Invasive Earthworms

*Amynthas* spp.

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Earthworms general biology, phenology and ecology

**Adult vs Juvenile Earthworms**

*Clitellum*
Ecological groups of earthworms

- **Lumbricus terrestris**
  - Anecic
- **Lumbricus rubellus**
  - Endogeic, epigeic, or epi-anecic
- **Aporrectodea spp**
- **Allolobophora spp**
  - Endogeic

**Are all earthworms invasive?**

- In Northeast, no native earthworm species since 11,000-15,000 years ago
- Forest ecosystem evolved to survive without them
- ~30 species of earthworms are introduced
- In the 1600s, European settlers brought European earthworms to North America

**Beneficial or Damaging?**

- Important for soil health “intestines of the earth”:
  - Aerate the soil
  - Decompose decaying plant and animal materials
  - Enrich fertility in farmlands and gardens
  - Contribute to microorganisms communities
  - Dethatch turf, decreasing insect and disease occurrence

**Forest health**

- [Great Lakes Earthworm Watch](http://greatlakeswormwatch.org/forest/index.html)
Effect of earthworm presence on forest understory

- Losses of native understory plant species and tree seedlings
- Changes in soil structure
- Declines in nutrient availability
- Affect small mammal, bird and amphibian populations
- Increase the impacts of herbivores like white-tailed deer
- Facilitate invasions of other exotic species such as European slugs and exotic plants like buckthorn and garlic mustard
- Threatens biodiversity stability of native hardwood forest ecosystems

Forest soil profile without and with earthworms

Earthworms as pests in urban systems
The status of earthworm

- No product registered to control earthworm
- They are BENEFICIAL

Common earthworm species

**Nightcrawlers**

- Scientific name: *Lumbricus terrestris*
- Length: 3.5–12”

Earthworm species common in turfgrass

**Red head worms**

- Scientific name: *Lumbricus rubellus*
- Length: 1–4”

**Pale worms**

- *Allolobophora* spp. and *Aporrectodea* sp.
Poll question # 1

1. Have you ever seen the crazy/snake worm infestation?
   - Yes, at least at one location
   - No, but heard about them from the customers or/and colleagues
   - No, never seen or heard about them
   - I am not sure what they are

“Crazy” worms’ species complex

- *Amyntha agrestis* - 1939, Baltimore, MD (A)
- *Amyntha tokiensis* – 1947, New York City, NY (B)
- *Metaphire hilgendorfi* – 1948, Kingston, NY (C)

Snake worms

- Originally from Japan and/or Korea
- Fast moving, very active
- Close to surface / epi-endogeic
- Voracious feeders
- Soil looks very grainy at the surface, like coffee grounds
Reports in MA in 2020 season

Why in 2020?
- Mild winter
- Warm weather patterns
- People more aware and vigilant

European vs “snake” worms

1) FEEDING HABITS
- Voracious feeders
- Tolerate to inhabit areas in high densities
- Turn soil into coffee ground:
  - aeration and drying out roots
  - higher level of nutrients available

2) ECOLOGY
   Epigeic or epi-endogeic – litter dwelling

European vs “snake” worms

3) RATE OF REPRODUCTION
- Parthenogenesis: do not need to mate
- Produce 1-2 eggs per cocoon
- Each worm can produce about 60 cocoons per season

4) LIFE CYCLE
- Mature faster than European earthworms
- Active all summer
- Adaptable to range of the temperatures
Life cycle of night crawlers

- Mating: April
- Hatching in 2-3 weeks
- Growth 2-3 weeks
- Develop clitellum by 6th week
- Takes 1 year to mature
- Dormant in the summer
- Juveniles abundant in the late spring, fall
- Longevity 4-8 years

Amynthas life cycle

- Cocoon overwinter and hatch in late spring
- Reach reproductive maturity by summer
- Annual life cycle
- Do not undergo dormancy in summer
- Adults cannot survive winter

Temperature sensitivity

- Minimum survival threshold 41° F
- Maximum survival threshold 95°F
- Favorable range 54°F - 77° F
- Cocoon do not hatch at 40 °F and lower
- Most hatching occurs at 50 °F
- Immatures hatch 5-6 weeks after warm up

