

Toxicogenomics for Monitoring Pharmaceutical Residues in Aquatic Environments

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Background

Relevant trace substances, such as pharmaceuticals, enter wastewater systems through domestic wastewater, industrial discharges, or rainwater and, if not efficiently removed, can contaminate rivers, lakes and even drinking water. Because pharmaceuticals are highly potent substances, they pose a significant risk to aquatic compartments, causing effects ranging from acute to chronic toxicity, sometimes even at environmentally relevant concentrations. Moreover, they often occur as complex mixtures, whose combined effects may exceed those of the individual components [1,2].

Challenges

Pharmaceuticals are typically present at very low concentrations, making their analytical detection challenging. Targeted methods are limited to known compounds, whereas non-targeted approaches generally lack the sensitivity required to reliably detect these substances, including complex mixtures and transformation products [3,4].

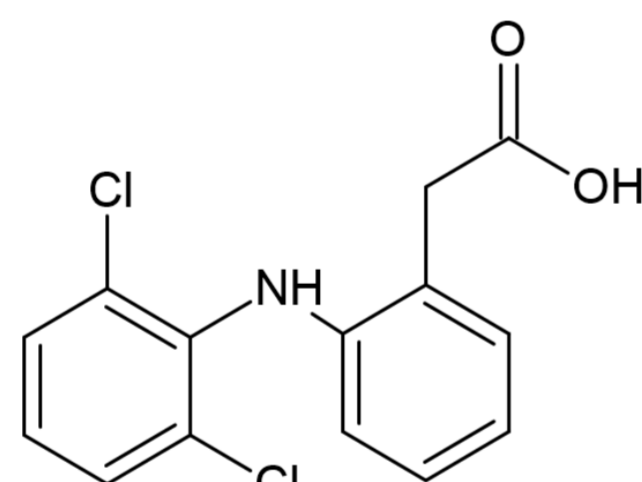
Transcriptomic approach

Transcriptomics capture initial molecular effects (gene expression changes) from single pharmaceuticals and mixtures. As a biological non-target method, it sensitively detects effects at ng/L levels, contributes to mode of action (MoA) identification, and covers both known and unknown substances [5,6].

Test substances

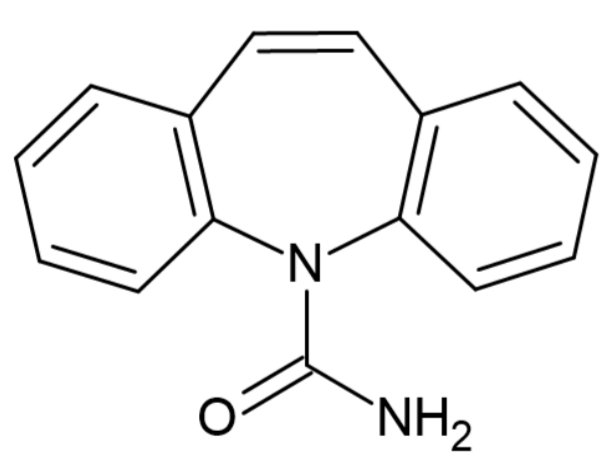
Diclofenac

Non-steroidal anti-inflammatory drug



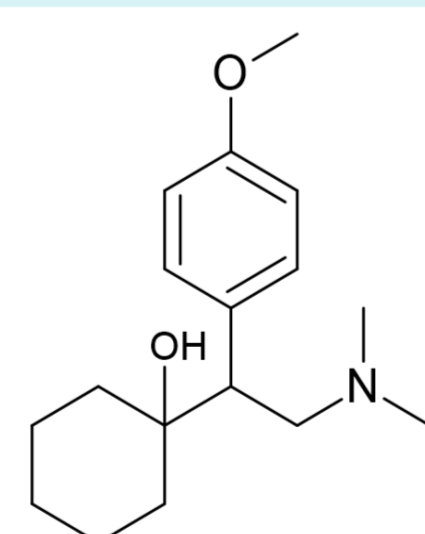
Carbamazepine

Anti-epileptic drug



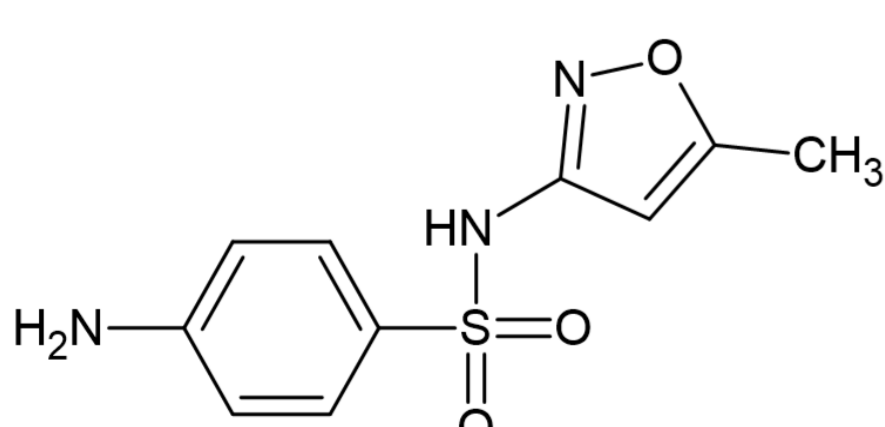
Venlafaxine

Antidepressant



Sulfamethoxazole

Antibiotic



And a few more...

