TITLE:

Data from: Field and lab conditions alter microbial enzyme and biomass dynamics driving decomposition of the same leaf litter

AUTHORS:

Zachary L. Rinkes

Dept. of Environmental Sciences

University of Toledo

2801 W. Bancroft St.

Mail Stop 604

Toledo, OH 43606

Robert L. Sinsabaugh

Dept. of Biology

University of New Mexico

Castetter Hall 184

Albuquerque, NM 87131

505-277-3407

rlsinsab@unm.edu

Daryl L. Moorhead

Dept. of Environmental Sciences

University of Toledo

2801 W. Bancroft St.

Mail Stop 604

Toledo, OH 43606

(419) 530-2017

<http://www.utoledo.edu/nsm/envsciences/faculty/weintraub.html>

A. Stuart Grandy

Dept. of Natural Resources and the Environment

University of New Hampshire

114 James Hall

Durham, NH 03824

(603) 862-1075

<http://pubpages.unh.edu/~asf44/>

Michael N. Weintraub

Dept. of Environmental Sciences

University of Toledo

2801 W. Bancroft St.

Mail Stop 604

Toledo OH 43606

419.530.2585

<http://www.utoledo.edu/nsm/envsciences/faculty/weintraub.html> michael.weintraub@utoledo.edu

FUNDING SOURCE AND GRANT NUMBER:

National Science Foundation, Ecosystem Program

Award # 0918718

PHYSICAL LOCATION:

Oak Openings Preserve Metropark, Northwest Ohio

Latitude: 41.55

Longitude: -83.83

DATA SET OVERVIEW:

This dataset includes information on leaf litter enzyme activities; extractable nitrogen and phosphate; microbial biomass; respiration; leaf litter mass loss; and field temperature and moisture conditions. Measurements are from parallel field and laboratory incubations. Both studies were conducted using four leaf litter types: flowering dogwood (*Cornus florida*), sugar maple (*Acer saccharum*), white oak (*Quercus alba),* and a 50/50 combination of sugar maple and white oak litter (i.e., mixed litter). Leaf litter was placed in 1 mm² mesh-size litterbags - either 15 cm x 15 cm for the field study or 6 cm x 6 cm for the lab study. The field study litterbags were replicated eight times for sugar maple, white oak, and mixed litter and six times for dogwood litter in each of eight plots. The lab study litterbags were placed in microcosms with soil and replicated four times for each litter type; each set of 4 was then replicated eight times. Sugar maple, white oak, and mixed litterbags were harvested eight times during the field and the lab study. Dogwood litterbags were harvested six times during the field study and eight times during the lab study.

BACKGROUND:

<http://www.eeescience.utoledo.edu/Faculty/weintraub/Projects.htm>

SAMPLE COLLECTION:

*Litter and Soil Collection*: Freshly senesced flowering dogwood (*Cornus florida*), sugar maple (*Acer saccharum)* and white oak (*Quercus alba)* leaf litter was collected weekly from the Oak Openings Preserve Metropark in Northwest Ohio using litter traps in October of 2009. Litter was air-dried and cut into 1 cm² pieces. For the laboratory study, soils were collected from a 10 m² area within the area used during the field study. Soils were collected using a metal soil corer with a diameter of 5 cm to a depth of 5 cm. Soils were then taken immediately back to the lab and sieved (2 mm mesh) to remove coarse debris and organic matter and then homogenized by hand. Soil was stored in the dark at 20 °C and 45% water holding capacity for 1 month prior to the lab litterbag experiment. For more information, see Rinkes *et al*. (2013).

*Field Study*: Eight 30 m² plots were selected from within a 2,000 m² study area. All plots were separated by at least 150 m and were located within 500 m of a micrometeorological (eddy flux) tower. Litterbags, 15 x 15 cm in size, were filled with 5 g of either dogwood, sugar maple, white oak, or a 50/50 sugar maple-white oak mixture. Each of the eight plots received 6 dogwood and 8 sugar maple, white oak, and mixed litter bags for a total of 240 litterbags throughout the study area. All litterbags were placed directly on the soil surface with at least 3 m between litterbags. Litterbags were harvested 0, 50, 120, 220, 337, 512, 641, and 849 days after deployment with the exception of dogwood that was harvested 0, 50, 120, 220, 337, and 641 days after deployment due to its rapid decomposition. Litterbags were harvested for enzyme activities; extractable nitrogen and phosphate; and leaf litter mass loss. During harvests, litter was extracted with 0.5 M potassium sulfate (K₂SO₄). Extractions were performed by placing samples on an orbital shaker at ~120 rpm for 1 hour, and then vacuum filtering the mixture through Millipore APM 15 glass fiber filters. These extracts are labeled as non-fumigated.

