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Litter bugs and air pollution

EFFECTS OF AUTOMOBILE EXHAUST ON FOREST LITTER INVERTEBRATES*

JOHN P. GIESY AND ARLAN L. EDGAR
Alma College

This report concerns the influence of automobile exhaust on certain of the organisms which function as transformers and decomposers in the trophic energy cycling of organic matter in the forest. If the rate of recycling of energy is decreased, there are important implications for decreased productivity at other levels in the food chain. A slowdown in decay of fallen leaves, branches and other organic matter of the forest floor litter conceivably could mean the accumulation of such material and eventual ecologic consequences.

Field work was done in a young stand of mesic hardwoods in the University of Michigan Biological Station Forest at Douglas Lake, Michigan in the summer of 1969. Two groups of four, one-meter-square quadrats were selected in a fairly uniform area of the forest floor. One, the test group, was sampled and analyzed, while the other group, although treated the same as the test group, served only as replacement quadrats. Spaces left after litter was removed from the test quadrats were replaced by comparable litter from the second group of quadrats to help prevent unnecessary dessication and exposure of litter organisms remaining in the test quadrats.

Each of the four quadrats in the two groups was treated differently. The first two were controls: (1) dry control—no treatment with water or exhaust; (2) water control—single treatment with water only (treatment consisted of applying one gallon of water on Monday, Wednesday and Friday mornings). Quadrats three and four were test plots: (3) light exhaust—treatment with one gallon of water simultaneously with a five-minute exposure to exhaust, three times per week; (4) heavy exhaust—treatment with two gallons of water simultaneously with a ten-minute exposure to exhaust, three times a week.

Treatment of the quadrats with water and exhaust utilized the following apparatus and procedure: A flexible rubber hose four inches in diameter conveyed exhaust from the idling motor of a 1964 Buick Skylark which was in mechanically good running condition, to a 52″ × 52″ by 24″ enclosure of clear, flexible plastic. Exhaust was uniformly diffused into this enclosed space through 56 one-quarter inch openings in 1-1/2″ hard plastic pipe. No analysis of the exhaust was made. Water, under pressure from a portable garden sprayer, was released into this space through nine spray nozzles. These two systems of water and exhaust were integrated at the ceiling of the enclosure so as to produce an exhaust cloud and a simula-

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tion of rain falling through it carrying air-borne pollutants to the litter. The treatment procedure was standardized so that one gallon of water was sprayed through exhaust over a five minute period. The plastic enclosure was slit vertically at the four corners and the walls hung loosely so a build-up of gas pressure never occurred within the enclosure. The same apparatus without exhaust, was used to treat quadrats with water only.

Treatments were made on 17 days, beginning June 27 and ending August 6. The dry control received no water (except natural rainfall) or exhaust; the water control received a total of 17 gallons of water and no exhaust over the test period; light exhaust received 17 gallons of water sprayed through car exhaust for a total of 85 minutes; heavy exhaust received 34 gallons of water and 170 minutes of exposure to exhaust. One gallon of water applied in this manner is equivalent to approximately 0.12″ of rainfall on the quadrat. A total of slightly over two inches of water was added to the one meter-square quadrat in both the wet control and light exhaust plots; twice that amount was applied to the heavy exhaust quadrat.

A sample 800 cm^2 of litter was taken from each quadrat on each of four dates, June 25, July 10, July 24 and August 6. Four subsamples, 10 × 20 cm were used to obtain the 800 cm^2 sample area so as to decrease the influence of local variation. The sample depth extended from the loose surface leaves down to the usually indistinct interface of the A_0-A_1 strata (Dowdy, 1965). Sampling left off where organic matter gave way to predominantly mineral soil, hence a small part of the A_1 horizon was included. The sample depth was 4.2 to 4.9 cm. Dowdy found in his samples that at least 90 percent of the organisms present in the vertical section occur in the strata taken in this study.

Sixty-six entities (different species in most cases) were recognized from all samples taken. This assemblage was dominated by 34 forms of Acarina. Collembolans were second most numerous. Other forms included Diptera larvae and adults, Coleoptera larvae and adults, Thysanoptera, enchytraeid and non-enchytraeid oligochaetes, pseudoscorpions, nematodes, spiders, millipedes and centipedes.

