# Effects of Cattle Grazing and Wildfire on Soil-Dwelling Nematodes of the Shrub-Steppe Ecosystem

J. D. SMOLIK AND L. E. ROGERS

**Highlight:** *A comparison was made between nematode density and biomass values in grazed, ungrazed, and burned areas within a shrub-steppe community located on the Arid Lands Ecology Reserve in south-central Washington. Highest total population biomass values on grazed, ungrazed, and burned areas were 405, 502, and 400 mg/m², respectively. There were not consistent differences in density or biomass values between treatments, resulting in the conclusion that short-term effects associated with cattle grazing and burning had little impact on soil-dwelling nematodes.*

Grasslands comprise a major part of the land area in semiarid regions of the western United States. Soil-dwelling nematodes are an important part of the grassland fauna, although their abundance is seldom appreciated unless specific sampling techniques are employed. An example of their small size is shown in Figure 1.

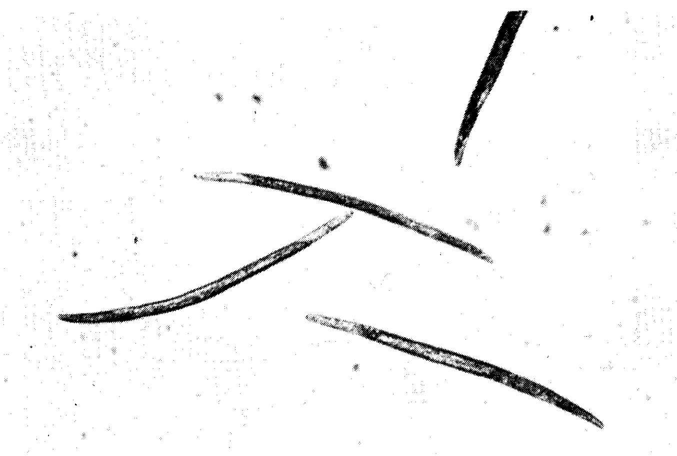

**Fig. 1.** *Lesion nematodes (*Pratylenchus *sp.), one of several phytophagous genera from the Arid Lands Ecology Reserve. Length ca. 0.6 mm.*

Authors are assistant professor, Plant Science Department, South Dakota State University, Brookings 57006; and research scientist, Ecosystems Department, Battelle-Northwest, Pacific Northwest Laboratories, Richland, Washington 99352.

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Nematodes occupy phytophagous, predaceous, and saprophagous trophic levels; however, their role in ecosystem functioning has received little attention (Twinn, 1974). A study of nematode ecology in South Dakota revealed phytophagous nematode biomass to be significantly higher in an ungrazed pasture as compared to a grazed pasture. In addition, nematodes were estimated to consume as much rangeland vegetation as consumed by cattle (Smolik, 1974). Nematodes are clearly an important consumer group in grassland regions.

## Study Site

This study was conducted on the Arid Lands Ecology (ALE) Reserve located within the boundaries of the Energy Research and Development Administration's Hanford Reservation near Richland, Washington. The study site is on the northeast slope of Rattlesnake Mountain at about 366 m elevation. Soils are deep, stoneless, Ritzville silt loam which developed from the eolian deposits mixed with small amounts of volcanic ash (Hajek, 1966). Historically there has been little livestock grazing in the area, and certainly none during the last 30 years following establishment of the Hanford Reservation (Rickard, 1972).

The dominant plant community is big sagebrush/bluebunch wheatgrass (*Artemisia tridentata/Agropyron spicatum*) association (Daubenmire, 1970). Other perennial grasses include *Poa cusickii, P. sandbergii, Stipa thurberiana,* and some *S. comata.* Common forbs include *Antennaria dimorpha, Crepis atrabarba, Erigeron filifolius,* and some *Lupinus* spp. Annuals include *Festuca octoflora, Descurainia pinnata,* and *Draba verna.* Cheatgrass (*Bromus tectorum*) occurs along roadways and in other disturbed areas but was not present on the study site.

