Title: Quantifying Asian worm population density and their impact on soil organic matter & turf cover

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Abstract: The investigation quantifies the change in organic matter, soil chemistry and turf quality in the presence of Asian worms. These worms degrade organic matter at a pace exceeding European worms or in landscapes devoid of worms and consume live plant material. Ammonium levels were found to be significantly lower when worms were present in the soil/container plots. Hardwood mulch plots with worms were significantly greener, likely due to the release of mulch's nutrients during worm feeding. There was not a significant difference in root, clipping or thatch mass with and without worms in the three treatments (hardwood mulch, compost or control, no mulch). Significant unexplained reduction in Asian worm populations in landscapes during 2018 compared to recent years were observed in several areas of NYS.

The habitat range of Asian worms is expanding from introduction in Southern Appalachia into the Northern Tier states. Better understanding of the destructive nature of these worms can lead to an appropriate management plan. Described as a forest invasive pest, it is also found in turf and landscape beds. Forest duff, mulches and composts degrade where populations of these worms are found. Correlating worm populations and organic matter degradation rates enables more accurate management strategy efforts.

Background/justification:

Asian worms were apparently unintentionally introduced into North America in the late 1800s in Southern Appalachia. They now found in the Midwest (Michigan, Ohio, Wisconsin), the Northeast (New York, Pennsylvania and New England) and the Northwest (Oregon). Described as a forest invasive pest, it very efficiently degrades the forest floor organic matter to their castings, resulting in an altered plant community that evolved without worms in the post ice age era. There is acknowledged change in soil surface structure. (K.M. Laushman et.al. Univ. Wisconsin 2017)

Confirmed locally, compost and mulch in landscapes appears to degrade more rapidly when Asian worms are present than areas without worms or only European worms (W. Nelson gardener per. corr. 2017). Less understood is how their number changes may be impacted by the amount of organic matter present.

Worm castings adversely impact ball roll on putting greens. (D.A. Potter Univ. Kentucky 2013) The castings create an environment less hospitable for native fungi and soil microbe life and seed germination. (ibid Univ. Wisconsin)

Threshold damage quantification is unavailable. (K. Wickings pers. comm. literature search 2017)

Appropriate management practices under investigation by others (ibid D. Potter, Univ. Kentucky; J. Gorres Univ. Vermont 2014) can be optimized with greater threshold understanding. Without registered pesticides, changing cultural practices is an option for slowing worm distribution. Changes in cultural practices may not be necessary in areas minimally or uninfested with the worms.

Turf managers initial concern related to casting mounds were clarified. Casting mounds relate to the European earth worm not the Asian species. A casting layer left on the surface left by Asian worms degrades that surface (spongy and or granular) for traffic and is of concern for turf managers. This study was unable to replicate the sponginess. The granular casting 'topdressing' was evident in the greenhouse study. The field study, and outside of the study reliable reports and observations confirm these changes in the turf surface.

The landscape industry's regulatory concern relating to unintentionally moving these worms was not studied. A greater understanding of where they might reside and how to minimize their unintended movement during the activities of landscape commerce is an appropriate education opportunity. The surge release of nutrients from organic matter (mulch, compost) could lead to nutrients passing beyond root zones more rapidly, in contrast to their slower release during organic matter breakdown in the absence of the Asian worms.

Objectives:

1) Quantify and evaluate the change in turf quality resulting from the presence of Asian worms.

2) Quantify the rate of mulch consumption, tracking change in mass and depth of mulch.

3) Ascertain any feeding preferences in amendments by Asian worms.

4) Compare differences in amendment removal rates. Quantify and evaluate the relationship between the number of worms in a given area and the organic matter content and type of that soil.

5) Comparing habitat preference between a turf cover and mulch/amendment cover over the soil.

6) Assess any reduction in turf quality in the presence of the Asian worms.

7) Evaluate the relationships between worm populations and percent soil organic matter.

Procedures:

1-6) A Summer Scholar in the Wicking lab looked for a change in soil composition and turf density relatable to worm populations in containers with greenhouse grown turf. A two compartment box with loamy sand soil, watered to field capacity, was inoculated with worms over one of three mulches (hardwood mulch, leaf mold compost, soil only no mulch) in half of the tray in June. Sod covered the second half of the tray. A coarse screen barrier separates the two sections.

At intervals, three destructive censuses of the trays July, August, October measured percent organic amendment remaining and percent organic matter in underlying soil and a count of adult worms and cocoons. The location of the worms (amendment vs. turf side of the box) and an assessment of turf color and density was recorded.

7) Early summer baseline assessment of worm population, organic matter content and soil texture via density separation [Day, P.R. (1965)]. Particle fractionation and particle-size analysis. In C.A. Black, D.D. Evans, J.L. White, L.E. Ensminger, F.E. Clark. (Eds.) *Methods of soil analysis (part 1) Physical and Mineralogical Properties, Including Statistics of Measurement and Sampling*. Madison, WI: American Society of Agronomy, Inc.) in landscape situations in 3 NY Counties (Broome, Monroe & Rensselaer).

Representative sample of soil 3 inches deep (less any surface organic duff) removed from a site with a previously known population of worms and submitted for organic matter determination. Texture by feel assessment of the site in May & October.