Results are summarized in Figures 1 and 2. Water, both atmospheric and treatment, appears to exert a marked influence, especially in numbers of individuals. After the initial sample, the number of recovered animals in the water control always exceeded the other three quadrats (Fig. 2). Animals from light and heavy exhaust quadrats were intermediate in numbers between the dry control and wet control. Even though water in the heavy exhaust was double that of the water control, the exhaust appeared to retard reproduction and/or reduce the existing number of individuals. Had the exhaust exerted no influence, the individuals in light exhaust would be expected to equal those in the water control and those in the heavy exhaust to exceed considerably those in the water control. This did not occur in either case. The fact that litter in the light and heavy exhaust quadrats supported similar numbers of individuals may

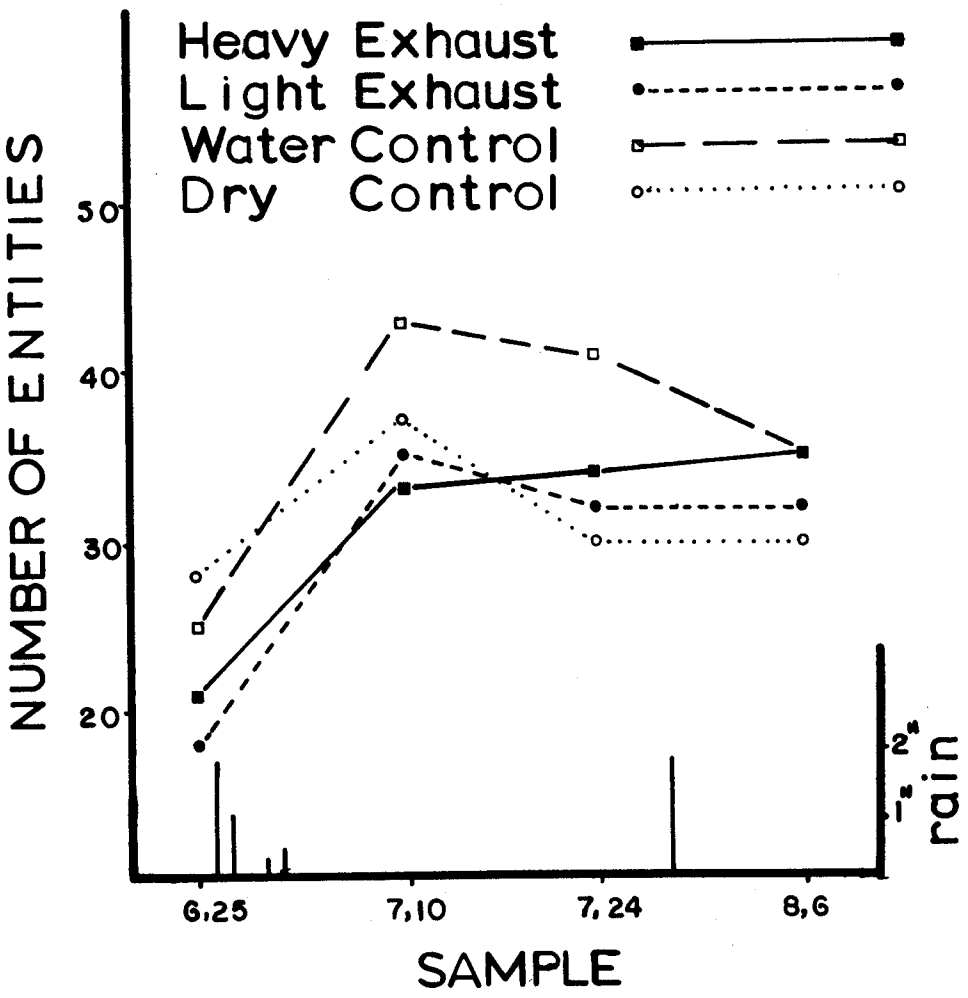

FIG. 1. Number of invertebrates recovered via Berlese sorting from water-exhaust regimes on four dates during the summer of 1969. Natural rainfall, in inches, is indicated.

