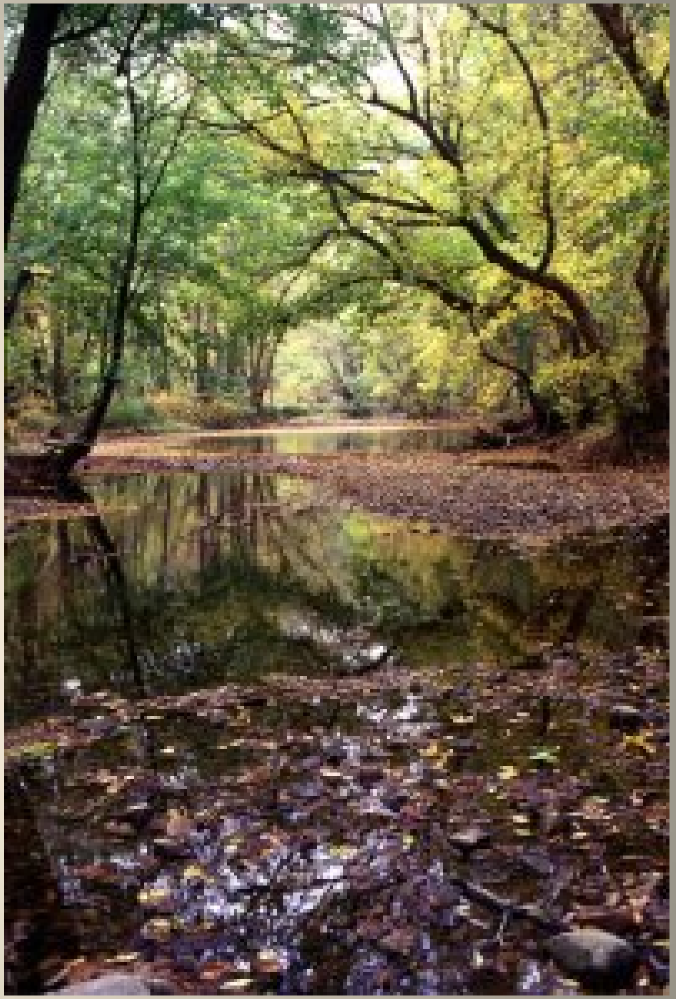
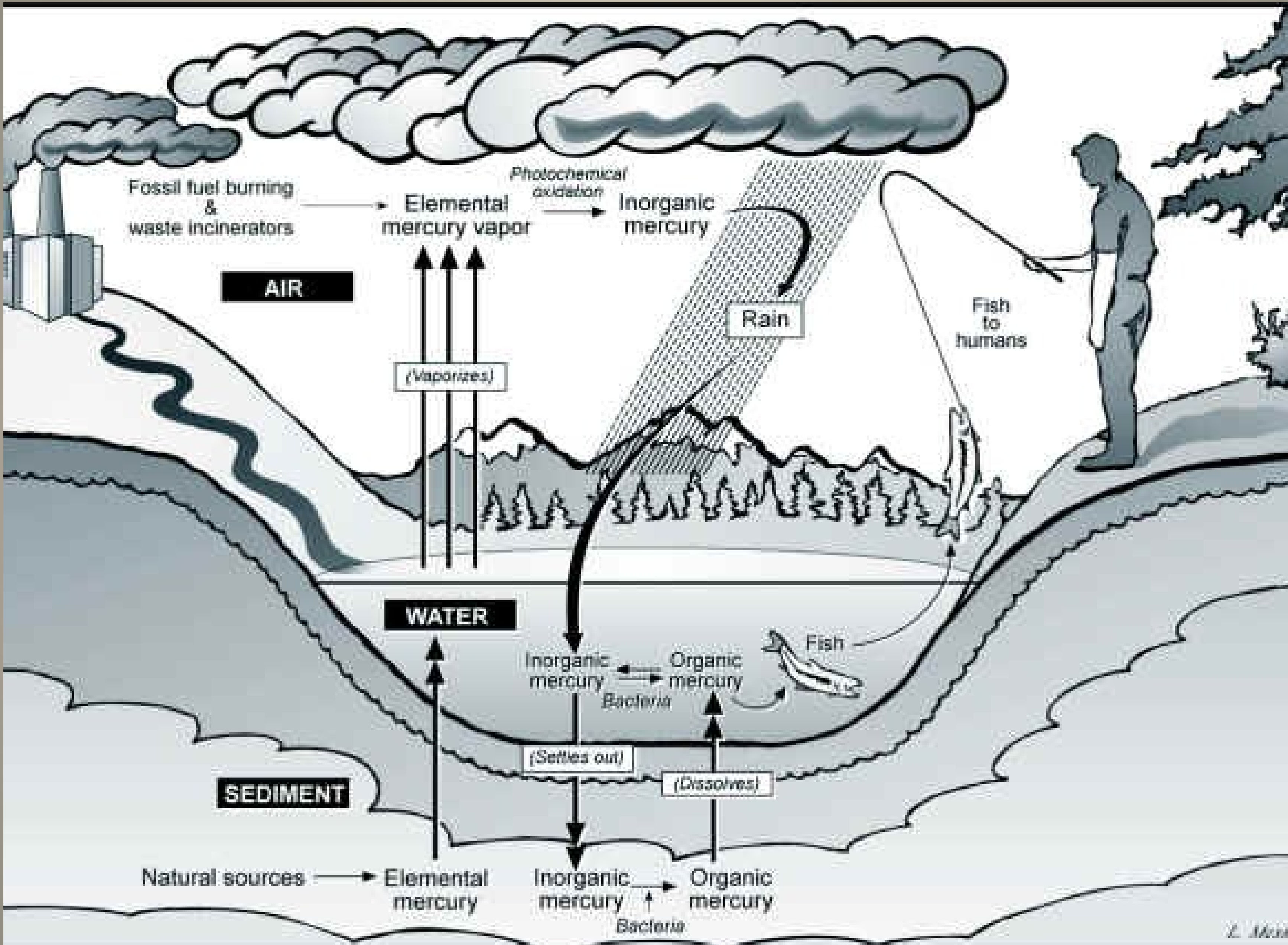
Methyl Mercury Bioaccumulation By the Crayfish (*Orconectes sanbornii*) in Acid Mine Impacted Streams



Ebenezer Aluma, Kelly Johnson and Patrick Hassett,

Ohio Center for Evolutionary and Ecological Studies, Biological Sciences Department, Ohio University, Athens OH



Fossil fuel burning & waste incinerators
Elemental mercury vapor
Photochemical oxidation
Inorganic mercury
AIR
Rain
Fish to humans
(Vaporizes)
WATER
Inorganic mercury
Organic mercury
Bacteria
Fish
(Settles out)
(Dissolves)
SEDIMENT
Natural sources
Elemental mercury
Inorganic mercury
Organic mercury
Bacteria

