

errors rose to unacceptable levels. Therefore, the exact behavior of these measures was calculated for small samples for all tables from 2×2 to 5×5 ; the resulting tables are presented and may be used in significance tests.

Scientists who decide to use Colwell's measures should sample at least twice during the period of the most rapid fluctuation of interest. To accommodate asymmetrical fluctuations, they should sample frequently enough to include the regularly encountered minima and maxima and calculate contingency over many time scales to allow the data to reveal their natural periodicities. If there is some question concerning detection of a significant periodicity by increasing sample size, then pilot calculations should be run on samples of 5-6 cycles of the longest periodicity desired. If M exceeds 0.2, more data should be gathered to double the sample, which will almost certainly result in detection of a significant periodicity. If not, larger samples will probably not change the conclusions reached.

Colwell's measures performed well on metric data where they could be compared with Fourier transforms. Fourier transforms remain the method of choice on metric data, but that Colwell's measures performed well and were consistent with Fourier measures on metric data gives us confidence in using them on nominal and ordinal data, where Fourier analysis is inappropriate. I urge their use on nominal and ordinal data and on smaller data sets than those traditionally exposed to time-series analysis.

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Litter Decomposition in the Desert

A condensation of "The Effects of Microarthropods on Litter Decomposition in a Chihuahuan Desert Ecosystem," by Perseu F. Santos and Walter G. Whitford, and "The Role of Mites and Nematodes in Early Stages of Buried Litter Decomposition in a Desert," by Perseu F. Santos, Janice Phillips, and Walter G. Whitford, both reports to be published in vol.62, no.2 (April 1981) issue of *Ecology*. The authors are with the Department of Biology, College of Arts and Sciences, New Mexico State University, Box 3AF/Las Cruces, NM 88001. These studies were supported by NSF Grant DEB 77-16633 to W. G. Whitford.

Little is known about the decomposition of plant litter in deserts and the organisms involved in that process. In Chihuahuan desert soils, Santos et al. (1978) found that the microarthropod fauna was dominated by prostigmatid rather than the oribatid mites that feed on dead plant material and are

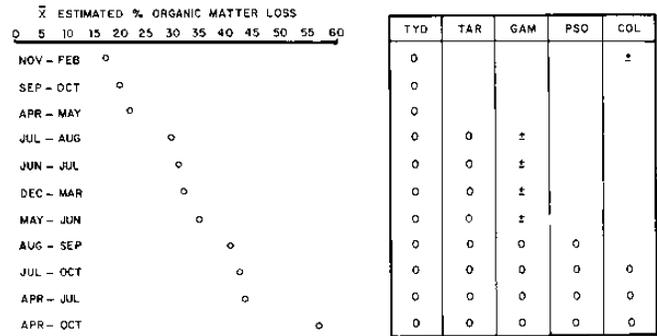


FIGURE 1. Mean percent of weight loss from untreated bags at various time intervals and major groups of microarthropods extracted. (0) indicates always present; (\pm) indicates present or absent. Key: TYD = tydeid mites, TAR = tarsonemid and pyemotid mites, GAM = gamasid mites, PSO = psocoptera, and COLL = collembola.

dominant in other ecosystems. This relationship raised questions concerning the role of these mites in decomposition. Since significant quantities of plant litter are buried by wind and water in this desert, we designed studies to address the following questions: What are the relative contributions of bacteria, fungi, and microarthropods to litter decomposition? Is there a pattern of microarthropod succession related to the stage of litter decomposition? What are the differences in buried and surface litter decomposition?

We used fiberglass mesh litter bags containing mixed litter and the following treatments: (a) no treatment (NT); (b) chlor-dane insecticide to eliminate arthropods (IT); (c) fungicides Benomyl and Dexon to suppress fungi (FI); and (d) a combination of the insecticide and fungicides (FIT). The bags were placed in the field and retrieved in an overlapping time sequence. Microarthropods were extracted from the remaining litter, and the litter was burned in a muffle furnace to obtain organic matter loss.

The loss of organic matter (highest to lowest) was always in the sequence untreated > fungicide treated > insecticide treated > fungicide-insecticide treated. The treatments accounted for between 61% and 90% of the variance in weight loss from buried bags and more than 90% of the variance in weight loss from surface bags. In the buried litter, there was a repeatable sequence of microarthropods that was independent of season but related to the degree of decomposition (Figure 1).

The loss of organic matter from surface bags, August to October, was $57.4 \pm 7.7\%$, which was significantly higher than loss from buried bags for that period. All NT surface bags contained termite galleries. The high mass loss from the surface bags was attributed to termites.

TABLE 1. Percent organic matter loss \pm one standard deviation from buried litter bags (N = 5) and numbers \pm one standard deviation of bacteria (N = 3), tydeid mites (N = 5), and bacteriophagous nematodes (N = 3) per gram of litter in buried insecticide treated (IT) and untreated (NT) creosotebush (*Larrea tridentata*) litter bags. Data are reported for the time periods following burial.

Item	Day 10		Day 20	
	NT	IT	NT	IT
Organic matter weight loss	20.7 \pm 2.4%	5.6 \pm 2.5%	23.3 \pm 1.3%	8.2 \pm 2.4%
Bacteria	3.3 $\times 10^6$	2.0 $\times 10^6$	1.0 $\times 10^7$	1.6 $\times 10^6$
Bacteriophagous nematodes	4.6 \pm 2.2	25.0 \pm 9.4	1.2 \pm .2	9.3 \pm 3.4
Tydeid mites	3.4 \pm 1.0	0	4.7 \pm .9	0

Stepwise multiple regression analysis of abiotic parameters and decomposition showed that abiotic factors explained 80–90% of the variation in the biocide treatments but less than 50% of the variation in the untreated bags. Treatments that simplified the biota caused decomposition to fluctuate with changes in climate, whereas the presence of microarthropods partially uncoupled decomposition from environmental constraints.

