The Role of Subterranean Termites in the Decomposition of Above Ground Creosotebush Litter

by

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ABSTRACT

We investigated the role of the termite *Gnathamitermes tubiformans* (Isoptera: Termitidae) in the breakdown of above ground creosotebush (*Larrea tridentata*) litter in the northern Chihuahuan Desert of New Mexico, USA. Comparison of decomposition rates of control plots with termite-excluded plots demonstrated that termites (and microarthropods) had no significant effect on mass loss. This species normally consumes other organic matter and only uses creosotebush litter when nothing else is available. This keystone species therefore plays a minor role in the breakdown of surface litter of the dominant shrub of the Chihuahuan Desert.

INTRODUCTION

Gnathamitermes tubiformans (Buckley) is a dominant subterranean termite of the northern Chihuahuan Desert (Whitford et al. 1982; Mackay et al. 1985, 1987a, 1987b). We used exclusion experiments to demonstrate that this termite is a keystone species in the decomposition community of the area (MacKay et al. 1987b). Regarding creosotebush litter (*Larrea tridentata*), Fowler and Whitford (1978) found no evidence that subterranean termites consume creosotebush litter. Elkins et al. (1982) later reported that termites harvested and apparently consumed 85% of the *Larrea tridentata* leaf litter. Whitford et al. (1982) concluded that *G. tubiformans* accounted for a significant amount of the removal of *L. tridentata* litter. The latter two studies were conducted between September and December, and thus do not reflect the annual activity of subterranean termites.

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Because of these conflicting data, we designed a two year experiment to attempt to determine the actual effect of subterranean termites on creosotebush litter on the soil surface.

MATERIALS AND METHODS

The study area is located on the Jornada Long Term Ecological Research (LTER) Site located 40km NNE of Las Cruces, Dona Ana Co., New Mexico. The long-term average annual precipitation is 211mm (Houghton 1972), over half occurring in late summer. Maximum air temperatures reach 40°C, while winter temperatures often fall below 0°C. The study sites are on creosotebush covered non-arroyo areas of a watershed drainage slope. Silva et al. (1985) provide detailed site descriptions. The roles of microarthropods and termites in mass loss from surface litter was assessed on termite-present and termite-free plots established by Elkins (1983). His original plots, treated with 10.3kg/ha chlordane in 1977, lacked termites throughout the entire period of this study. When first applied, chlordane also eliminated the microarthropods. All of the invertebrate populations (except for termites) returned to pretreatment levels within two years (Silva et al. 1985).

The litter was collected from creosotebush shrubs near the study area by either shaking senescent leaves from the canopy (1982 study) or stripping leaves from the living plants and air drying them on racks in the field (1983 study). Fowler and Whitford (1980) found no differences in decomposition rates between senescent and fresh creosotebush litter. Air dried litter (15.0g) was placed on the soil surface in open-bottom screen cylinders (cf. Whitford et al. 1982). On 7 December 1982 a total of 160 cylinders were placed on the soil surface under the edges of randomly selected creosotebush canopies, 80 in a treated plot (without termites) and 80 in a control plot (with termites). On 6 February 1984 a second set of 80 cylinders each containing 15.0g litter was placed in the same plots (40/plot). Half of the cylinders in each plot for both the 1982 and 1984 studies were treated with 200ml of 0.5% chlordane at three month intervals to eliminate microarthropods and termites. Control cylinders were treated with 200 ml distilled water. Treatments consisted of litter with termites and microarthropods (Control), without termites but with microarthropods (plots treated with chlordane in 1977) and without either termites or microarthropods (litter treated with chlordane throughout the study). The litter from 5 randomly selected cylinders from each of the treatments was returned to the laboratory at 3 month intervals to estimate mass loss. The samples were

oven dried at 60°C for 72h, weighed, and burned at 600°C for 8h to determine ash content. The litter masses were corrected for handling, moisture content and ash content and the organic matter remaining was calculated using the following formula:

$$\%r = \frac{F-((A-Cl)/S) \times 100}{I}$$

Where %r = Percent of organic mass remaining

I = Dry mass (dried litter, 72 hrs at 60°C and corrected for handling error and based on 10 samples)