USGS 2004

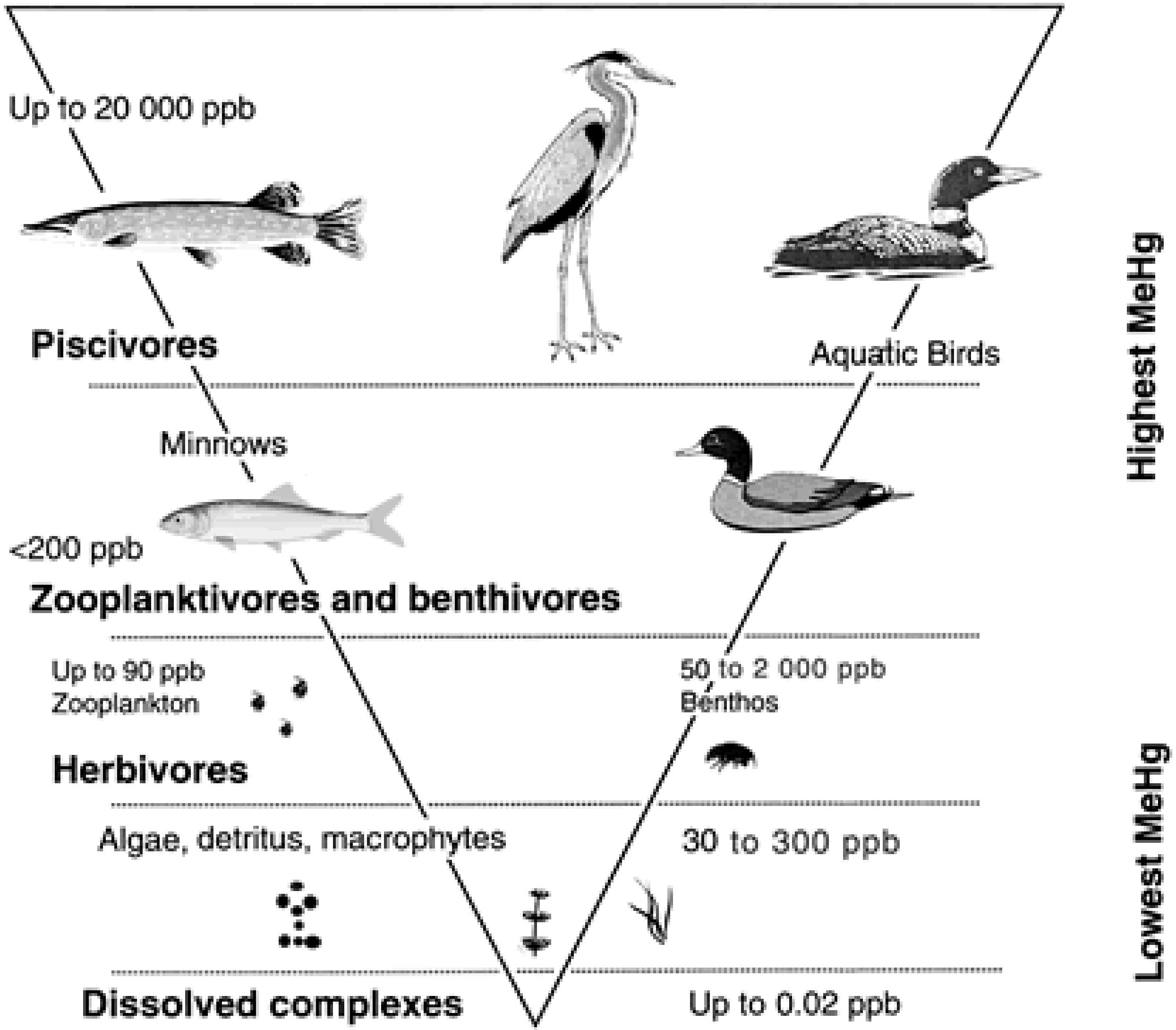


Figure 4: Bioaccumulation and biomagnification of mercury

Courtesy ; http://www.ec.gc.ca

AMD vs Unimpacted streams:

Low pH promotes MeHg bioaccumulation in lakes (Celo et al. 2006)

Sulfur strongly influences methylation

- addition to wetlands promotes methylation (Jeremiasson et al., 2006).

Anoxic layers of iron/sulfur –rich precipitate may represent 'methylation zones' rich in methylating/sulfur reducing bacteria

Food webs simplified, dominated by taxa prone to bioaccumulation (sediment burrowers, predators, long-lived taxa)

Hypothesis

Methylmercury bioaccumulation is promoted in acid mine impacted stream sites as opposed to non impacted stream sites

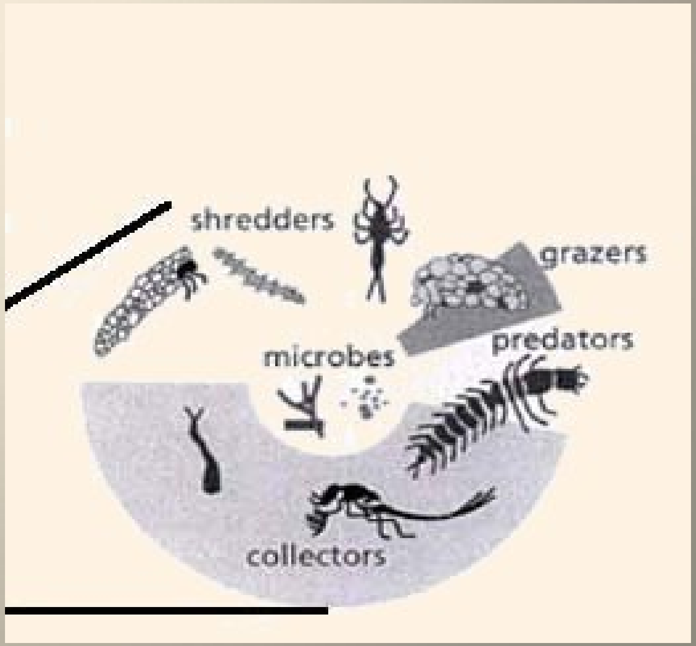
Crayfish as indicators of Hg/MeHg bioavailability:

-long-lived (2-10 years)
-strong site fidelity
-widespread/high densities
-tolerant

-Feed at several trophic levels
- periphyton/vegetation
- decaying leaf litter
- invertebrates
- small fish
- smaller crayfish

- Important prey for fish!

www.crayfishworld.com/internationalusa2.htm



Methodology
(The AMD Impact Index)

- Historical Sunday Creek Watershed data from www.watersheddata.com
- Six water chemistry parameters (pH, Al, Mn, Fe, Sulfate, acidity) raw values were assigned numerical ranks (Williams, 1999; Gray, 1996) and the numerical ranks were summed to produce index describing severity of AMD impact
- AMD Index values ranged from 8-14
- AMD impact ≥ 10 – impacted site and < 10- unimpacted site

