ARE YOUR WATER SYSTEMS SAFE? A STUDY ON CYP1A EXPRESSION IN BROWN BULLHEAD AND CATFISH IN RESPONSE TO SEDIMENT EXPOSURE FROM KILLBUCK CREEK WOOSTER, OHIO

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Background

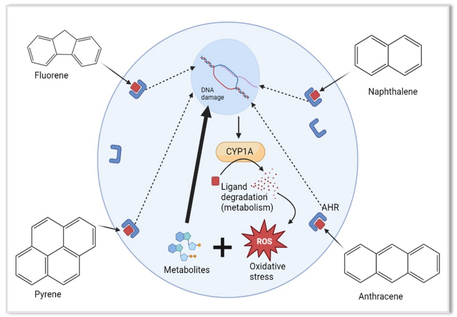


Figure 1. **CYP1A Induction through the AHR Pathway.** The toxins on the outside of the cell membrane (1) bind to the AHR receptor in the cytoplasm. Once bound to the ligand, the compounds enter the nucleus via the help of already present transporters (2) promoting the transcription of CYP1A (3). The toxins can then either be (a) metabolized through CYP1A expression or (b) react negatively with the produced metabolites, causing damage or altering the function of the DNA (mutagenesis, carcinogenesis, or immunosuppression).

- Big agriculture and industrial sources cause runoff and waste to enter our freshwater ecosystems (1)(4)(2).
- Many systems contain PAHs (toxins) that collect in the sediment at the bottom of the water column (1)(3)(5).
- Most biodiverse places that contain toxins have more vulnerability, because these biodiverse species are vital for the whole ecosystem's survival (6).
- Fish as bioindicators of the environment to gauge the contamination of our water systems and the effects they have on living organisms (1)(7).

Research Question

To assess the health of the environment in Wooster, Ohio through:

1. Sediment exposure to fish bioindicators and 2. the measurement of CYP1A biomarkers

Methods

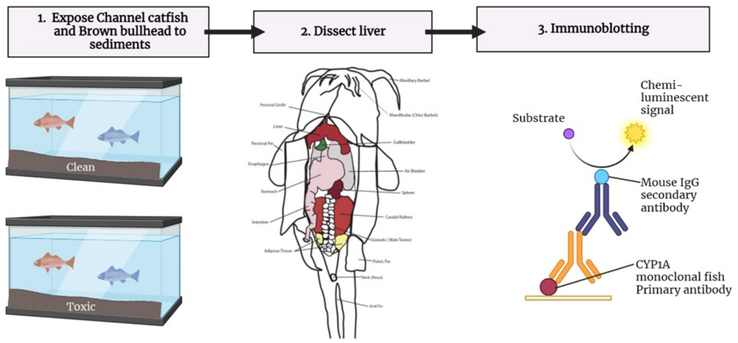
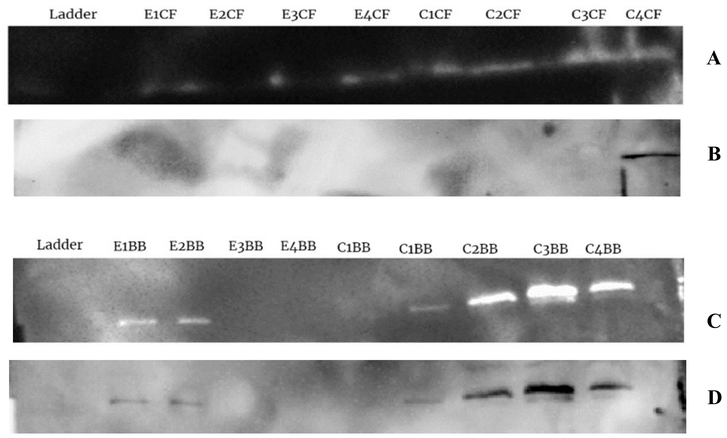


Figure 2. **Flow chart illustrating how** [1] fish (eight Brown bullhead and eight Channel catfish) were exposed to sediments from sites (figure 2) in five-gallon tanks, [2] Organs that were sampled [3] and signal produced from tissue immunoblot.