A core of soil 0.1 sq. ft. and 3 inches deep extracted, crumble and submerged in water. The floating empty cocoons counted. (protocol ibid Univ. Wisconsin)

An adjacent site will be drenched with a mustard solution flushing adult worms to the surface for counting, using a protocol developed by the Univ. of Minnesota (http://nrri.d.umn.edu/worms/research/methods_worms.html).

Cocoon and adult worms from the May census become a site's population baseline. A second sample for organic matter, adult and cocoons in October reports population change.

Results & discussion objectives 1-6

There was strong evidence that worms are breaking down soil organic matter proteins. The worms did not appear to break down chitin. Ammonium levels were significantly different in boxes with worms present. The soil nitrogen increase significantly 'greened' turf in boxes with hardwood mulch. The turf 'greening' was not significant in the compost boxes. This 'greening' could be seen as a short term positive benefit (nutrients availability to the grass) when worms are present. Longer term this is less desirable as the nutrient reservoir prematurely depletes and there is risk of nitrogen loss to surface or ground water. Without worms, mulches and forest litter slowly breaks down, providing 'time released' nutrients.

The percent organic matter in the three treatments profiles (hardwood, compost, control) with and without worms was not significant. Root, clipping and thatch mass was not significant between worm and no worm boxes.

Relatively small, confined spaces did not appear to foster healthy Asian worms. Mortality increased as the study progressed. This may be due to limiting the amount of mulch forage available to the worms over time. The study was designed to assess their impact on turfgrass. Limiting other forages encouraged their movement to the turfgrass. That was successful, as most worms were found on the turf side of the boxes during destructive harvests.

The greenhouse study was unable to find a difference in feeding preference between hardwood mulch and compost, as the mulches were quantity-limited. Organic matter differences with and without worms in all mulch treatments was not significant.

Results of objective & procedure 7

Soil moisture may impact worm population numbers. There was not consensus for reason(s) in reduced landscape population numbers during the 2018 growing season in contrast to previous years. A suggestion was low soil moisture, as two sites were very dry. A dozen other sites with low populations in 2018 compared to previous years had ample to excessive moisture.

Site one is a clay loam soil pH 6.8 in a perennial flower bed covered with chopped leaf mulch. Initially seven worms were flushed per square foot and no cocoons found. The end of season assessment yielded eight worms and no cocoons.

Site two a clay loam soil with 7.8 pH in a perennial flower bed with a chopped leaf mulch. Initial flush yielded five worms and no cocoons. The end of season assessment collected six worms with no cocoons found.

Site three is a silt loam with a neutral pH in a perennial flower bed without mulch. The initial flush harvest was two Asian worms and no cocoons. The end of season assessment found two Asian worms, four pigmented worms and two cocoons.

Site four is a sand soil with 7.4 pH in a perennial flower bed with pine bark mulch. The initial flush harvest was one Asian worm and no cocoons. The end of season flush yielded no worms or cocoons.

Site five is a clay loam soil with 7.4 pH. It is a deep forest-edge repository of leaves. The average initial flush in twelve assessments averaged twenty-five Asian worms/square foot. No worms were flushed in the final assessments. No cocoons were found. The leaf repository remains significant, although degradation is taking place.

Worm castings present in all sites (2017 & 2018) appear as those of Asian worms. Visually, the four beds and the leaf storage area assessed were minimally changed from June to October. Lack of rain in the early summer may have contributed to the absence of

worms in the October assessment in the fourth and fifth sites. There was ample to excessive rainfall at sites one, two and three with insignificant change in worm numbers. Field study worm population differences did not vary based on soil type. The small sample size may cloud that conclusion.

The assessed sites were selected based on higher worm numbers in the previous year. Numerous reports, not part of the study, from the Southern Finger Lakes and the Lower Hudson Valley noted dramatic decline of Asian worms in landscape beds compared to previous years. These observations were in areas with ample growing season precipitation.

Asian worms are characterized as a forest invasive species. Numerous reports across the State of their presence in mulched landscape beds, degrading the mulch and thinning or creating a spongy surface in turfgrass, lead to this investigation.

A broader multi-year census of Asian worms is necessary to quantify their presence in landscape areas and the ongoing impact they (may) have there. Unanswered is the question: Why the apparent decline in their numbers in 2018 in landscape areas?

Greater understanding of Asian worm impact in ornamental landscape and turfgrass could be an outcome of increased awareness of this worm among gardeners and landscape caretakers. Without greater reported adverse impact in these areas there may be less interest in quantifying their presence. This contrasts reports and observations of numerous Asian worms and degradation of mulch in previous years.

The Southern Finger Lakes, Lower Hudson Valley and the Greater Rochester area, have previously reported antidotal and empirical observation of degraded landscape mulch with large numbers of Asian worms present. Assessing Asian worm populations in these areas would likely be more fruitful in demonstrating their impact in the landscape ecology.

Winter meetings and articles (electronic publication & social media to the nursery landscape industry; electronic publication & social media to gardeners) are scheduled in the first quarter of 2019, reporting results of this study. Preliminary results were presented by the Summer Scholar as her final report in the project. She also intends to submit this study as a senior project.

The Asian worm more rapidly degrades mulches than European worms or when compared to areas without worms as evident by the field study and field observations beyond the study. Mulch use in landscapes and or movement of mulch and plant material could introduce the Asian worms to a new area.

Vocal stakeholder interest in Asian worms adversely impacting landscape beds in several areas of the State was a motive for the field study. Similar reports of degrading turfgrass in the presence of these worms led to the greenhouse portion of the study.