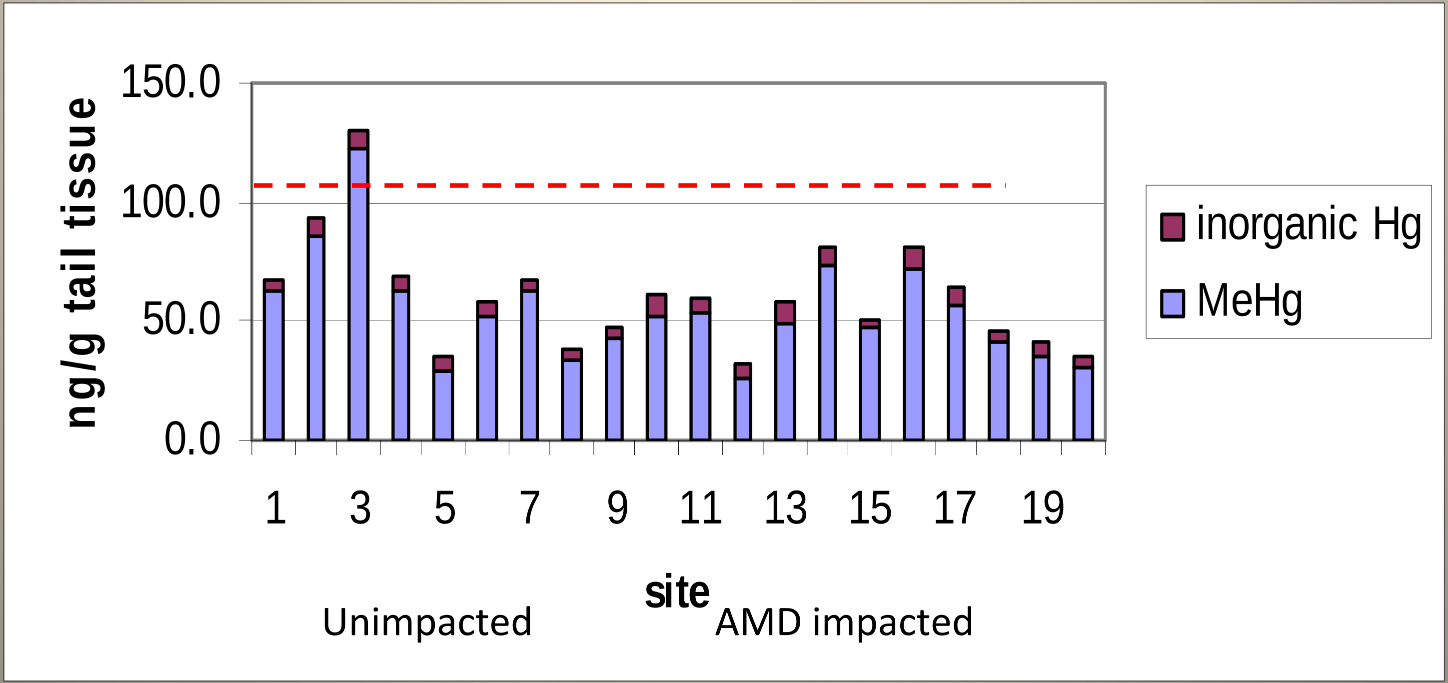
Parameter	Actual Value	Index Value
Acidity(mg/l)	0-10	1
	10-100	2
	100-1000	3
Aluminum(mg/l)	0-1	1
	1-10	2
	10-100	3
	100-1000	4
Iron(mg/l)	0-1	1
	1-10	2
	10-100	3
	100-1000	4
Manganese(mg/l)	0-0.1	1
	0.1-1	2
	1-10	3
	10-100	4
Sulfate(mg/l)	0-10	1
	10-100	2
	100-1000	3
	1000-10000	4
pH	2-5 and 8.1-14	2
	5.1-8	1

RESULTS

Total Hg content ranged from 30 – 130 ng/g
MeHg ranged from 26 – 122 ng/g

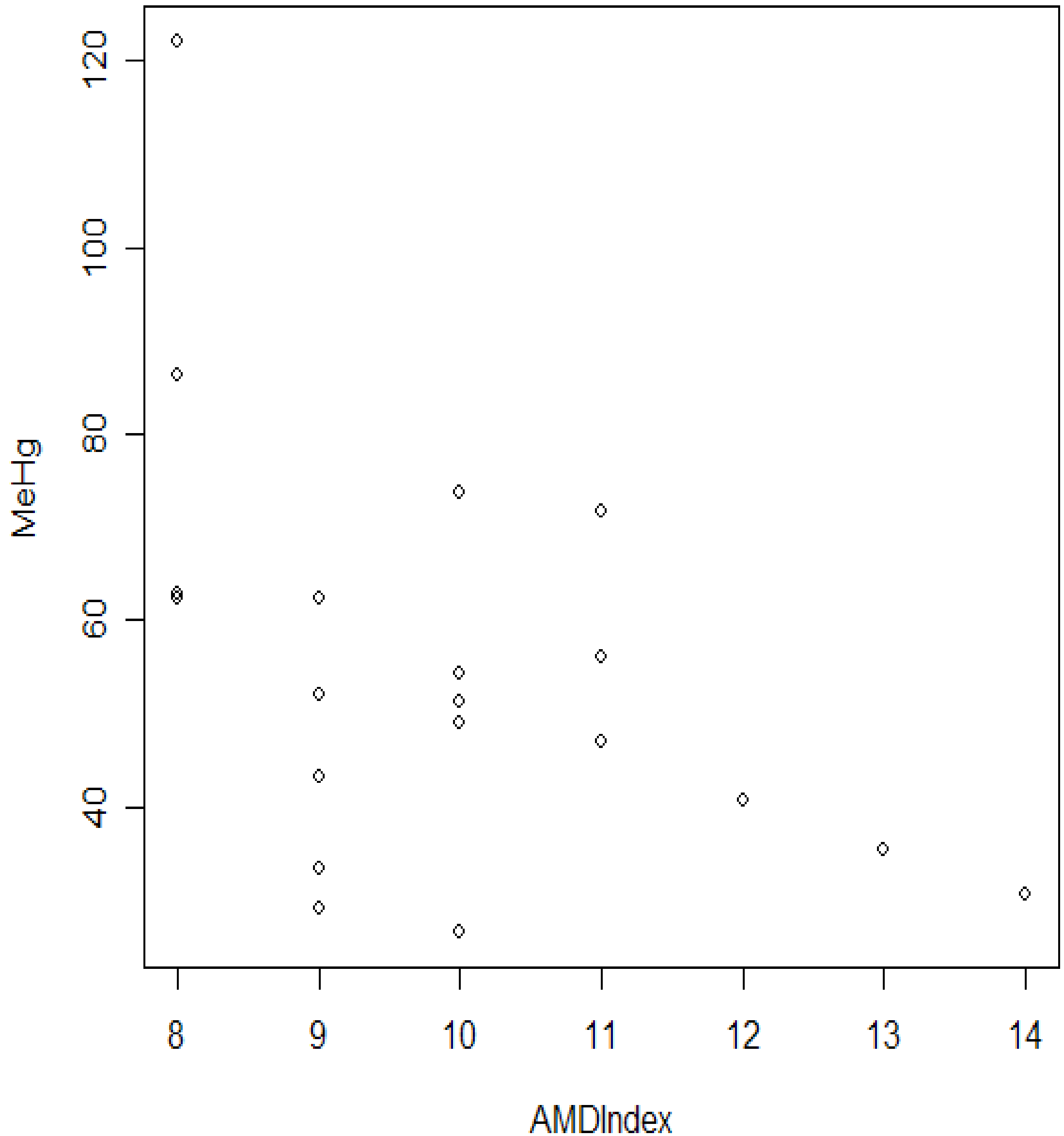
Only one site elevated above background
100 ng/g (Parks and Hamilton 1987)

Pennuto et al. (2005) reported mean of 120 ng/g Total Hg
and 100 ng/g MeHg in *O.virilis* tails from New England



AMD Index versus Methyl mercury content in tail tissue

- Counter intuitive decrease in methyl mercury content with increasing AMD impact- why?
- Spearman's correlation r= 0.44 (not very strong)
- T-test results for AMD impacted versus non impacted sites- p=0.25. No statistically significant difference in bioaccumulation between impacted and unimpacted sites



