PP SYSTEMS

Application Note

Measuring Soil CO_2 Efflux from Ant Nests in the Brazilian Rainforest

A common assertion is that tropical forests (especially tropical wet forests) are more productive than temperate forests, and on an annual basis, rates of net primary productivity (NPP: carbon fixed per unit area per year) of tropical wet forests greatly exceed rates of NPP in temperate deciduous or coniferous forests. Yet, on shorter time scales (daily or monthly), NPP of temperate forests is about equal to that of NPP of tropical forests, and "ecologically relevant" productivity is thought to be highest in latitudes between 30° and 50° [1]. Comparable data for organisms at other trophic levels, however, are scant; for example, the carbon flux rate from soils (*i.e.*, "soil respiration") is a crucial part of any terrestrial ecosystem model, but values for soil respiration used in ecosystem models include only soil microbes and plant roots. Although soil respiration of ant nests rarely has been measured in the field [2], nests of red wood ants (*Formica rufa* group) in northern Europe have respiration rates nearly five times higher than that of surrounding ant-free soils [3]. How this compares to tropical ants is unknown, but extrapolation from temperate studies suggests that contribution of ants to carbon cycling in tropical ecosystems could be quite large.

With support from the Museo Paraense Emílio Goelde in Belém, Brazil, Drs. Aaron M. Ellison (Harvard University, Harvard Forest) and Rogério R. Silva did a pilot study of CO_2 efflux from ant nests at the Caxiuanã National Forest, Pará, Brazil. Instantaneous rates of soil carbon efflux from nests of five species of ground-nesting and arboreal-nesting ants and nearby soils lacking ants were measured for CO_2 with an EGM-5 Portable CO_2 Gas Analyzer and an SRC-2 Soil Respiration Chamber.

CO_2 efflux rates from ant-free soils (mean = 1.3 μmol CO_2 m^{-2} s^{-1}) and from nests of the ground-nesting *Mycoperus* and *Pheidole* spp. were lower than those measured previously during the dry season at Caxiuanã (≈3 μmol CO_2 m^{-2} s^{-1}) [4], but efflux rates of both leaf-cutter ants (*Atta* sp.) and fire ants (*Solenopsis* sp.) were substantially higher than background (ant-free) levels. CO_2 efflux from nests of the arboreal nesting *Odontomachus* species also were comparable to ant-free soils. Future work will include more extensive measurements of these and other ant species, adjacent ant-free soils, and large arboreal nests of *Azteca* species. Together, these data will help to improve estimates of soil CO_2 fluxes from tropical forests.

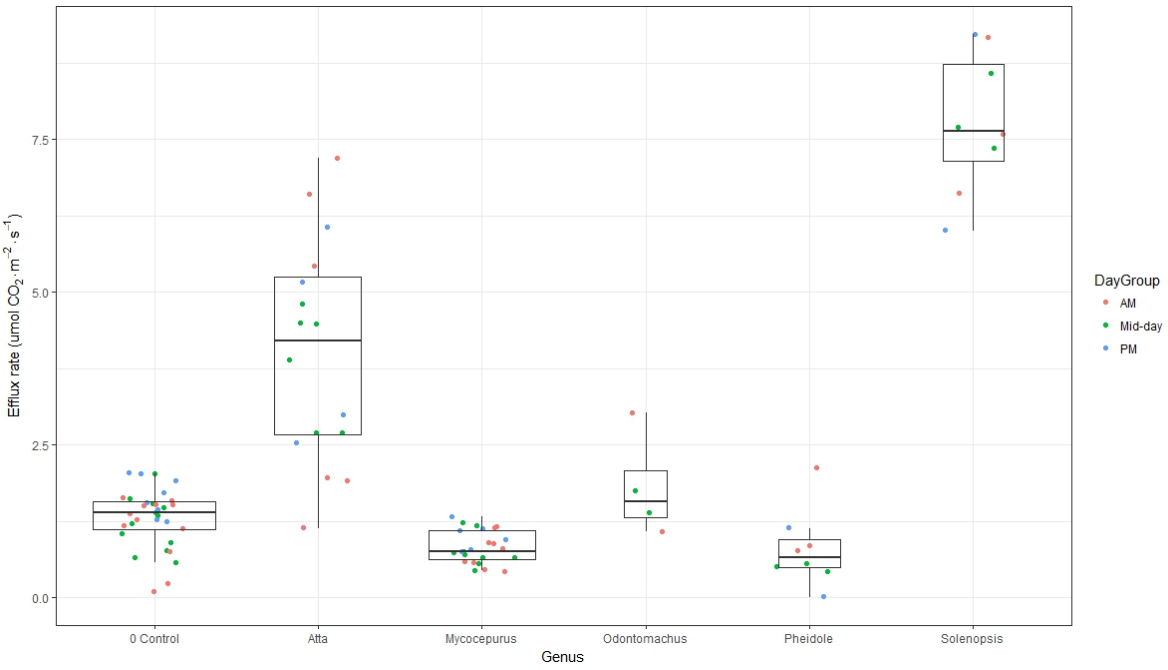

Figure. Estimates of CO_2 efflux from ant nests at Caxiuanã and ant-free soils ("0 Control"). Box plots illustrate medians, quartiles, and upper and lower deciles; widths of the boxes are proportional to sample size, and points denote values of individual observations taken in the morning (red), mid-day (green), and afternoon (blue).

EGM-5 Portable CO_2 Gas Analyzer and SRC-2 Soil Respiration Chamber on a *Solenopsis* nest at the Caxiuanã field station.

Custom collar on a *Mycocepurus* nest in the lab compound at the Caxiuanã field station.

Aaron Ellison (left) and Rogério Silva (right) measuring CO_2 efflux from a *Solenopsis* nest at Caxiuanã.

References

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[3] Jílková, V., T. Cajthaml, and J. Frouz. 2015. Respiration in wood ant (*Formica aquilonia*) nests as affected by altitudinal and seasonal changes in temperature. *Soil Biology and Biochemistry* 86: 50-57.

[4] Sotta, E. D., E. Veldkamp, B. R. Guimarães, R. K. Paixão, M. L. P. Ruivo, and S. S. Almeida. 2006. Landscape and climatic controls on spatial and temporal variation in soil CO_2 efflux in an Eastern Amazonian rainforest, Caxiuanã, Brazil. *Forest Ecology and Management* 237: 57-64.

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