Heavy metal contamination in urban vacant lots and its influence on structure and function of the soil food web

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ABSTRACT

Increased demand for local produce and food security has escalated interest in utilizing urban vacant lots for food production. However, soil quality and heavy metal contamination are major concerns for urban agriculture. We determined the extent of heavy metal contamination in vacant lots in two post-industrial cities and nematode community was used as a surrogate to assess the condition of the soil food web. Both cities showed large spatial variation in soil metal contamination. Thirty-four nematode genera were identified, with most being plant-parasitic (14) followed by bacteria-feeding (12), omnivorous (5), fungal-feeding (2), and predatory (1), respectively. A decrease or absence of the more sensitive higher trophic levels and increased abundance of plant-parasitic nematodes indicated the disturbed nature of the urban soil food webs. Correlation analysis showed that the total, bacterial, and fungal feeding nematodes were negatively correlated with As and Cd concentrations. Nematode food web structural index showed positive correlation with all heavy metals, except Pb, and enrichment index was positively correlated with As and Cr. The ratio of non-plant parasitic to parasitic nematodes was negatively correlated with all studied heavy metals. We conclude that the opportunistic bacterivore and fungivore nematodes are more sensitive to metal contamination.

INTRODUCTION

- Heavy metal contamination poses a major concern to urban agriculture
- Metal concentration in soil may depend on the parent bedrock geochemistry and anthropogenic activities (Adriano, 2001)
- Health of the soil food web can be determined using nematodes community analysis due to their presence at multiple trophic levels and differing sensitivities to pollutants (Cheng and Grewal, 2009)

Objective: To determine relationships between soil heavy metal concentrations and the abundance of different nematode trophic groups and community structure indices

Hypothesis: Nematode trophic structure will be significantly affected by heavy metal contamination and lower trophic levels (bacteria and fungal feeding) will be more sensitive than the higher trophic groups

MATERIALS & METHODS

Study Area and soil sample collection
- 28 vacant lots in Hough Neighborhood in Cleveland and 15 in Weinland Park Neighborhood in Columbus, Ohio.
- Soil samples collected using a soil corer (2cm dia.) from a depth of around 10 – 12 cm.

Assessment of soil characteristics
- Soil pH and texture analysis (Gee et al., 1986)

Assessment of heavy metals in soil
- Acid digestion by EPA method 3051A followed by ICP-AES.

Nematode Community analysis:
- Nematodes extracted from 10g soil using Baermann funnel technique and identified and enumerated using ‘Interactive Diagnostic Key to Plant Parasitic, Free-living and Predaceous Nematodes’ by University of Nebraska
- Soil from vacant lots and nearby undisturbed forest areas was analyzed.

RESULTS

1. Level of disturbance in the urban vacant lots

Total number of nematodes (± S.E.) by trophic group (extracted from 10g soil) and their classification based on the colonizer-persister (c-p) scale in the two cities as compared to the numbers found in relatively undisturbed forest soil.

2. Correlation between soil heavy metals and phisical parameters with nematode trophic levels and community indices.

DISCUSSION & CONCLUSIONS

- As compared to other trophic levels, bacteria and plant-parasitic feeding nematodes were more abundant in URBAN vacant lots indicating nutrient enrichment of the soil.
- Low abundance of omnivorous and predatory nematodes indicated lack of structural and functional diversity in the soil food web.
- As compared to relatively undisturbed forest soil, higher trophic levels and higher colonizer-persister scale nematodes were absent in the urban lots, indicating a disturbed soil food web.
- Correlation analysis showed that the lower trophic levels, bacteriovores and fungivores were negatively correlated to the As and Cd concentrations supporting our hypothesis.
- Channel index was negatively correlated to As concentration representing a disturbed food web with a lower abundance of higher functional guilds required to perform essential ecosystem services such as a fungal decomposition pathway for complex organic matter containing high C:N ratio.
- The ratio of non-plant parasitic to parasitic nematodes was negatively correlated to the heavy metals, indicating an increased population of plant parasitic nematodes with increased pollution stress on urban soil.

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KEY REFERENCES