Questions

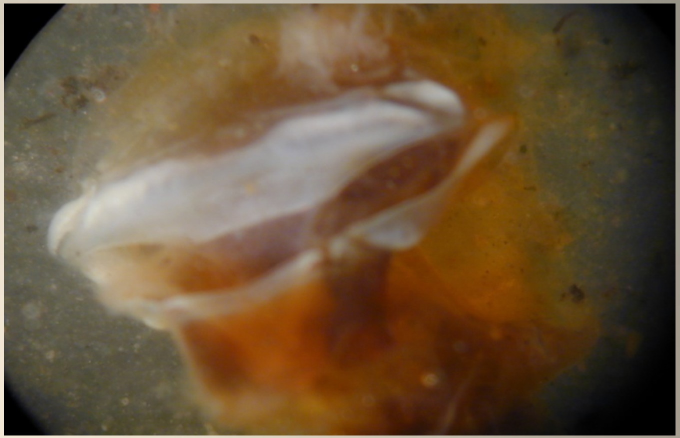
- **What correlations exist between *O. sanbornii*'s diet and mercury bioaccumulation in the species?**

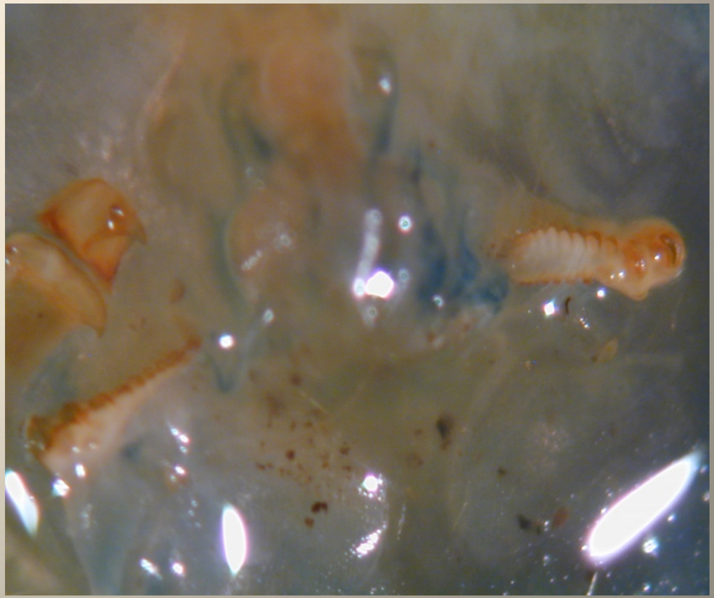
- **What is *Orconectes sanbornii* eating in SE Ohio?**

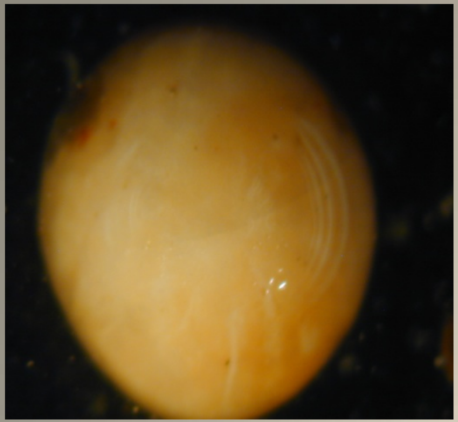
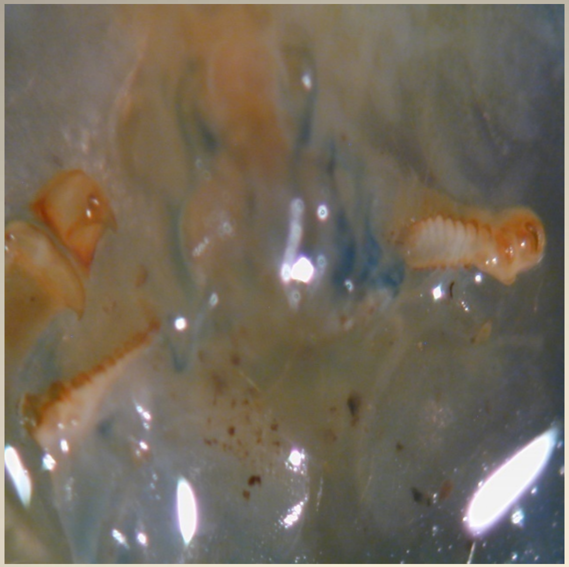
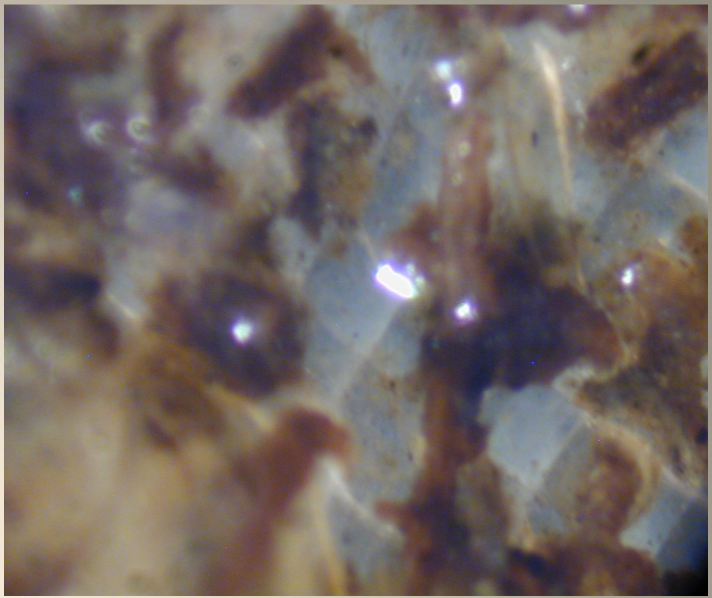
- **Does AMD affect the diet of *O. sanbornii* ?**

