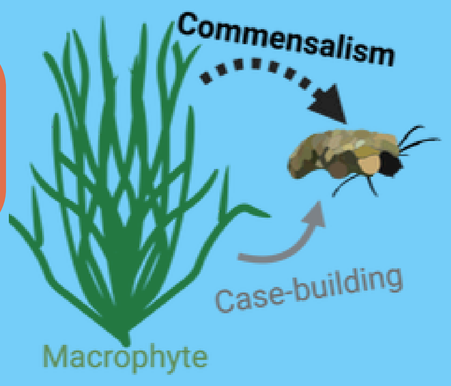
Possible Functional Impacts

Reduced Herbivory

Reduced Food Intake Increased Predation

Reduced Predation Rate (i.e. Pest Control) Generational Population Loss





Possible Ecosystem-Scale Impacts

Nutrient Cycling
Habitat Structure
Food Web Structure
Pest Outbreaks
Biological Diversity
Water Quality

Methods

Paired Field Sampling of Invertebrates & River Water

Exposure Assessments Monitoring Gammarus sp. Behaviour Acute vs Chronic Exposure

Mesocosm Streams with Invertebrates Monitoring Ecosystem Structure & Function

Expected Outcomes

Determine the Functional Impact of Neuroactive Chemicals in a Natural River System

Determine the Sublethal Effects of Neuroactive Chemicals on Key Ecosystem Species

Demonstrate how Ecological Interactions & Ecosystem-Scale Effect Studies May Help Inform Environmental Risk Assessments

1) Heye, K., Wiebusch, J., Becker, J., Rongstock, L., Bröder, K., Wick, A., Schulte-Oehlmann, U., Oehlmann, J., 2019. Ecotoxicological characterization of the antiepileptic drug carbamazepine using eight aquatic species: baseline study for future higher tier tests. J. Environ. Sci. Health Part A 54, 441–451. https://doi.org/10.1080/10934529.2018.1562819
2) Dinh Van, K., Janssens, L., Debecker, S., Stoks, R., 2014. Warming increases chlorpyrifos effects on predator but not anti-predator behaviours. Aquat. Toxicol. 152, 215–221. https://doi.org/10.1016/j.aquatox.2014.04.011
3) Pelli, M., Connaughton, V.P., 2015. Chronic exposure to environmentally-relevant concentrations of fluoxetine (Prozac) decreases survival, increases abnormal behaviors, delays predator escape responses in guppies. Chemosphere 139, 202–209.

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