Results



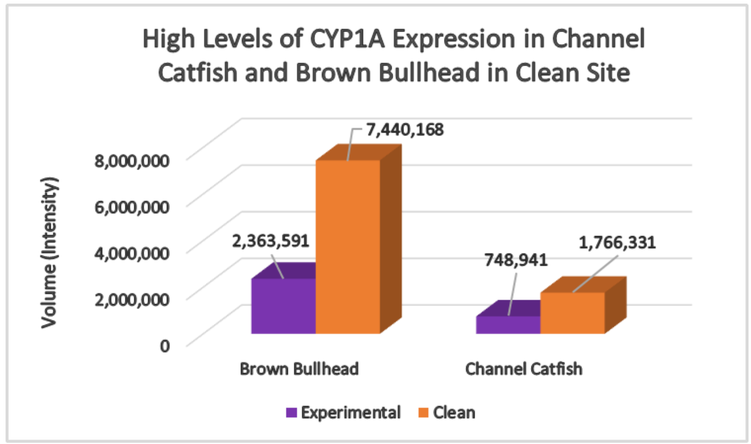


Figure 3. **CYP1A and Actin Expression in Fish of Killbuck Creek Wooster, Ohio. (A)** CYP1A Brown bullhead **(B)** Actin Brown bullhead **(C)** CYP1A Channel catfish **(D)** Actin Channel Catfish. Actin did not show up for catfish but did show up for Brown bullhead. Another round of western blotting will have to be done to confirm whether actin is compatible with catfish.

Figure 4. **Comparison of CYP1A Expression in Brown Bullhead and Catfish between the experimental and clean sites in Killbuck Creek .** CYP1A expression was highest in the clean sites of both Channel catfish and Brown bullhead , while the lowest CYP1A expression was seen in the experimental groups of both Brown bullhead and Channel catfish.

Discussion

CYP1A expression was higher in clean sites than polluted sites in both Brown bullhead and Channel Catfish.

1. This may be explained by the CYP1A gene variant going through selection overtime, changing the way fish express CYP1A in response to toxins (8)(9).
2. This may be due to the higher molecular weighted PAHs in the clean sites compared to the polluted sites, making CYP1A more inducible by the PAHs in the clean sites since they are larger in size (5).

References & Acknowledgments

(1) Williams, R., T. Taggart, K. Ganger, T. Koetsier, S. Johnson, and A. Dinchman. 2022. CYP1A expression in freshwater fish of western New York as an indicator of pollution levels. Ecology and Evolution 12:e8526. **(2)** Baumann, P. C., and J. C. Harshbarger. 1998. Long Term Trends in Liver Neoplasm Epizootics of Brown Bullhead in the Black River, Ohio. Environmental Monitoring and Assessment 53:213–223. **(3)** De Andrade, V. M., J. da Silva, F. R. da Silva, V. D. Heuser, J. F. Dias, M. L. Yoneama, and T. R. O. de Freitas. 2004. Fish as bioindicators to assess the effects of pollution in two southern Brazilian rivers using the Comet assay and micronucleus test. Environmental and Molecular Mutagenesis 44:459–468. **(4)** Govindasamy, R., and A. A. Rahuman. 2012. Histopathological studies and oxidative stress of synthesized silver nanoparticles in Mozambique tilapia (Oreochromis mossambicus). Journal of Environmental Sciences 24:1091–1098. **(5)** Goksøyr, A. 1995. Use of cytochrome P450 1A (CYP1A) in fish as a biomarker of aquatic pollution. Pages 80–95 *in* G. H. Degen, J. P. Seiler, and P. Bentley, editors. Toxicology in Transition. Springer, Berlin, Heidelberg. **(6)** Recabarren-Villalón, T., A. C. Ronda, A. L. Oliva, A. L. Cazorla, J. E. Marcovecchio, and A. H. Arias. 2021. Seasonal distribution pattern and bioaccumulation of Polycyclic aromatic hydrocarbons (PAHs) in four bioindicator coastal fishes of Argentina. Environmental Pollution 291:118125. **(7)** Adams, S. M., K. L. Shepard, M. S. Greeley, B. D. Jimenez, M. G. Ryon, L. R. Shugart, J. F. McCarthy, and D. E. Hinton. 1989. The use of bioindicators for assessing the effects of pollutant stress on fish. Marine Environmental Research 28:459–464. **(8)** Tuvikene, A. 1995. Responses of fish to polycyclic aromatic hydrocarbons (PAHs). Annales Zoologici Fennici 32:295–309. **(9)**Wirgin, I., N. K. Roy, M. Loftus, R. C. Chambers, D. G. Franks, and M. E. Hahn. 2011. Mechanistic Basis of Resistance to PCBs in Atlantic Tomcod from the Hudson River. Science 331:1322–1325. ***Figure 1 & 2*** were created with BioRender.com

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