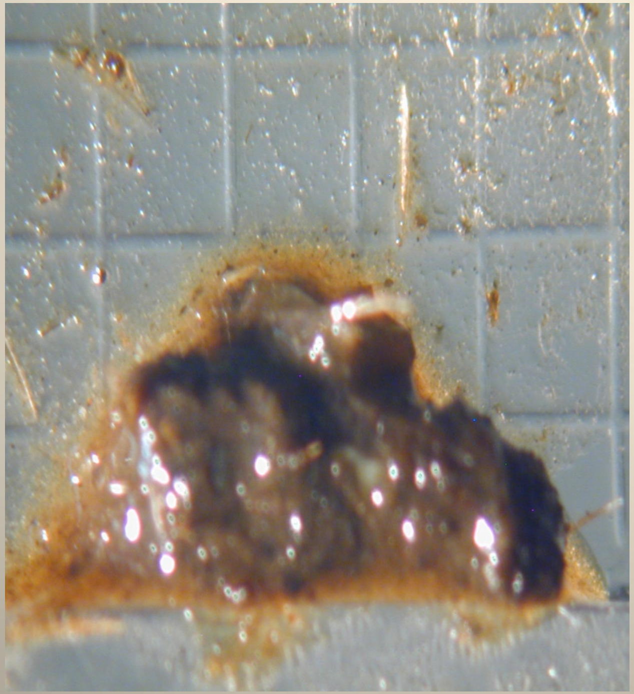
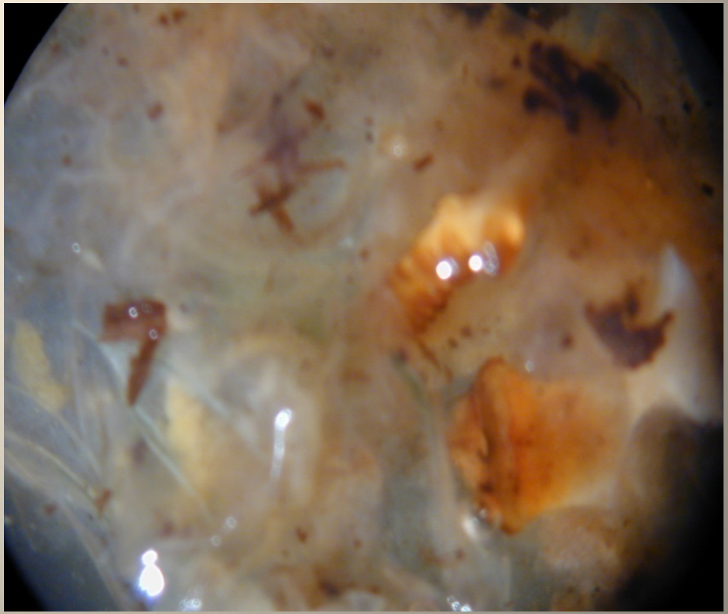
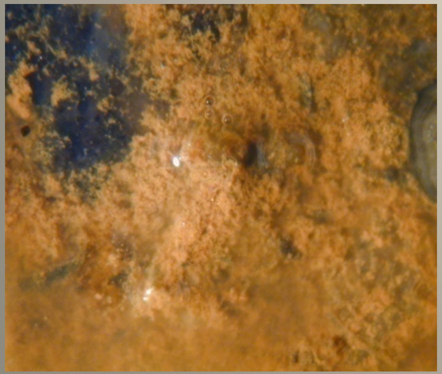
Methods

- Composite stomach content per site
- Composite samples sorted under dissecting scope into plant, animal and amorphous matter
- Stomach contents dried and weighed
- NCSS, GPower 3.0