Samples were also harvested for microbial biomass. Microbial biomass carbon (MB-C) was quantified using a modification of the chloroform fumigation-extraction technique (Brookes et al. 1985; Scott-Denton et al. 2006). Following chloroform fumigation, litter was extracted as described above. These extracts were labeled as fumigated. Fumigated and non-fumigated extracts were then frozen until time of analysis.

The field study also included measurements of environmental variables (i.e., soil temperature and moisture) and respiration during the course of the study. For more information, see Rinkes *et al*. (2013).

*Laboratory Study:* Litterbags for the lab study were placed in 0.437 L Mason jars (Ball Pint Wide Mouth Canning Jars, Jarden Corporation) with lid and septa. Each treatment jar contained a litter bag containing 1 g of litter (one of the four types described above) and 100 g soil (dry weight equivalent). Soil-only control jars contained 100 g of soil (dry weight equivalent). Four jars of each litter type plus four soil-only control jars were replicated eight times and incubated in the dark at 20 °C. Jar lids were kept loose in order to minimize water loss while allowing gas exchange. Water loss was replenished gravimetrically on a weekly basis. Litterbags were destructively harvested after 0, 2, 34, 99, 161, 230, 312, and 376 days of incubation. Soil-only control jars were harvested less frequently. Litterbags and soil-only controls were harvested for enzyme activities; extractable nitrogen and phosphate; microbial biomass; and mass loss and extracted as described in the *Field Study* section. The lab study also included respiration measurements. For more information, see Rinkes *et al*. (2013).

DATA COLLECTION:

*Nutrients*: Nutrients were analyzed in both studies using non-fumigated samples. Nitrogen analyses included nitrate and ammonium. Nitrate was analyzed using the method described by Doane & Horwath (2003). Final nitrate values are reported in μg NO3⁻ g-1 dry litter or soil. Ammonium was analyzed using the method described by Rhine *et al*. (1998). Final ammonium values are reported in μg NH4+ g-1 dry litter or soil. Phosphate analysis was conducted using the method described by D’Angelo *et al*. (2001). Final phosphate values are reported in μg PO43- g-1 dry litter or soil. For more information, see Rinkes *et al*. (2013).

*Microbial Biomass*: Microbial biomass C and microbial biomass N were analyzed in both studies using fumigated and non-fumigated litter extracts. Samples were analyzed for dissolved organic carbon (DOC) and total nitrogen (TN) using a Shimadzu total organic carbon (TOC-VCPN) analyzer equipped with a total nitrogen unit (Shimadzu Scientific Instruments Inc., Columbia, MD, USA). Microbial biomass was calculated by subtracting non-fumigated sample concentrations of total organic carbon or total nitrogen from fumigated sample concentrations of carbon and nitrogen. Final values are reported in μg C or N g-1 dry litter or soil. For more information, see Rinkes *et al*. (2013).

*Enzyme Activities*: Hydrolytic and oxidative extracellular enzyme activities were analyzed in both studies. Samples were analyzed for β-glucosidase (BG), N-acetyl-β-glucosaminidase (NAG), Leucine amino peptidase (LAP) and phenol oxidase (PHENOX). BG produces glucose from the hydrolysis of cellulose oligomers; NAG, a chitinase, produces N-acetyl glucosamine from the hydrolysis of chitin derived oligomers; LAP produces leucine and other amino acids from the hydrolysis of peptides; PHENOX is an oxidative enzyme involved in lignin degradation. Hydrolytic enzyme activities (BG, NAG, and LAP) were analyzed using the fluorometric assay described by Saiya-Cork *et al*. (2002). Oxidative enzymes (PHENOX) were analyzed using the colorimetric assay described by Saiya-Cork *et al*. (2002).

*Respiration Analysis*: Respiration was measured in both studies. Jars were vented for two minutes and then tightly sealed and incubated at 20°C for minutes to hours. During the lab study, respiration was measured after 0, 1, 2, 3, 5, 7, 8, 25, 43, 53, 78, 99, 139, 161, 230, 259, and 376 days of incubation. Respiration was measured by injecting gas samples collected from the headspace of each jar into a Li-820 Infra-Red Gas Analyzer (LI-COR Biosciences, Lincoln, Nebraska, USA) setup for static gas injections. Final respiration values are reported in μg C g-1 dry soil hour or day-1. For more information, see Rinkes *et al*. (2013).