Amyntas hupeiensis on golf course

INVASION OF THE GREEN STINKWORMS

Photos by Daniel A. Potter
*Amyntas hupeiensis* on the golf courses

**How to ID?**

**ID characteristics**
- Clitellum shape and color
- Color of the worm

**ID characteristics**
- "Grainy" Soil
- Movement
Dispersal
Natural dispersal – 40 ft per year

Poll question #2
What are the visual cues that help to identify crazy worms? Choose All that apply
- White clitellum, located close to the head
- Flattening the tail while moving
- Fast thrusting movements, resembling snakes
- "Coffee ground" appearance of the soil at the site of infestation

Management
Saponins and Earthworm control
- Tea-seed meal or extract containing triterpene saponins
- Irritates/destroys earthworm mucus
- Early Bird™ organic fertilizer containing tea extract
• Nothing is registered as earthworm control
• Most of them are beneficial
• No longer produced
• Not labeled for the raised beds

Extracting
• Hot mustard extraction: ~ 2-3 oz of hot mustard powder per 1 gal of water
• 1 pint of solution per 1 sq. ft
• 10–15 min

Soapy flush – adults (disclosing solution)
• 1 or 2 Tbsp lemon-scented liquid detergent
• 1 or 2 gallons of water
• Spread over area 1 or 2 feet

Heat kills the worms and cocoons
• Study shows that 104°F kills the cocoons (Blackmon et al. 2019)
• Commercially produced compost must be heated to 131°F

Pitfalls:
• Dirty equipment
• Cold spots
• What about plants?
Caution when brining/moving mulch and compost

• Buy certified compost and mulch: ensure that compost goes through specified heating procedure (temperature and duration) – 104F kills the cocoons
• Make sure that compost worm free: in the spring is challenging – only cocoon are present, hard to notice

Heat kills worms

• Solarization
• Several weeks
• Turf?

Plants

• Earthworms avoid biochar treated areas for 4.5 (Tammeorg 2014)
• Most likely due to water potential, elevated pH
• Benefits for earthworms were documented as well

Biochar and earthworms
Poll question # 3

TRUE OR FALSE.

Earthworms are considered to be beneficial, so there is no chemicals or other product labeled or registered for earthworm control.

The non-target effect of chemicals on earthworms survival and behavior

Wetting agents/ surfactants

- Used to achieve uniform moisture distribution
- Usually at the high maintained turf
- Many different chemistries
- Empirical observations on reduced activity/ castings in the area where these chemicals were used regularly

Toxicity assays

- Petri dish assays
- Earthworms were directly exposed
- Early Bird was included as positive control
- Wetting agents and insecticides of different classes were included
Results

- No toxicity of wetting agents on earthworms was observed
- Early bird TM fertilizer caused mortality within 24 h
- Insecticides caused delayed mortality
- Insecticides classes that affected earthworms: organophosphates and neonicotinoids
- Anthranilic diamides had no apparent effect on earthworms survival

Choice assays

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<tr>
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<th>TRT</th>
<th>Control</th>
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<tr>
<td>HydroMax</td>
<td></td>
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<tr>
<td>Revolution</td>
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<tr>
<td>Early Bird</td>
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Escape Assays

- To measure repellency
- 24 h of acclimatization
- Treatment applied
- Arenas observed for 72h

Escape time ET50

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<tr>
<th>TRT</th>
<th>Night crawlers</th>
<th>Jumping worms</th>
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<tbody>
<tr>
<td>Control</td>
<td>57.7 (55.3 – 60.6)</td>
<td>37.8 (33.4 - 42.3)</td>
</tr>
<tr>
<td>WA: Revolution™</td>
<td>18.4 (16.3 – 20.5)</td>
<td>11.6 (9.5 - 13.9)</td>
</tr>
<tr>
<td>WA: HydroMax™</td>
<td>15.0 (12.9 – 17.3)</td>
<td>6.2 (4.9 – 7.5)</td>
</tr>
<tr>
<td>WA: TriCure™</td>
<td>5.8 (4.9 – 6.8)</td>
<td>9.4 (8.1 – 10.7)</td>
</tr>
<tr>
<td>Fertilizer: RizoAid™</td>
<td>13.4 (11.4 – 15.7)</td>
<td>19.0 (17.0 – 21.5)</td>
</tr>
<tr>
<td>Fertilizer: Early Bird™ G</td>
<td>9.8 (8.9 – 10.7)</td>
<td>6.9 (6.3 – 7.6)</td>
</tr>
<tr>
<td>Fertilizer: Early Bird™ L</td>
<td>11.4 (9.9 – 12.9)</td>
<td>4.2 (3.8 – 4.6)</td>
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Field trials

Thank you!
Questions?