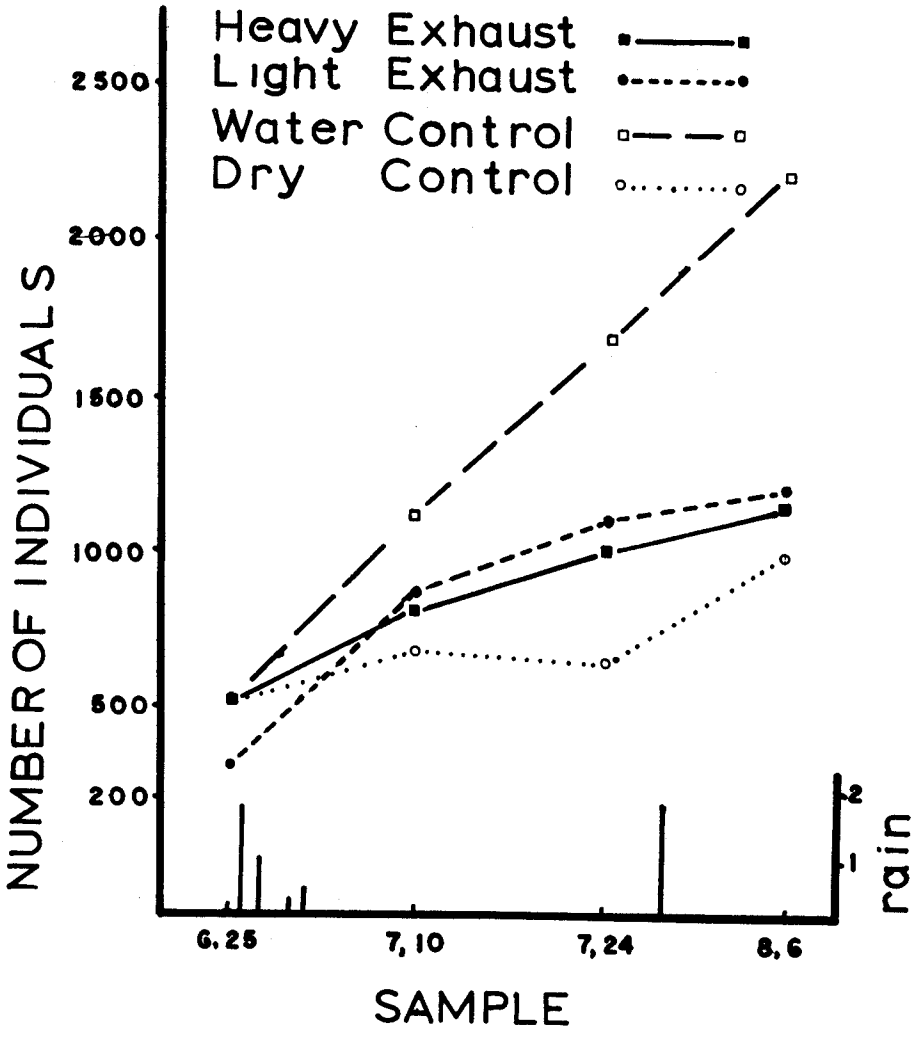

FIG. 2. Number of invertebrate entities recovered, via Berlese sorting, from water-exhaust treated regimes on four dates during the summer of 1969. Natural rainfall, in inches, is indicated.

indicate that some component in the exhaust is deleterious at a lower dosage almost irrespective of the quantity of water present.

Most of the observations made for numbers of individuals (Fig. 2) apply to the numbers of entities found (Fig. 1), although such observations are generally less clear-cut. This might be expected since numbers of an entity should be affected before elimination of the entity. Probably seasonal influences on composition of the litter community are reflected to a greater extent in entities present and recovered than in number of individuals. Inspection of slopes of the lines in Figures 1 and 2 tend to support this explanation. After the second sample (July 10) there is either no increase or a decrease in number of entities in three of the four quadrats, whereas numbers of individuals increase in all but one instance (dry control, July 10–24).

A period of 28 days elapsed without measurable natural precipitation (July 2–29), providing the opportunity to observe naturally-occurring changes in the dry control. A reduction in both entities and individuals occurred with time. In the dry control the precipitation of July 29 appeared to contribute heavily toward the rapid increase of numbers of individuals in the sample from July 24 to August 6. During the non-rainfall period, involving samples taken on July 10 and July 24, the individuals in both light and heavy exhaust increased in numbers at a rate intermediate between the dry and wet controls, even in the presence of three- and six-gallon applications of water per week. The rate of increase in numbers of water control individuals was about the same in non-rainfall as in rainy periods. These observations suggest that automobile emissions may be more detrimental to litter decomposer and transformer organisms in areas with higher or more regular rainfall than in drier areas.

Areas downwind from industrial centers have been shown to receive up to 47 percent more precipitation than the adjacent countryside. Apparently water vapor from industrial processes and natural sources condenses around emitted particles and carries them to the ground. Dense concentrations of people, with their ubiquitous automobile aggregations, are associated with industrial centers. This combination of industry and automobile concentrations may contribute to a slowdown in recycling of energy derived from natural resources over an increasingly large proportion of the terrestrial environment.

LITERATURE CITED

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