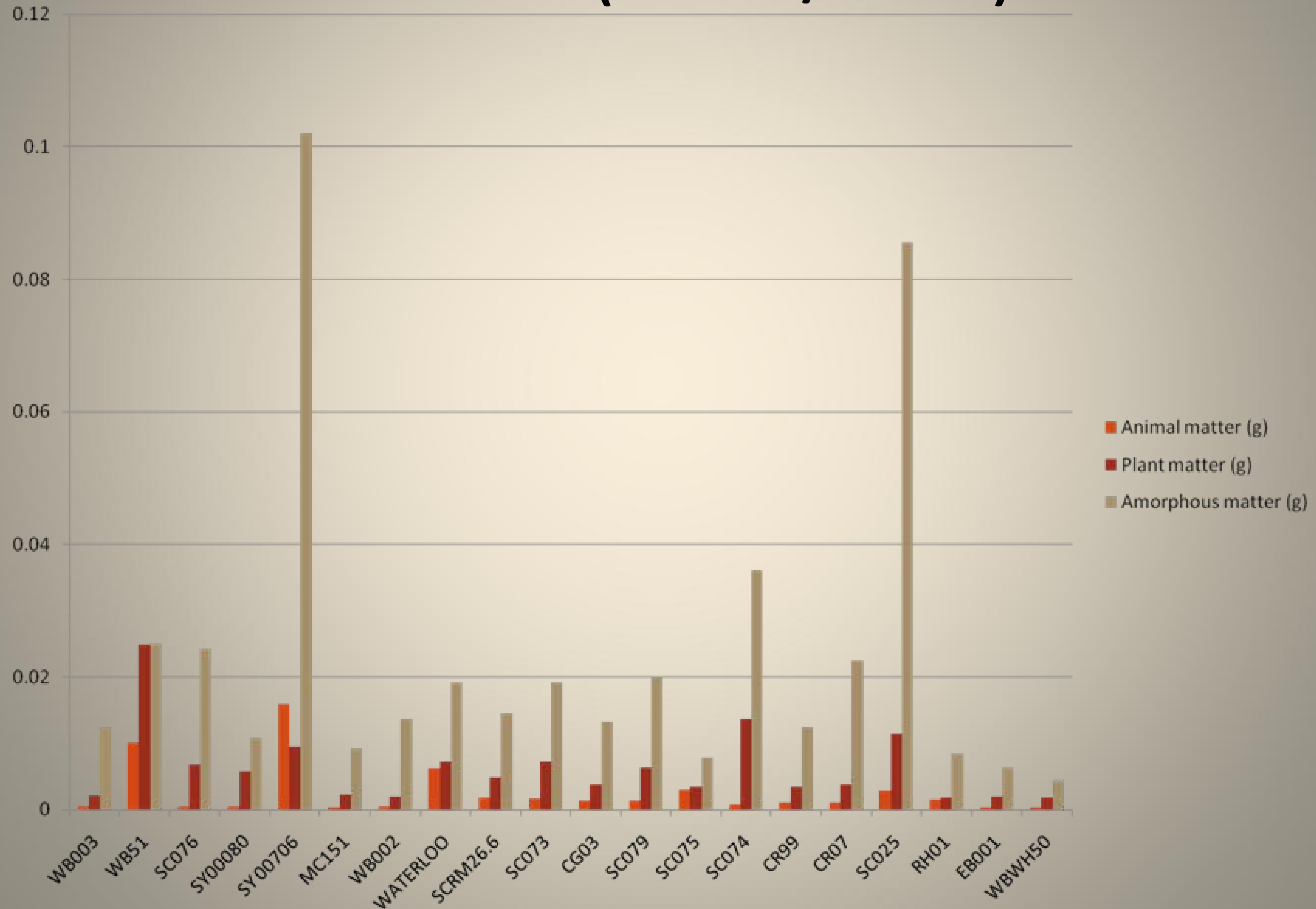




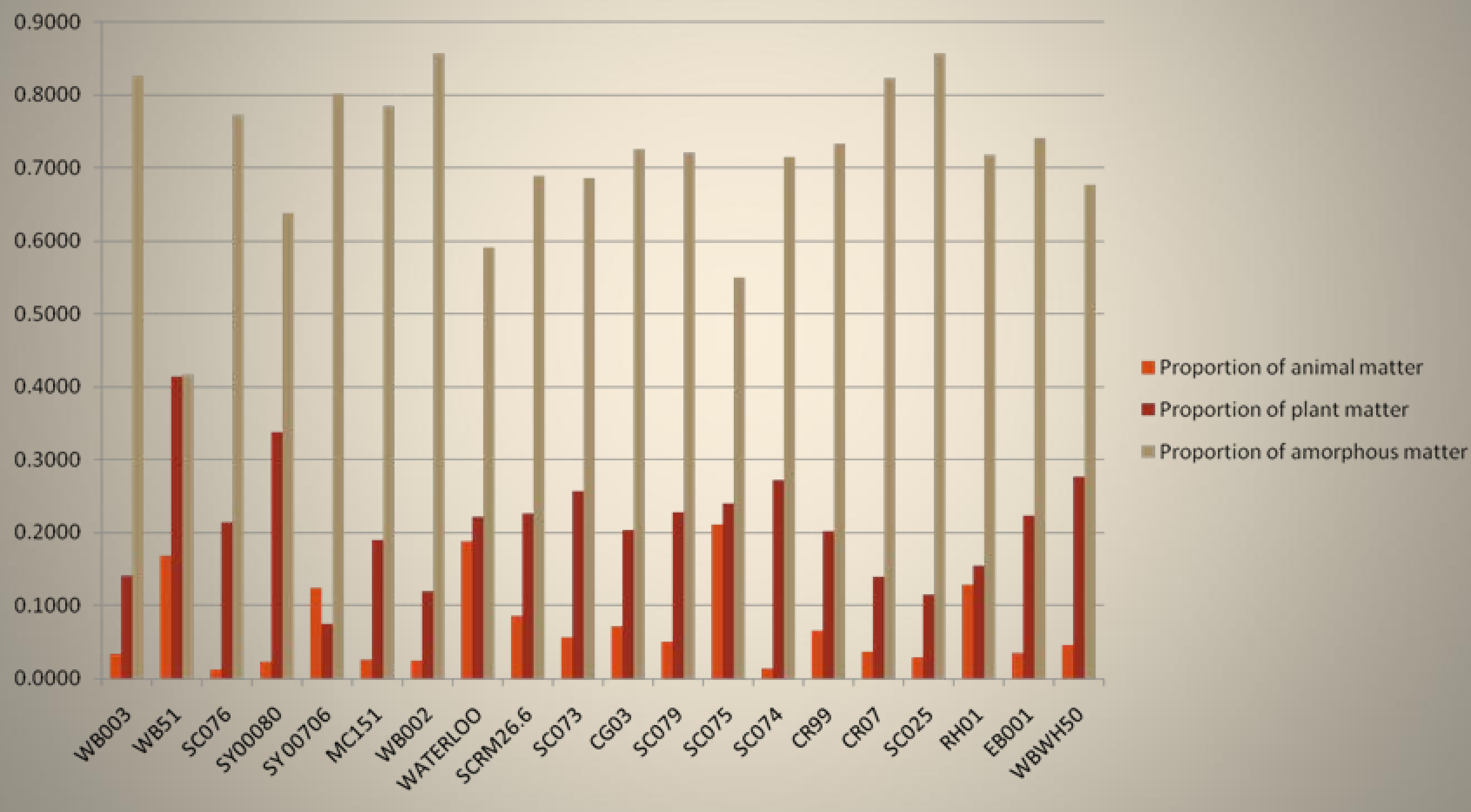




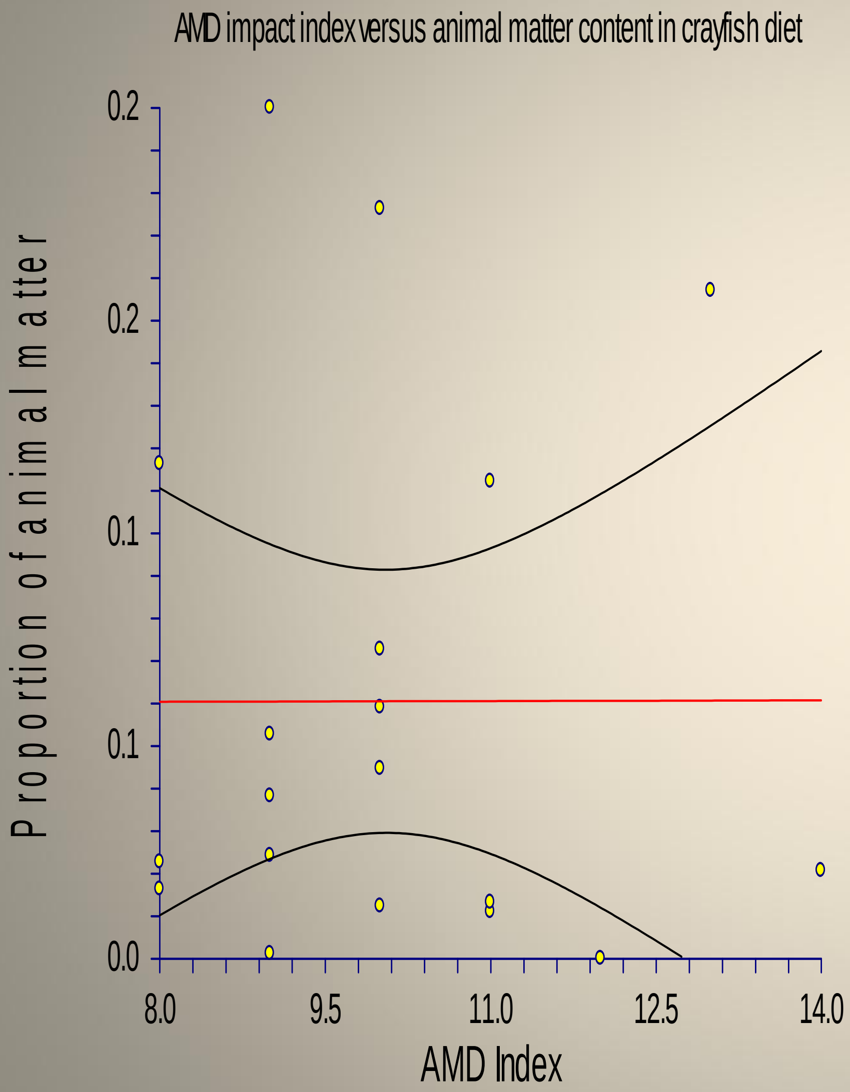
Results (AMD/Diet)



AMD diet results contd.