*Mass Loss*: Mass loss was determined during both studies by measuring litter initial and final mass. Mass loss is reported as litter mass remaining in percentage of initial mass.

NAMING CONVENTIONS:

The following refer to headers or terms used in the data spreadsheets:

*General definitions:*

litter type: dogwood (Cornus florida), sugar maple (Acer saccharum), white oak (Quercus alba), or 50:50 maple oak mix

replicate: replicate number

month: month of harvest

year: year of harvest

harvest day: day of harvest (in terms of days after incubation start)

blank cells=no data available; cell value = 0 means no activity

*Harvests:*

Mass: Litter mass remaining, % of initial mass

BG: Beta glucosidase activity, µmol hr-1 g-1 litter (fluorescent enzyme assay protocol)

NAG: N-acetyl-beta-glucosaminidase activity, µmol hr-1 g-1 litter (fluorescent enzyme assay protocol)

LAP: Leucine aminopeptidase activity, µmol hr-1 g-1 litter (fluorescent enzyme assay protocol)

PHOS: Phosphatase activity, µmol hr-1 g-1 litter (fluorescent enzyme assay protocol)

NH4: µg NH4-N g-1 litter from 0.5M K2SO4 extractions using microplate assay

NO3: µg NO3-N g-1 litter from 0.5M K2SO4 extractions using microplate assay

PO4: µg PO4-P g-1 litter from 0.5M K2SO4 extractions using microplate assay

PHENOX: Phenol oxidase activity (ABTS as substrate). µmol g-1 litter hr-1 (colorimetric microplate protocol)

MBC: microbial biomass C, ug C g-1 litter, measured in 0.5 M K2SO4 extract on Shimadzu analyzer

TOC: Total dissolved organic C, ug C g-1 litter, measured in 0.5 M K2SO4 extract on Shimadzu analyzer

TN: Total dissolved N, ug N g-1 litter, measured in 0.5 M K2SO4 extract on Shimadzu analyzer

MBN: microbial biomass N, ug N g-1 litter, measured in 0.5 M K2SO4 extract on Shimadzu analyzer; TN and MBN data are not available for October 2011 field harvest

CO2: µg C g-1 litter hour (field) or day (lab)-1 (measured using IRGA with static injection method under lab conditions; incubation time was around 1 hr)

*Environmental Variables*

Date/Time: date and time of measurement

Soil moisture: soil moisture, %

Soil temp: soil temperature at 5cm and 20cm, degrees C

Precipitation: measured in millimeters

Air temperature: measured in °C

NAN = no data available

LINKS:

<http://www.eeescience.utoledo.edu/Faculty/weintraub/Projects.htm>

REFERENCES:

Brookes, P.C., Landman, A., Pruden, G., Jenkinson, D.S., 1985. Chloroform fumigation

and the release of soil nitrogen: a rapid direct extraction method to measure

microbial biomass nitrogen in soil. Soil Biology & Biochemistry 17, 837e842.

D'Angelo, E., Crutchfield, J., Vandiviere, M., 2001. Rapid, sensitive, microscale determination of phosphate in water and soil. J. Environ. Qual. 30, 2206-2209.

Doane, T.A., Horwath, W.R., 2003. Spectrophotometric determination of nitrate with a single reagent. Analytical Letters 36, 2713-2722.

Rhine, E.D., Sims, G.K., Mulvaney, R.L., Pratt, E.J., 1998. Improving the berthelot reaction for determining ammonium in soil extracts and water. Soil Sci Soc Am J 62, 473-480

Rinkes ZL, Sinsabaugh RL, Moorhead DL, Grandy AS, Weintraub MN 2013. Field and lab conditions alter microbial enzyme and biomass dynamics driving decomposition of the same leaf litter. Frontiers in Microbiology 4:260. DOI: 10.3389/fmicb.2013.00260

Saiya-Cork KR, Sinsabaugh RL, Zak DR, 2002. The effects of long term nitrogen deposition on extracellular enzyme activity in an Acer saccharum forest soil. Soil Biology and Biochemistry 34: 1309e1315.

Scott-Denton, L.E., Rosenstiel, T.N., Monson, R.K., 2006. Differential controls by climate and substrate over the heterotrophic and rhizospheric components of soil respiration. Global Change Biology 12, 205-216.