Invasion Dynamics and Community Changes in Hardwood Forests Following the Arrival of Asian Jumping Worms

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Acknowledgements

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• Basic earthworm ecology

• The effect of earthworms on the environment

• Asian jumping worms
  o Background
  o Research questions
  o Methods and study site
  o Results
  o Conclusions and future research
Earthworm Functional Groups

**epigeic** - litter dweller

**endogeic** - topsoil dweller

**anecic** - subsoil dweller
Earthworms influence the physical, chemical, and biological properties of the soil through:

- Burrowing
- Casting
- Feeding
- Mucus secretion
- Death/decomposition

The effects of the above depends on the functional group of earthworms.

Changes to the Soil Environment

**Physical**
- Mixing of the soil profile
- Incorporation of organic materials
- Water infiltration & holding capacity
- Soil aeration
- Soil erosion
- Soil structure & aggregate formation

**Chemical**
- Nutrient pools and dynamics
- Change soil cation-exchange capacity

**Biological**
- Micro/Macro organisms
- Nematodes
- Food source for birds and mammals
- Plant productivity
Amynthas spp. (Jumping worm)

- Native to Asia; commonly found in grasslands
- Hundreds of species and affiliated genera worldwide
- First WI record at the Arboretum in 2013
- Listed as “restricted” under WI NR 40
- Three most common species that co-occur in upper Midwest include:
  - A. tokioensis
  - A. agrestis
  - M. hilgendorfi
- All three are epi-endogeic and parthenogenic
How do the vegetation and forest floor characteristics compare in Arboretum forests with and without *Amynthas*?

Has the distribution and abundance of *Amynthas* in Arboretum forests changed over time?
Data Collection

1m² vegetation plots surveyed in July/August 2015-2018

0.36m² earthworm abundance plots surveyed in August/Sept. 2015-2018

Other measurements: Litter depth and biomass, soil pH, and soil moisture.
Methods
Results

*Amynthas* spp.
Mean = 15 per plot
Max = 37 per plot

European spp.
Mean = 22 per plot
Max = 92 per plot

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European abundance in plots with *Amynthas*
Mean = 3 per plot
Max = 41 per plot
Results

Amynthas spp.
Mean = 10 per plot
Max = 49 per plot

European spp.
Mean = 19 per plot
Max = 50 per plot

Amynthas spp. increased 7 ha between 2015 and 2016; European species decreased by 7 ha.
Results

- Generally plots with *Amynthas* spp. had higher plant species diversity (only significant in 2015).
- Generally plots with European earthworms had lower plant species diversity (not significant).
- Leaf litter biomass was greater in plots with *Amynthas* spp. but significantly lower in plots with European species.

Results: Leaf Litter Depth

Plots with *Amyntas* present had deeper leaf litter

Plots with European earthworms present had shallower leaf litter
Results

**Amynthas spp.**
- Mean = 7 per plot
- Max = 26 per plot

**European spp.**
- Seven individuals found in three plots.
**Results**

*Amyntahas* spp.
Mean = 9 per plot
Max = 42 per plot

European spp.
Ten individuals found in two plots

Over four growing seasons, *Amyntahas* spp. invaded approx. 10 ha; European species decreased by approx. 12 ha.
Results

Mean Species Richness in Original *Amynthas* Plots

Mean Number of Sugar Maple Stems in Original *Amynthas* Plots
Results

Distribution and abundance of two *Amynthas* species

7:3 mean ratio of *A. tokioensis* to *A. agrestis* in 2017; 9:2 in 2018
Conclusions and Considerations

• *Amynthas* does not appear to have negative consequences on plant diversity or litter depth/biomass.

• However, time since initial invasion may have an effect on sugar maple density.

• *Amynthas* spread rapidly and displaced European species.

• *A. tokioensis* is more abundant and more widely distributed compared to *A. agrestis*. 
Conclusions and Considerations

• Invasion by European species preceded *Amynthas*.

• Sampling time may miss some changes caused by *Amynthas*.

Future Analyses

• Further investigation the effect of time since invasion on the vegetation and forest floor community

• Potential impact of high vs low abundance of *Amynthas*

• Species effects of *A. tokioensis* and *A. agrestis*
Questions?
Results

Distribution and Abundance of two *Amynthas* species

7:3 mean ratio of *A. tokioensis* to *A. agrestis* in 2017; 9:2 in 2018
Results: Plant species richness

- Species richness was significantly higher in plots with *Amynthas* present in 2015.
- Species richness did not change significantly based on presence of European earthworms.
- Sugar maple abundance did not change significantly based on any

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Results

2015 Earthworm Abundance by Type

Number of Earthworms

- Amynthas
- European
- European with Amynthas

Mean vs Max
Earthworms have considerable capacity to **change the nature of their environment to suit their survival.** Ecological requirements (moisture, temperature, and food supply) greatly influence the rates of reproduction and growth.