Let me know your ideas!



Methods

- OECD guidelines combined with transcriptomics
- *Danio rerio* (embryo) & *Raphidocelis subcapitata*
- Environmentally relevant concentration range
- tPOD calculation & bioinformatic evaluation

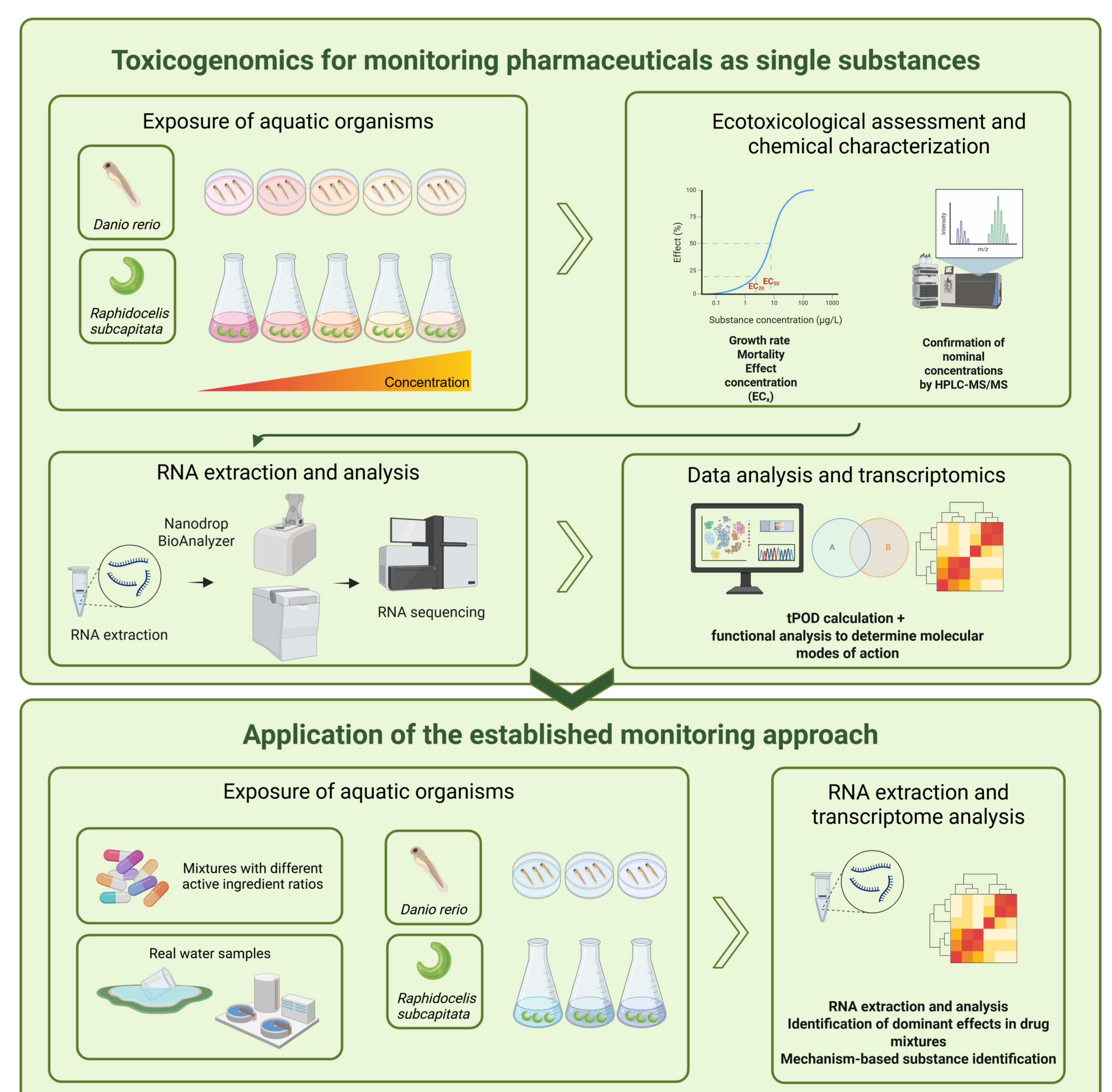


Figure 1. Workflow of the project. Created with Biorender.com

Aim of my PhD project

1. Development of a mechanism-sensitive approach for detecting the molecular effects of pharmaceuticals in aquatic environments

2. Application to pharmaceutical mixtures and real water samples for the detection of compounds by their MoA