

Ecological groups of earthworms

Lumbricus terrestris
Anecic

Lumbricus rubellus
endogeic, epigeic, or epi-anecic

Aporrectodea spp.
Allobophora spp
endogeic

Anecic burrow entrance called "mucilage" can be surrounded with a mound of cast material (brown poop) and covered with debris (fragmented leaf parts)

Epigeic

- Litter dwellers, feeder
- Pigmented skin
- No burrows
- Small size

Epi-Endogeic

- Feeds on just beneath litter
- Pigmented skin
- Burrows shallowly
- Moderate size

Anecic

- Fresh litter feeder
- Soil dweller
- Pigmented skin
- Digs deep, vertical, glistening burrows
- Large size

Endogeic

- Soil dweller
- Minimal soil dweller (10-50 cm)
- No skin pigmentation
- Creates a network of horizontal, branching burrows
- Small to medium-sized

Three major ecological groups of earthworms have been identified based on the feeding and burrowing behaviors of the different species

Anecic burrows may reach depths up to two meters!

Earthworms in the Ecosystem © Rick Kollath

Are all earthworms are 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":

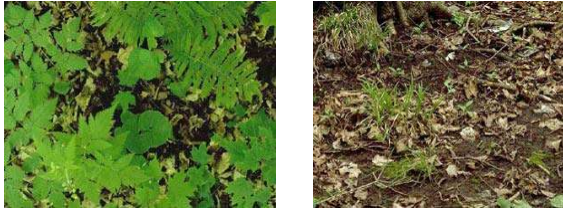
- aerate the soil
- decompose decaying plant and animal materials
- enrich fertility in farmlands and gardens
- contribute to microorganisms communities
- dethatch turf, decreasing insect and disease occurrence

Forest health



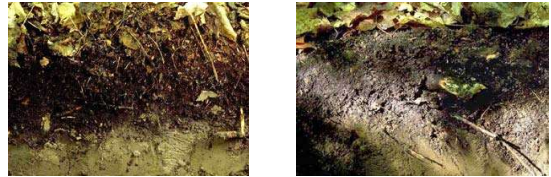

<http://greatlakeswormwatch.org/forest/index.html>

Effect of earthworm presence on forest understory



<http://greatlakeswormwatch.org/forest/index.html>

Forest soil profile without and with earthworms



<http://greatlakeswormwatch.org/forest/index.html>



- 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

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"



Lumbricus rubellus
(approximate length 10 cm)



Photo: Malcom Storey

Common earthworm species Pale worms

- *Allolobophora* spp. and *Aporrectodea* sp.



David T. Jones



David T. Jones



Trustees of the Natural History Museum



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

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



Photo: Maria Johnston



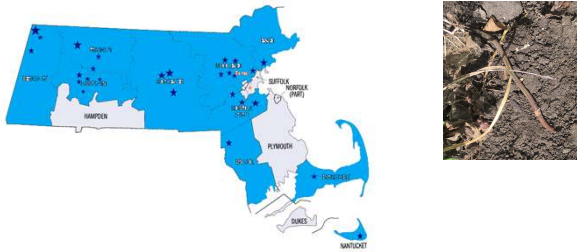
Chang et al. 2016

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



November 11, 2013

IN THE GARDEN

The New York Times

As Summer Takes Hold, So Do the
Jumping Worms

7/11/2013 11:00 AM

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

Amyntas life cycle



Photo: Marc Johnston
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

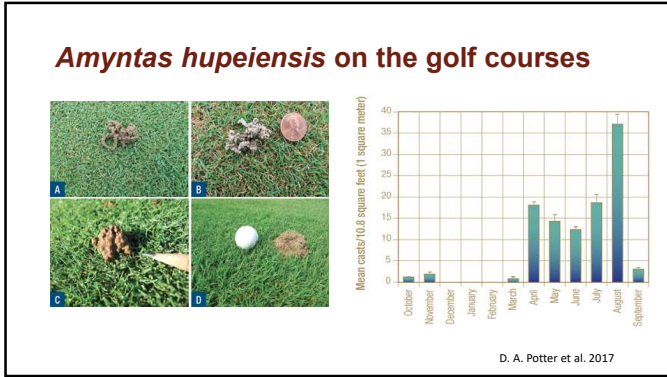
- Minimum survival threshold 41° F
- Maximum survival threshold 95° F
- Favorable range 54° F - 77° F
- Cocoon do not hatch at 40 °F and lower
- Most hatching occurs at 50 °F
- Immatures hatch 5-6 weeks after warm up