Decomposition of buried litter in the Chihuahuan desert (56.6% loss in six months of growing season) was higher than the 29% loss of grass litter in a semiarid grassland (Vossbrinck et al. 1979) and falls within the range of mesic grassland herbage (Curry 1969).

The initial arthropod colonizers of buried bags were undescribed species of tydeid mites, and in the IT bags we found large numbers of nematodes. We therefore studied buried litter decomposition in the initial 30 days using the same biocide treatments and estimated changes in numbers of bacteria, nematodes, and mites at 5-day intervals. In the absence of tydeid mites, there were significantly higher populations of bacteriophagous nematodes and reduced numbers of bacteria (Table 1). Although tydeid mites were not present in the litter at day 5, they were more abundant in soil around the bags than at some distance away (i.e., 71.4 ± 22.9 vs 4.6 ± 4.3 per 200 cc of soil). In laboratory cultures, tydeid mites fed voraciously on nematodes and nematode eggs.

The initial stages of buried litter decomposition appears to be via bacteria, which are grazed upon by nematodes. Removal of the nematode predator apparently allowed nematodes to overgraze the bacteria, reducing their population size and reducing decomposition. Without predators, grazers appear to be detrimental to decomposition, as has been suggested by Hanlon and Anderson (1979). Thus, in desert ecosystems, microarthropods affect litter decomposition by a heretofore undescribed mode: preying on free-living nematodes.

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American Journal of Botany
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Comparing Seed Proteins from *Pinus radiata* Populations

A condensation of "Immunochemical Comparisons of Seed Proteins from Populations of *Pinus radiata* (Pinaceae)," by Terence M. Murphy, to be published in vol. 68, no. 2 (February 1981) issue of the *American Journal of Botany*. Murphy is with the Department of Botany, University of California, Davis, CA 95616.

Pinus radiata D. Don (Monterey pine) consists of a complex of populations scattered in coastal and insular habitats along western North America. A partial description of the evolutionary history of these populations has been suggested on the basis of fossil evidence. Axelrod (1980) has described seven dated sets of fossils of *P. radiata*, which show an evolutionary trend toward longer cone lengths and larger, thicker apophyses. He also has documented an ascending sequence of mean cone lengths among the five extant populations, increasing from 6.5 cm (Cedros Is.) to 8.2 (Guadalupe Is.), 9.6 (Monterey), 11.4 (Año Nuevo), and 13.9 (Cambria). He suggested that the populations arose in a step-wise fashion, such that those with smaller cones gave rise progressively to populations with larger cones, which implies that populations with similar-sized cones are closely related and that populations with greater differences in cone size are more distantly related.

Axelrod's emphasis on cone size as a trait to measure evolutionary relationships is useful, because it allows a comparison of extant populations to fossil populations. But it might be questioned on the basis that cones are exposed to and are responsive to several fluctuating selective pressures (Linhart 1978). The isolation of the extant populations from the ancestral population may have occurred without regard for cone length; then selection may have led to a change in the distribution of cone lengths in each population according to the ecological pressures at each habitat.

The populations of *P. radiata* can be compared by using characteristics other than cone length to test the likelihood that difference in cone length is a good index of systematic relationship. I have compared the seed proteins of the five populations of *P. radiata* (and of several other species of *Pinus*), using semi-quantitative agar-diffusion immunochemical techniques applied previously to seed proteins of members of the Pinaceae by Prager et al. (1976). The data indicate that differences between seed protein antigens from the five populations of *P. radiata* correlate closely with differences in cone lengths.

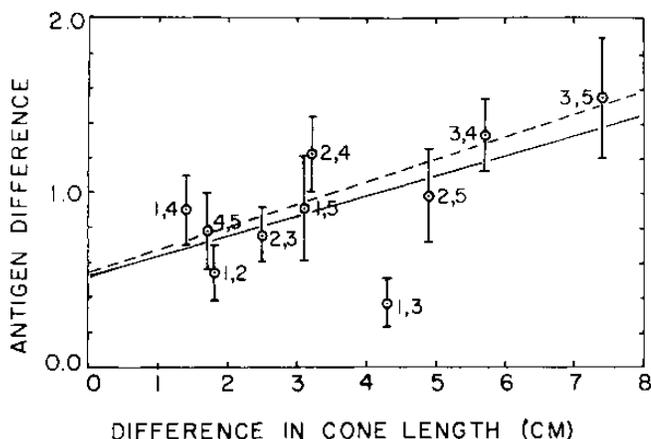


Figure 1. Comparison of immunochemical differences and cone-length differences between pairs of *P. radiata* populations. The ordinate shows the weighted mean \pm S.E. of antigenic difference scores for all antisera, including antisera to both members of each pair. The abscissa shows the difference in the mean cone lengths for each pair; S.E. for these differences were approximately 0.11 cm. The solid and dashed lines are least-square regression lines calculated with, and without, the Monterey-Cambria pair, respectively. Numbers by each point identify the populations that were compared: 1, Monterey; 2, Año Nuevo; 3, Cambria; 4, Guadalupe; 5, Cedros.