

Megaloptera as a Sentinel Organism: A Comparison of Benthic Invertebrate Orders

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ENTRIX

ABSTRACT

It is often difficult to collect sufficient masses of benthic invertebrates to make measurements of residue concentrations that reflect community diversity. We investigated the order Megaloptera (i.e., alderflies, dobsonflies) to determine if it could serve as a sentinel benthic invertebrate from which to determine representative concentrations of residues to be used in screening-level assessments. Megaloptera are in contact with substrata for two to five years, have high lipid content, and are opportunistic feeders. Megaloptera are relatively easy to collect and have relatively large masses. Previously, we have demonstrated the utility of Megaloptera in a study of PCBs in the Kalamazoo River (MI). Concentrations of PCBs in Megaloptera were equal to or greater than those in five other co-collected benthic invertebrate orders. In this study, concentrations of 2,3,7,8-TCDD equivalents (TEQ), were calculated from seventeen 2,3,7,8-substituted PCDD/Fs in benthic invertebrates from the Tittabawassee River (MI) and at two upstream reference locations. Total TEQ concentrations were greatest in Megaloptera relative to all other orders of benthic invertebrates at target sites. Concentrations of total TEQ in Megaloptera were generally 10-fold greater at target sites (15.9 to 36.3 ng/kg) than at reference sites (0.61 to 4.5 ng/kg). Concentrations of TEQ in Megaloptera were > Ephemeroptera > Odonata > Amphipoda > Trichoptera > Bivalvia > Gastropoda. Thus, it appears that Megaloptera species are useful as a surrogate for other benthic invertebrates in a screening level assessment.



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INTRODUCTION

Aquatic insects were collected from the Tittabawassee River as part of a large scale food chain analysis to determine polychlorinated dibenzofuran (PCDF) and polychlorinated dibenzo-p-dioxin (PCDD) exposure to upper trophic level receptors. Aquatic insects were also collected from the Kalamazoo River (in southwestern Michigan) for a similar food web study based on PCBs. Data collected during these studies were used to test the hypothesis that Megaloptera can serve as a representative aquatic insect for food web investigations which include bioaccumulative contaminants.

Problem

Screening level assessments are an important part of identifying chemicals of potential ecological concern for environmental risk assessments. Collection and chemical analysis of aquatic insects for food chain studies is hampered by difficulty in obtaining sufficient sample masses that appropriately reflect community diversity.

Proposed Solution

Rather than collection and analysis of all of the different benthic invertebrates, Megaloptera can be used as a representative aquatic insect for screening level exposure assessments of bioaccumulative contaminants. Megaloptera larvae are in contact with sediment between two and five years, have high lipid content, and are indiscriminate, opportunistic feeders. In addition, they are relatively easy to collect in most river systems and have large body masses.

MATERIALS AND METHODS

- Invertebrates from the Kalamazoo River were collected during the summers of '99, '00, and '01 at Fort Custer, an upstream reference site, and within the Trowbridge floodplain, an area of concern.
- Kalamazoo River samples were Soxhlet extracted, H₂SO₄ hydrolyzed, and cleaned in Florisil® silica gel columns.
- Congener specific PCB analysis was conducted via gas chromatography with an electron capture detector.
- PCB congeners 77, 81, 105, 118, 126, 156, 157, 167, and 169 (IUPAC nomenclature) were used to calculate TEQs.
- Benthic invertebrates and aquatic emergent insects were collected from the Tittabawassee and Pine Rivers during 2003 and 2004. Upstream reference sites included Sanford on the Tittabawassee River and the Chippewa Nature Center located on the Pine River. Sites in the area of concern on the Tittabawassee River included Smiths Crossing, Tittabawassee Township Park, Freedom Festival Park, and Imerman Park (Fig. 2).
- Concentrations of seventeen 2,3,7,8-substituted PCDD/F congeners were determined at AgriQuality Limited (Lower Hutt, New Zealand) using EPA method 8290.
- All benthic invertebrates and aquatic emergent insects were collected by use of seines, kick nets, sieve buckets, mercury vapor lamp, and by manually picking with forceps.
- All aquatic invertebrates were identified to order and massed for analysis on an order specific basis.
- Samples of invertebrate orders meeting or exceeding five (5) grams of biomass per site were analyzed.
- Megaloptera larvae and non-feeding adults were combined for analysis.
- Concentrations of TEQ values were calculated by use of World Health Organization 2,3,7,8-TCDD equivalency factors (TEFs) for mammals.

RESULTS AND DISCUSSION

Kalamazoo River

- Mean concentrations of TEQs (due to PCBs) in Megaloptera were greater than or not significantly different from concentrations in other aquatic invertebrates (Table 1 and Fig. 1).
- Invertebrate concentrations of TEQs (due to PCBs) were 3-fold greater in the target area than at the reference site.

Tittabawassee River

- At the target (more contaminated) sites, mean concentrations of total TEQ were greater in Megaloptera than all other benthic invertebrates (Table 1 and Fig. 2).
- Concentrations of total TEQ in Megaloptera were up to 10-fold greater at target sites than at reference sites.

TEQs in Megaloptera are either greater than or not significantly different from other benthic invertebrates.

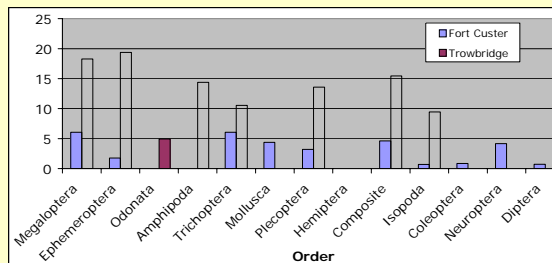


Figure 1. Mean PCB TEQ concentrations (ppt) in Kalamazoo benthic invertebrates.

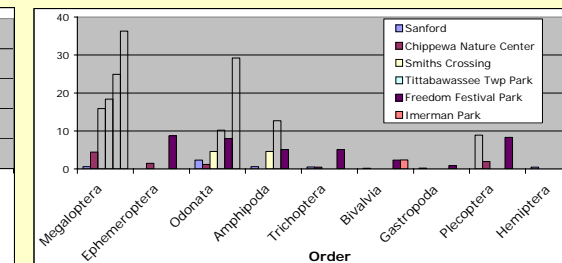


Figure 2. Mean PCDD/F TEQ concentrations (ppt) in Tittabawassee benthic invertebrates.

Mercury vapor lamp insect sampling



Adult male dobsonfly



Table 1. Mean mammalian TCDD equivalents in Megaloptera and benthic invertebrates.

River	Target		Reference	
	Megaloptera	Other BI's	Megaloptera	Other BI's
Tittabawassee	23.9	7.2	2.5	1.7
Kalamazoo	18.3	10.6	6.1	3.6

CONCLUSIONS

- In the Kalamazoo River, total concentrations of TEQs in Megaloptera were not significantly different from other aquatic insect orders.
- In the Tittabawassee River, total concentrations of TEQs were greater in Megaloptera than all other orders of benthic invertebrates.
- Mean concentrations of total TEQs in Megaloptera were generally 3-9-fold greater at target sites than at reference sites.
- Megaloptera larvae were found most often in wood debris.
- Collecting Megaloptera is more efficient than sampling other orders separately.
- Screening level exposure risk assessments can be simplified by using Megaloptera as a representative order for all aquatic insects.



Acknowledgments

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