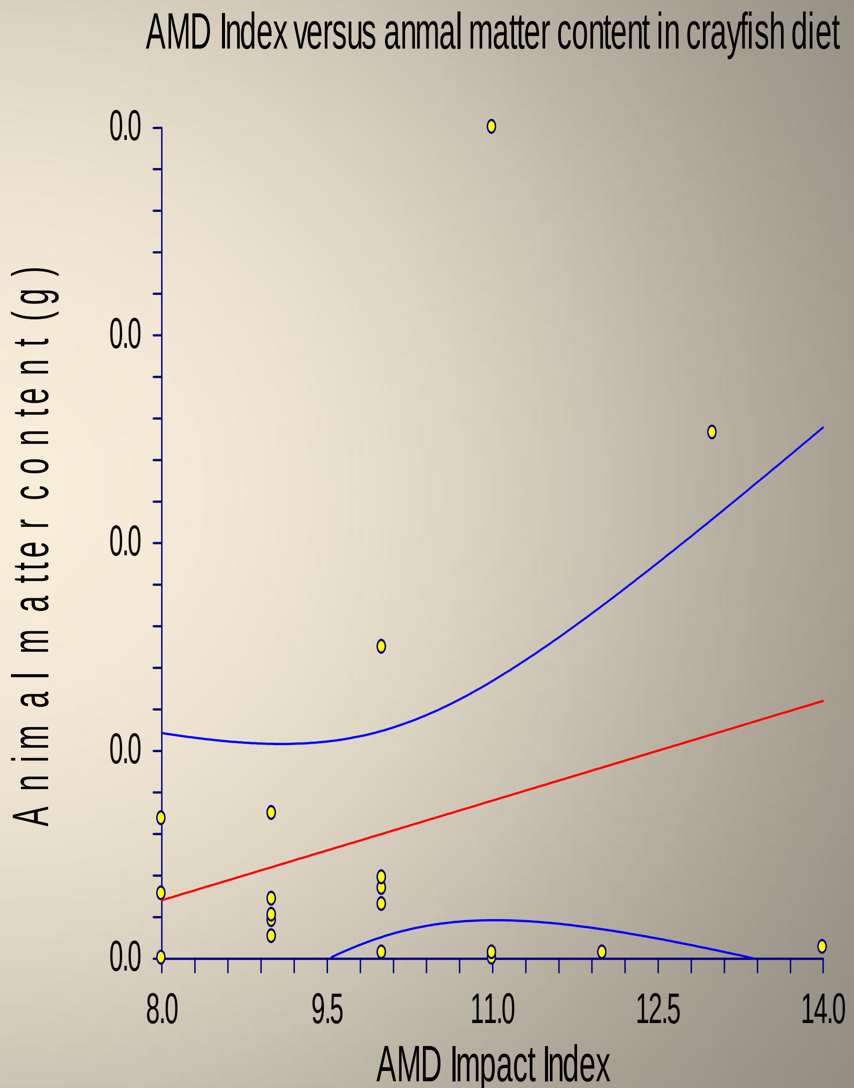


AMD diet results contd.



R = 0.0014

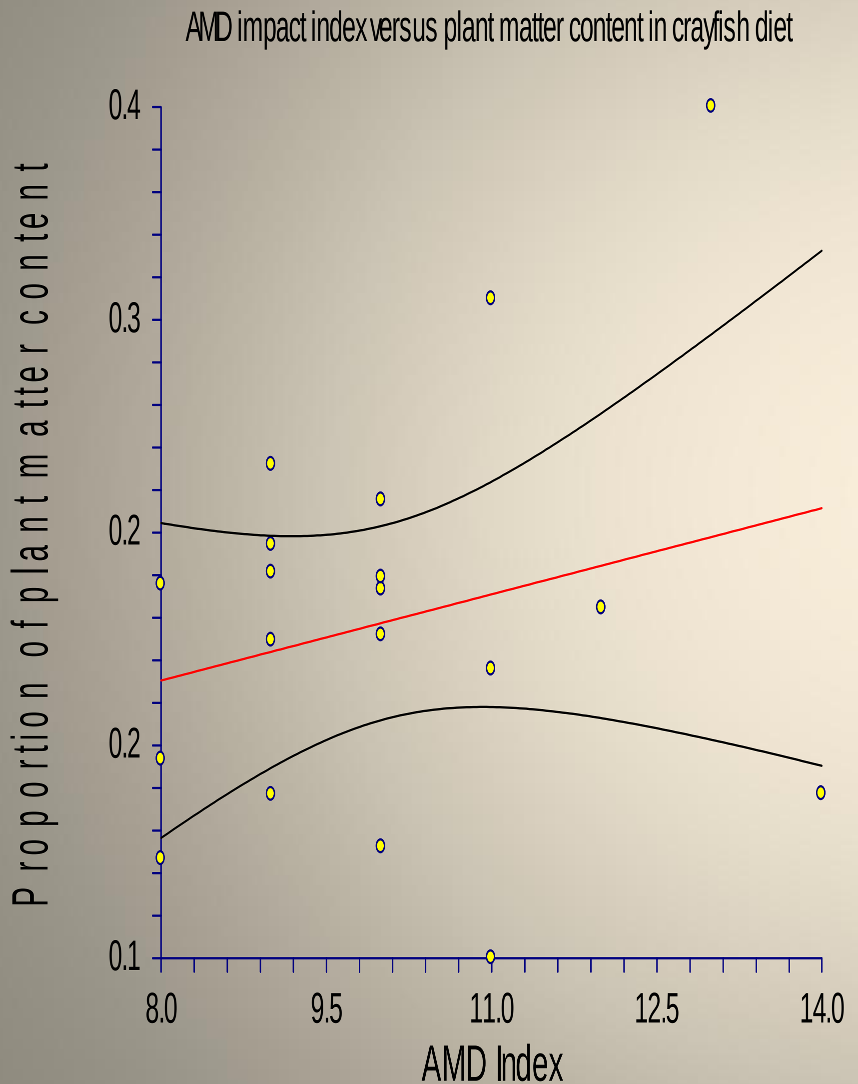
P = 0.9954



R = 0.256

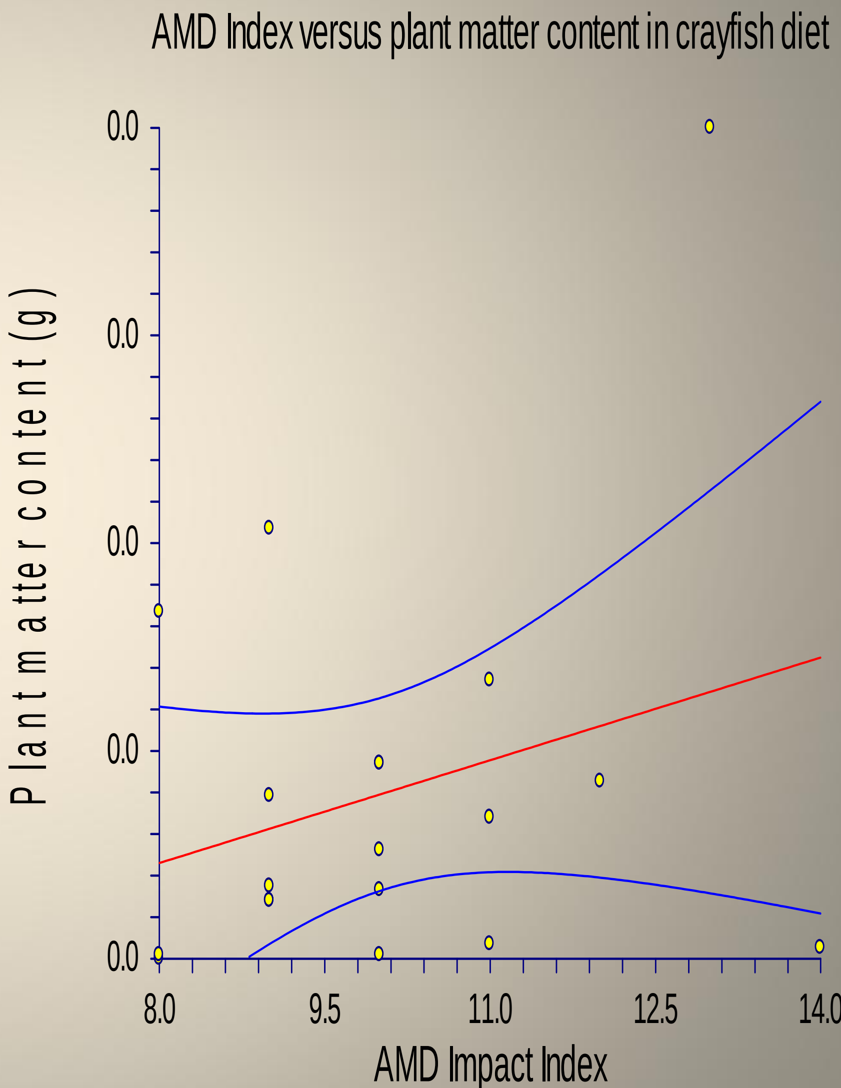
P = 0.29

AMD diet results contd.