Ecological studies were initiated on the ALE Reserve to determine the impact of domestic herbivores on an arid land ecosystem as a contribution to the IBP Grasslands Biome program. Cattle grazing was established in April 1971 with the introduction of 15 yearling Hereford steers. The cattle were rotated weekly between two, 8-ha pastures until about 50% of the aboveground standing grass crop had been removed. Identical procedures were repeated during 1972. During 1973 and 1974 only seven and five steers were used, respectively; and grazing was restricted to one pasture, permitting an evaluation of pasture recovery. The study areas were essentially identical in terms of vegetative composition and in physical and chemical soil properities prior to the initiation of cattle grazing in 1971 (Rickard et al., 1975).

In August, 1973, a dry thunderstorm started a wildfire that ultimately burned about 4,000 ha of the ALE Reserve. The fire was extremely hot and killed all shrubs within the burned area. Native grasses recovered during the first growing season, but several years will be required for re-establishment of big sagebrush, the only shrub present. The fire did not burn the grazing study area or a nearby ungrazed area subsequently designated as a control area. The purpose of this study was to evaluate short-term effects of wildfire and cattle grazing on soil-dwelling nematode populations.

## Methods

A total of six replicates were sampled in each treatment to evaluate nematode abundance under grazed, ungrazed, and burned conditions. An initial sample during June 1973 showed the majority of nematodes to be associated with the top 40 cm of soil (Rogers and Smolik, 1974). Soil samples were therefore collected to a depth of 40 cm during 1974. Samples were subdivided into 0–5, 5–10, 10–20, 20–30, and 30–40 cm increments. Three sample dates were selected; in early spring during the initiation of plant growth; during the period of peak standing crop; and late summer during the summer drought period.

Samples were taken with a sand auger with a cutting edge of 5.3 cm diameter. The soil was immediately placed in plastic bags and stored in an ice chest. They were then shipped in an insulated carton to the senior author in Brookings, South Dakota, for analysis, arriving within 24 hours.

Nematodes were separated from the soil by the Christie-Perry (1951) method. This consists of wet screening followed by Baermann funnel extraction. The efficiency of the wet screening was determined by re-extracting the soil sample. Efficiency of the Baermann funnel was established by examining approximately 10% of the residues to determine the number of nematodes that failed to pass through the screen. Nematode numbers were then corrected for the overall extraction efficiency, which varied from 60 to 70%. Density estimates were calculated by counting the number of nematodes (60x magnification) in three 1-ml aliquots of a 50-ml suspension in Scott hookworm larvae counting slides. Biomass estimates were determined by the method of Andrassay (1956). Measurements for biomass determinations were obtained from permanent mounts (Thorne, 1961) of randomly selected individuals.

## Results

A listing of identified nematode taxa and associated trophic levels is shown in Table 1. Trophic composition, based on density estimates, averaged 60% phytophagous, 32% saprophagous, and 8% predaceous. There were no discernible differences in trophic structure between treatments.

There were no consistent differences in total nematode population density or total population biomass estimates between treatments (Fig. 2). This differs from results obtained from a similar study conducted in the mixed-grass plains of South Dakota, where nematode biomass was higher in the ungrazed treatment (Smolik, 1974). This difference was attributed to high numbers of a phytophagous dagger nematode (*Xiphinema americanum*) in the South Dakota study. This species was absent from shrub-steppe soils, which may account for the lack of detectable biomass differences during this study. We are unable to account for the absence of *X. americanum* from the ALE study area.

There was little obvious response of density or biomass values to treatments of individual trophic levels (Table 2). The peak total population biomass values for grazed, ungrazed, and

