

Litter Arthropod Forest Communities After the 1988 Yellowstone NP Fires

By Tim Christiansen, Robert Lavigne,
and Jeffrey Lockwood

Most of earth's biodiversity is inconspicuous. Probably only 1 to 2 percent of all species are higher plants and less than 0.2 percent are vertebrates. The remainder are a vast array of invertebrates, fungi, algae, and other microorganisms that provide important ecological services (Wilson 1985). Arthropod ecology has not been of special interest except in cases of pest species and the occasional listing of endangered arthropod species that undoubtedly represent but a tiny fraction of the actual numbers of arthropods facing extinction.

Studies recently have illustrated the role of arthropods in ecosystem processes such as nutrient cycling, litter decomposition, and plant productivity (Christiansen et al. 1989; Schowalter et al. 1991; Lavigne and Kumar 1974; McBrayer 1977). A disturbance, such as fire, changes the habitat structure and this, in turn, can affect arthropod community structure and function. With this in mind, we conducted a 2-year study of the effect of the 1988 Yellowstone NP fires on litter arthropod communities.

Data collection for the first year began in early July 1989 and continued through September (Christiansen et al. 1991). Data from the second post-fire year were gathered between May and early September 1990. Nine heavily burned forest sites (where fire left very little litter or logs) and 9 unburned lodgepole pine forest sites were established randomly at locations throughout the park. Three permanently placed 100 m transects were situated in each site, from which litter samples were collected every 10 days. Berlese funnels were used to isolate the litter arthropods.

Site description included: Litter biomass, herbaceous cover, and the densities of saplings, logs, standing dead trees, and older trees. Analysis of variance and principal component analysis were used to correlate arthropod density and species composition with habitat data. Our general conclusions have been verified by the use of repeated measures analysis.

Springtails (Collembola) are a major component of the litter community. These insects feed on plant litter, fungi, algae, and bacteria. Springtails are

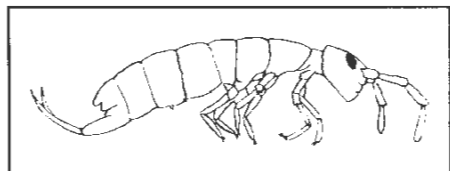


Figure 1. A typical *Collembola* (springtail) found in leaf litter.

important in initiating litter decomposition, maintaining nutrient cycling, and regulating fungi and other organisms that help in the decomposition process. Density and species composition of springtails were greater in unburned sites containing more than 10 tree seedlings per square meter, at least 12 logs per hectare, at least 36 saplings per hectare, and 50 grams of litter per square meter.

The importance of both tree seedlings and logs was evident in burned sites. Tree seedlings and

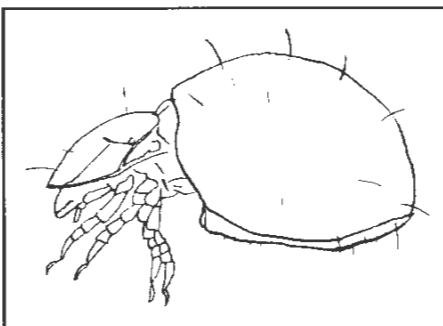


Figure 2. A typical *Oribatida* mite found in both leaf litter and soil.

fallen trees had to be present by the second year for burned sites to support springtails. Tree seedlings and logs provide protection against predators and the elements, and represent food sources for springtails. Dindal and Metz (1977) reported decreased springtail populations in prescribed forest burns. As found by this earlier study and reemphasized by our work, some springtail species are more tolerant of fire than others. In order to recover, burned forest sites will need arthropods such as springtails, as well as fungi and bacteria, to initiate decomposition and the release of essential nutrients.

Mites (Acari) also are important to ecological processes through involvement in litter decomposition or regulation of other organisms, such as fungi and bacteria, which decompose litter. Litter mite density in unburned forest sites was found to be significantly greater where there were at least 10 seedlings per square meter, 14 logs per hectare, and 45 grams of litter. Additionally at least 40 percent vegetative ground cover was necessary before mite density became statistically significant.

