New Insights of Soil Bioturbation by the Ant and Other Soil-Dwelling Organisms: Modern and Paleopedologic Significance

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The role of most soil-dwelling animals in bioturbation has traditionally been described as animals transporting material from within the soil to the surface as they excavate and maintain their burrows and nests. Many studies have recognized the impact of animals bringing organics down into their nests. Movement of material has a strong influence on organic carbon and other soil properties. Little if any recognition, however, has been given to subsurface mixing and deliberate downward movement of clastic sediments by soil-dwelling animals. To test this behavior, we observed 1000 western harvester ants, *Pogonomyrmex occidentalis* (Insecta: Hymenoptera: Formicidea), in a 64 cm long x 120 cm high x 10.7 cm wide glass enclosure filled with several thin layers of colored sand, gravel, and carbonate shells. Ants were allowed to burrow uninterrupted for 12 weeks after which the distribution of color sediments was measured for each respective layer. We show several patterns of sediment distribution, including the upward relocation of sediment to the surface, the interhorizon mixing of sediment, and the deliberate downward movement of sediment. The volume of excavated sediment was calculated using a modified cylinder volume equation. This equation provided a conservative estimate of the total volume of excavated material. Of the total volume of sediment (54,099 cm^3), 16% was estimated to have been excavated by the ants (8,523 cm^3). Our estimates were compared to the volume of the nest mound to evaluate how much sediment was excavated to the surface. Our data indicate that nearly 55% of all sediment excavated was not placed on the surface, but incorporated into the backfill of unused chambers and galleries within the nest. Removal of sediment from the enclosure revealed that the majority of backfill occurred 20 cm or more below the surface. It was also evident that backfill material was taken from all horizons in the nest as well as from the surface. Our experiment provides new empirical data on the downward mixing of sediments by ants. This mixing may have a greater impact on soil bioturbation than what has traditionally been understood. We suggest these implications also apply to other social insect activity, which is often overlooked yet a significant pedologic component of modern and ancient environments.