R = 0.2362

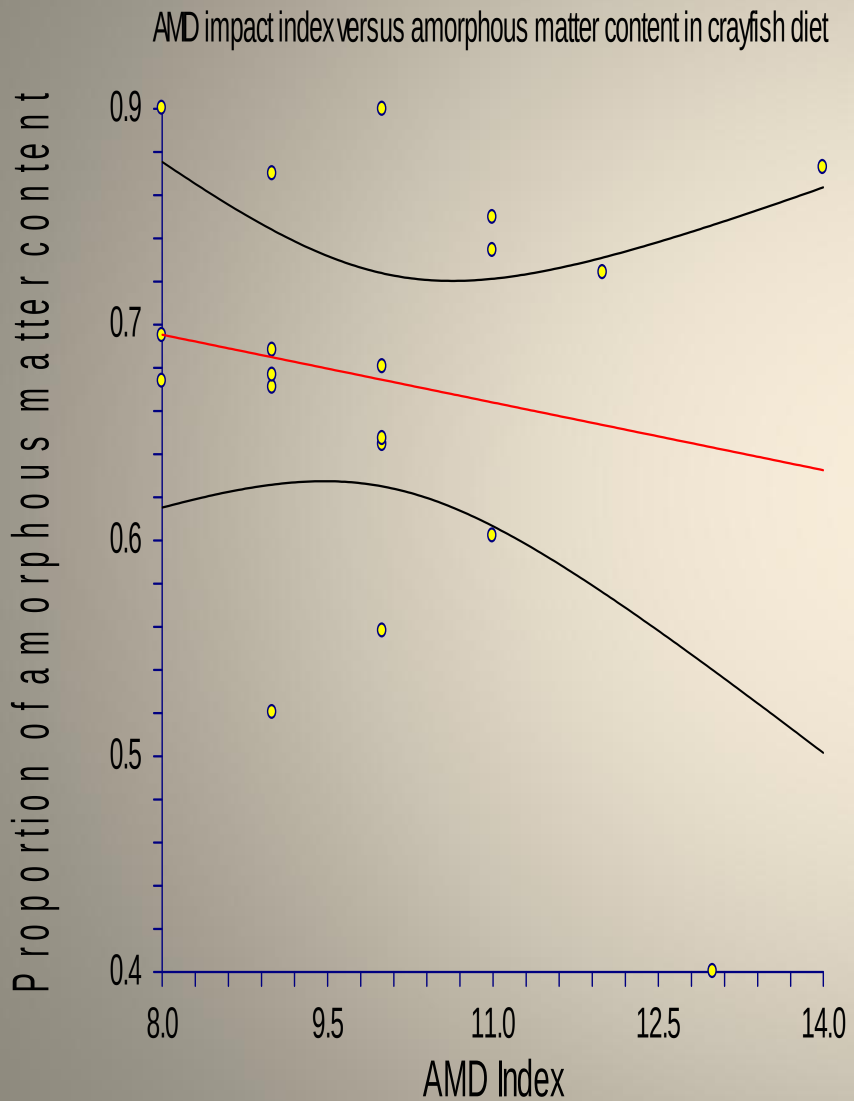
P = 0.3303



R = 0.2801

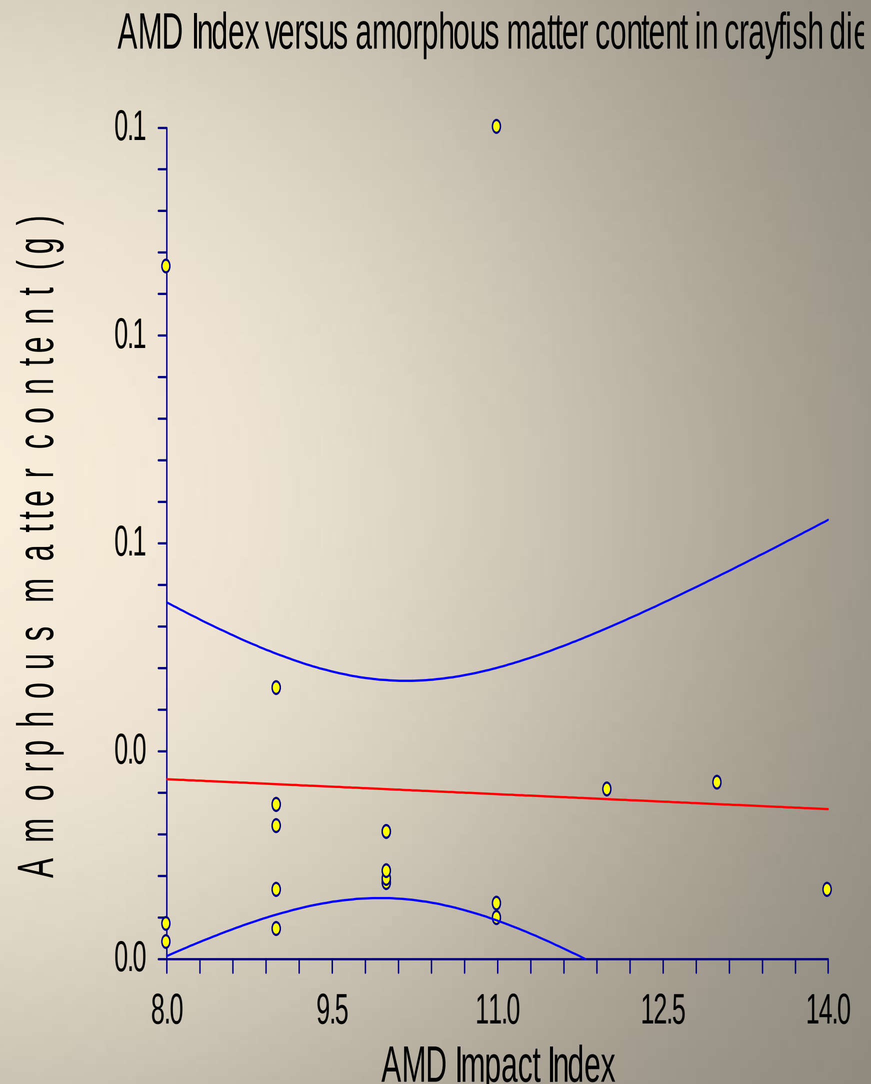
P = 0.2454

AMD diet results contd.



R = -0.1715

P = 0.4827



R = 0.0375

P = 0.8787

Multiple regression (Mercury, AMDI, Diet)

- **Estimated Model -** 163.42-9.61*AMD Index+ 3504.04*Animal matter-1091.51*Plant matter- 245.23*Amorphous matter
- Standardized partial regression coefficients

AMD Index = -0.6685

Animal matter = 0.6069

Plant matter = -0.2499

Amorphous matter = -0.2692

Conclusions

- AMD does not **appear** to have a significant effect on the proportions of dietary items in *O. sanbornii.*
- Animal matter content **appears** to be the major dietary driver of mercury bioaccumulation in *O. sanbornii.*

Future Directions

- Food web structure

- Species composition

- Expanded study

- Gut content analysis
- Size class analysis

- Collaborations invited – ea236905@ohio.edu

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