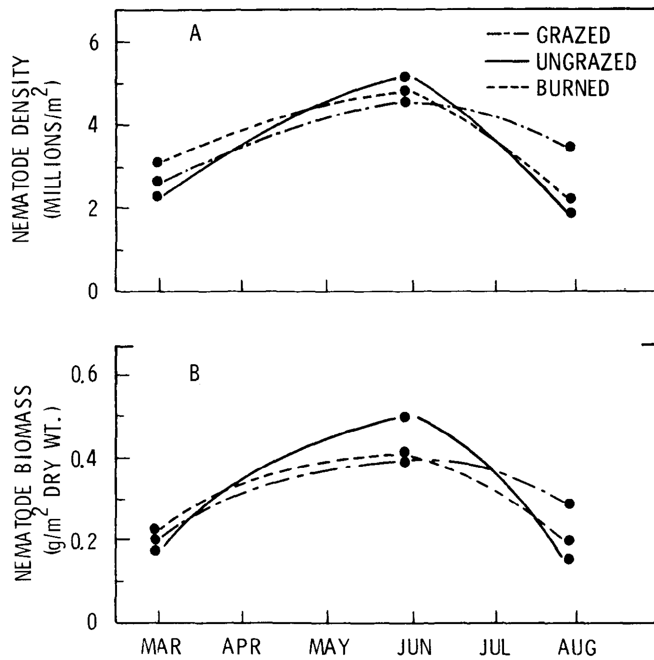


**Fig. 2.** *Nematode density (A) and biomass (B) in the top 40 cm of shrub-steppe soil.*

**Table 1. Trophic groupings of soil-dwelling nematode genera from the Arid Lands Ecology Reserve in south-central Washington.**

| Phytophagous | Predaceous | Saprophagous |
|---|---|---|
| *Aphelenchoides* spp. | *Aporcelaimellus* sp. | *Acrobeles* sp. |
| *Axonchium* sp. | *Discolaimus* sp. | *Acrobeloides* sp. |
| *Ditylenchus* sp. | *Eudorylaimus* sp. | *Aphelenchus* sp. |
| *Heterodera* sp. | | *Cephalobus* sp. |
| *Nothotylenchus* sp. | | *Cervidellus* sp. |
| *Paratylenchus* sp. | | *Chiloplacus* sp. |
| *Pratylenchus* sp. | | *Eucephalobus* sp. |
| *Pungentus* sp. | | |
| *Scutellonema* sp. | | |
| *Steineria* sp. | | |
| *Subanguina* sp. | | |
| *Tylenchorhynchus* spp. | | |
| *Tylenchus* spp. | | |

**Table 2. Number and biomass of phytophagous, predaceous, and saprophagous nematodes in grazed, ungrazed, and burned range at the Arid Lands Ecology Reserve site, 1974.**

| Grouping and sampling date | Number[1] | | | Biomass[2] | | |
|---|---|---|---|---|---|---|
| | Grazed | Ungrazed | Burned | Grazed | Ungrazed | Burned |
| Phytophagous | | | | | | |
| March | 1,793 | 1,543 | 2,428 | 80 | 68 | 107 |
| June | 3,063 | 2,762 | 2,930 | 160 | 163 | 152 |
| August | 1,857 | 948 | 837 | 100 | 62 | 45 |
| Predaceous | | | | | | |
| March | 114 | 256 | 241 | 36 | 80 | 75 |
| June | 419 | 485 | 376 | 131 | 152 | 118 |
| August | 170 | 111 | 132 | 53 | 35 | 41 |
| Saprophagous | | | | | | |
| March | 713 | 261 | 363 | 64 | 24 | 33 |
| June | 1,262 | 2,074 | 1,447 | 114 | 187 | 130 |
| August | 1,574 | 798 | 1,133 | 142 | 72 | 102 |
| Total | | | | | | |
| March | 2,620 | 2,060 | 3,032 | 180 | 172 | 215 |
| June | 4,744 | 5,321 | 4,753 | 405 | 502 | 400 |
| August | 3,601 | 1,857 | 2,102 | 295 | 169 | 188 |

[1] Thousands of nematodes/m² to 40 cm depth.
[2] Dry weight in mg/m² to 40 cm depth.

burned areas was 405,502, and 400 mg/m$^2$, respectively. Peak density values for these areas were 4.7, 5.3, and 4.8 million nematodes per square meter. Highest density and biomass corresponded to the period of peak plant standing crop values, which was also noted in an earlier study (Smolik, 1974). Short-term effects associated with cattle grazing and wildfire had little impact on soil-dwelling nematodes of the shrub-steppe.

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