Blackmon 2009

Amyntas hupeiensis on golf course INVASION OF THE GREEN STINKWORMS



Photos by Daniel A. Potter



ID characteristics

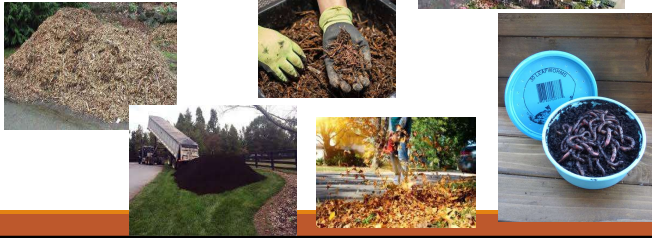
- Clitellum shape and color
- Color of the worm

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)







Photo: P. J. Vitum

- 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 104F kills the cocoons (Blackmon et al 2019)
- Commercially produced compost must be heated to 131 F

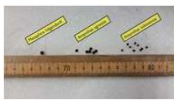
Pitfalls:

- 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



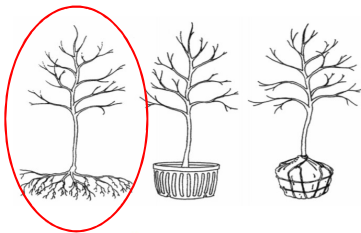
Photos: UW Extension, Williams and Johnson

Heat kills worms

- Solarization
- Several weeks
- Turf?



Plants



Biochar and earthworms

- 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



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

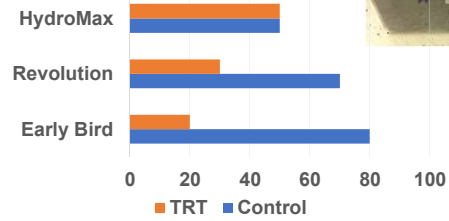
Toxicity assays

- 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



Escape Assays

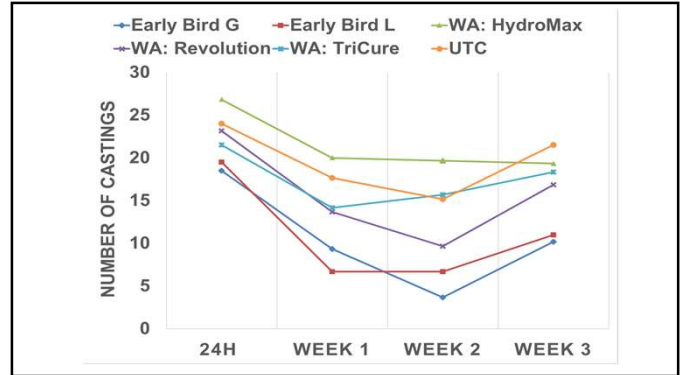
- To measure repellency
- 24 h of acclimatization
- Treatment applied
- Arenas observed for 72h



Escape time ET50

| TRT | Night crawlers | | Jumping worms | |
|---------------------------|--------------------|------|--------------------|------|
| Control | 57.7 (55.3 – 60.6) | | 37.8 (33.4 - 42.3) | |
| WA: Revolution™ | 18.4 (16.3 – 20.5) | 3.1* | 11.6 (9.5 - 13.9) | 3.3* |
| WA: HydroMax™ | 15.0 (12.9 – 17.3) | 3.9* | 6.2 (4.9 – 7.5) | 6.1* |
| WA: TriCure™ | 5.8 (4.9 – 6.8) | 9.9* | 9.4 (8.1 – 10.7) | 4.0* |
| Fertilizer: RizoAid™ | 13.4 (11.4 – 15.7) | 4.3* | 19.0 (17.0 – 21.5) | 1.9* |
| Fertilizer: Early Bird™ G | 9.8 (8.9 – 10.7) | 5.9* | 6.9 (6.3 - 7.6) | 5.5* |
| Fertilizer: Early Bird™ L | 11.4 (9.9 – 12.9) | 5.1* | 4.2 (3.8 – 4.6) | 9* |

Field trials



Thank you !
Questions?