C = Inorganic (ash) content of litter as a proportion of 1

S = Inorganic (ash) content of soil under cylinders as a proportion of 1

A = Ash mass of litter after burning in the muffle furnace

F = Final dry mass of each sample after collection (after 72 hrs at 60°C)

RESULTS AND DISCUSSION

Creosotebush litter mass loss was especially high during the first twelve month period (Fig. 1). This is especially obvious in the 2 year study in which the mass loss rates were reduced to some degree after the end of the first year (Fig. 1). An analysis of variance showed no significant effect of termites or microarthropods on litter mass loss within dates; analysis of covariance showed no significant differences between slopes of mass loss against time (the initial two year study data were analyzed in 2 separate 1 year portions).

We have shown that termites (and microarthropods) had no significant effect on the mass loss of creosote litter in the northern Chihuahuan Desert during our 2 year study. These data are consistant with those of Fowler and Whitford (1980), but contradict the data of Elkins et al. (1982) and Whitford et al. (1982). Apparently *G. tubiformans* does not use above-ground creosotebush litter except during years when very little other organic matter is available (Whitford et al. 1982). The study area has received more than average precipitation during recent years (Houghton 1972; MacKay et al. 1986; Whitford et al. 1986), which could result in higher primary production (MacKay and MacKay 1984) and the availability of other preferred organic matter.

As creosotebush litter does disappear in the ecosystem, and 2 of the dominant decomposer groups, termites and microarthropods, often play little or no role in the process, what can account for the disappearance? Apparently abiotic factors, especially solar

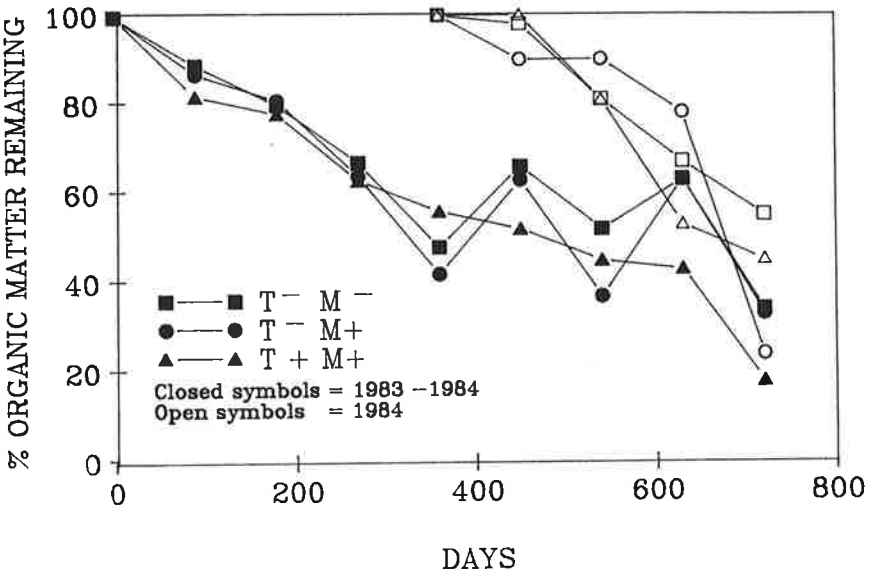

Fig. 1. Mass loss rates of creosotebush surface litter in the northern Chihuahuan Desert. Triangles indicate litter with termites and microarthropods (Control), circles indicate litter with microarthropods present but termites absent (treated with chlordane in 1977) and squares indicate litter without microarthropods or termites (litter treated with clordane during this study).

insolation (ultraviolet light), account for much of the litter disappearance in this ecosystem. Loring et al. (unpublished manuscript) have demonstrated that abiotic creosotebush litter on the soil surface decomposes at about the same rate as control litter. Rainfall apparently further enhances the fragmentation of litter and is necessary for the movement of the material into the soil.

We have only considered the above ground creosotebush litter. Much of the litter is buried due to soil erosion, mammal activity etc. and it is quite clear that decomposition of litter belowground in desert ecosystems occurs by very different processes and processors (Santos et al. 1984). The below ground decomposition of organic matter in deserts deserves much more attention than it has been given.

Therefore this keystone species in the northern Chihuahuan Desert decomposer community often plays a minor role in the breakdown of creosote surface litter.

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