Thus, several conditions are necessary in order to support large mite communities. These conditions were not present in heavily burned sites. Data showed that mite communities in burned sites had only 10 percent of the density and 20 percent of the species found in unburned forest sites even 2 years after fires. The combination of reduced density and species richness of mites and springtails could delay decompositional processes until both these arthropods regain their prefire community structure.

Ants (Formicidae) are important seed predators, soil mixers, and pollinators in forest habitats. Unburned sites with greater than 30 seedlings per square meter contained higher ant densities than sites with less than 30. The more seedlings in an area, the more cover and other resources were available to ant communities. Burned sites containing any type of cover and/or tree seedlings one year after the forest fire contained significantly more ant species and greater ant densities than burned sites, which lacked cover in the form of seedlings or logs. Ants can disturb soil crusts, create soil pores for water penetration, and import seeds from unburned sites. Thus, ants may be important in helping reestablish forest communities by aiding in succession.

Most beetle species (Coleoptera) are not harmful, despite population explosions of *Ips* and other

tree damaging species. For example, some beetles such as carabids, prey on tree-damaging beetles. Others may carry seeds, while some are pollinators. As expected, the 1988 forest fires seriously disrupted beetle communities. Species of ground beetles were significantly greater by the second post-fire year in burned sites with at least 35 percent herbaceous cover, numerous logs, at least 25 grams of litter, and 10 tree seedlings per square meter. Again, as seen in mite, springtail, and ant communities, some vegetative cover (or log cover) is necessary for these invertebrates to exist.

Many different types of other litter arthropods were found in unburned habitats that were not

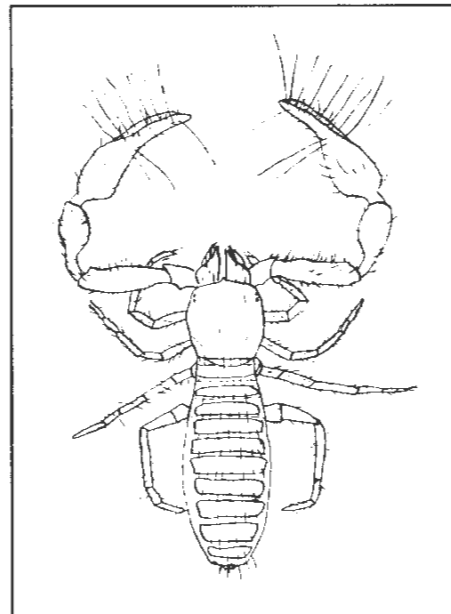


Figure 3. A pseudoscorpion which was found in leaf litter.

found more than occasionally, even after 2 years, in burned forested sites. These arthropods also are connected with ecosystem processes. They included (1) bark lice, (2) webspinners, (3) pseudoscorpions, (4) centipedes, and (5) millipedes.

Disruption of predators, prey, decomposers, and

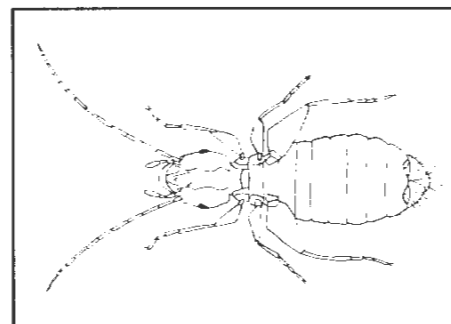


Figure 4. A psocoptera (bark lice) which was found in leaf litter.

other trophic levels may severely impact nutrient cycling, litter decomposition, seed dispersal, and plant growth and succession. Animals, both large

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and small, affect forest composition and regeneration by a multiplicity of interactions (Probst and Crow 1991). In total, it appears that arthropods and other invertebrates dominate the fauna of Yellowstone NP in terms of biomass, biological diversity, and ecosystem regulation. Thus, conservation of species – including arthropods and other invertebrates – is more than the saving of biodiversity. These organisms are vitally important in ecological process functions and need further study if our parks are to survive the increasing influx of humanity.

Christiansen is a post-doctoral researcher in the U/WVA Dept. of Forestry at Morgantown, WV; Lavigne and Lockwood are professors in the U/WY Dept. of Plant, Soil, and Insect Sciences, Laramie, WY. This work was supported by U/WY's National Park Research Center.

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