1975

Biology of Nematodes in Desert Ecosystems

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1975 PROGRESS REPORT

BIOLOGY OF NEMATODES IN DESERT ECOSYSTEMS

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US/IBP DESERT BIOME
RESEARCH MEMORANDUM 76-25

in

REPORTS OF 1975 PROGRESS
Volume 3: Process Studies
Invertebrate Section, pp. 29-32

1975 Proposal No. 2.3.3.5

Printed 1976

Citation format: Author(s). 1976. Title.
US/IBP Desert Biome Res. Memo. 76-25.
Utah State Univ., Logan. 4 pp.

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ABSTRACT

Estimates of nematode oxygen consumption at Rock Valley have been completed for 1974. These estimates do not include the effect of cryptobiotic periods during which there is a lower metabolic rate on nematode oxygen consumption. Nematode numbers and biomass for each trophic group were completed for the Rock Valley site. Microbial feeders were the most numerous, 2648/500 cm^3 soil, of all trophic groups at the 0-10 cm depth at the base of the plant, followed by omnivore-predators, fungal feeders and plant parasites. An average of all trophic groups showed a significant decline in numbers of nematodes with increasing depth and distance from plant. Of the four plant species, the largest numbers and biomass of nematodes were associated with *Lycium andersonii* and *Larrea tridentata*, including the most numerous populations of plant parasites. The density of omnivore-predators was not significantly different from plant to plant whereas the density of microbivores and fungivores was slightly higher under *Ambrosia* and *Krameria*, respectively. The annual mean number of nematodes was 422,590/m^2; annual respiration was 1590 ml $O_2 \cdot m^{-2} \cdot yr^{-1}$ (uncorrected for any cryptobiotic periods).

METHODS

Nematodes were collected, extracted (Freckman et al. 1975a), identified and tabulated into four trophic groups (microbial, fungal feeders, plant feeders and omnivore-predators) and an unidentifiable group (Freckman et al. 1975b). Nematode numbers for the nine samples at three depths (0-10, 10-20 and 20-30 cm) and three distances from the shrub base (base, edge of canopy and three shrub radii) were corrected for extraction efficiency.

The method for determining productivity of each nematode trophic group has been partially described (Freckman et al. 1975b) and is as follows: 100-150 nematodes in each of the respective trophic groups were measured to determine average length and width of the group; mean individual weight was determined according to Andrassy (1956); biomass was determined in kg/ha; respiration was measured according to the formula $R—1.40W^{-0.28}$ (Klekowski et al. 1972); effect of soil temperature on nematode respiratory rate was corrected to 20 C according to Winberg (1971); and a calorific equivalent of 4.8 cal/ml O_2 was used according to Yeates (1973). Some results are based on analyses of 1974 data. All four plant species were considered as a single replicate, because the differences between them were less significant than other effects (Freckman et al. 1975b).

Data for this report are stored under DSCODE A3UMB36.

RESULTS AND DISCUSSION

The distribution of the nematode trophic groups during 1975 on the four plant shrubs is shown in Figure 1. The trophic groups ranked quantitatively as follows: microbial feeders > omnivore-predators > plant parasites > fungal feeders. The microbial feeders and omnivores which represent 32-36 and 26-32% of the population, respectively, were distributed spatially as observed previously (Freckman et al. 1975b), decreasing in numbers with increasing depth and distance from the plants. Plant parasites represented 14-17% of the 1974 Rock Valley population and were positively correlated with roots at 11-20 cm depths near the four shrubs sampled. Higher numbers of plant parasitic nematodes were associated with roots of *Larrea tridentata* and *Lycium andersonii* and may be indicative of food preferences. Plant-parasitic nematodes observed at Rock Valley are all species of Tylenchorhynchinae (Freckman et al. 1975b) which browse on root surfaces. *Lycium andersonii* root systems have young, vigorous feeder roots around the root crown, while *Larrea tridentata* has a much larger root system with small-diameter roots (Wallace and Romney 1972).

There was only a slight seasonal change in the average numbers of nematodes in each trophic group during 1974 (Fig. 2). The numbers of nematodes decreased slowly with increasing soil temperatures and decreasing soil moistures from January to July. In July, a sudden rain increased soil moisture from 2-14%. Nematodes in all trophic groups declined sharply for a four-week period following the rain and slowly increased in numbers. It appears that the increased rainfall brought the nematodes out of cryptobiosis and, because of the additional moisture, enabled the nematodes to reproduce and increase their population by September. Average soil temperatures ranged from 3.7 to 30 C. The cooler, wetter periods from January-April and October-December were the periods of the larger populations. The annual mean number of nematodes was 422,590/m^2, estimated annual respiration was 1590 ml $O_2 \cdot m^{-2} \cdot yr^{-1}$ and the calorific equivalent of respiration was 7632 $cal \cdot m^{-2} \cdot yr^{-1}$. Our estimation of monthly nematode metabolic activity as expressed in mean numbers of oxygen consumption and calorific equivalents for each trophic group is given in Tables 1-4. Annual equivalents of these data are given in Table 5. These figures, however, are probably overestimates because the influence of cryptobiosis on the nematode population during the hot, dry months has not been considered. Cryptobiosis occurs in organisms with inconstant environment and is the possession of a dormant or latent state. While in this state, they have a lower or nondetectable metabolism (Bhatt and Rohde 1970). Corrections for cryptobiosis are now being determined.

Table 1. Mean numbers, oxygen consumption and calorific equivalents of fungal feeding nematodes for each of 12 months, and average soil temperatures at Rock Valley, Nevada

	Mean·m^{-2}·$month^{-1}$ (0-30 cm)	Oxygen consumption (ml O_2 consumed·m^{-2}·$month^{-1}$)	Calorific equivalent of oxygen consumption (cal·m^{-2})	Ave. soil temp. (°C) 0-30 cm depth
Jan	63,540	2	12	3.7
Feb	54,120	3	16	7.4
Mar	84,840	11	51	13.6
Apr	83,520	15	70	17.0
May	42,300	13	62	23.4
Jun	46,200	20	96	27.7
Jul	31,560	16	78	30.0
Aug	15,720	7	34	28.4
Sep	42,960	17	82	26.7
Oct	21,780	6	28	21.1
Nov	71,760	9	41	13.0
Dec	68,820	5	23	8.6

Table 2. Mean numbers, oxygen consumption and calorific equivalents of microbial feeding nematodes for each of 12 months, and average soil temperatures at Rock Valley, Nevada

	Mean·m^{-2}·$month^{-1}$ (0-30 cm)	Oxygen consumption (ml O_2 consumed·m^{-2}·$month^{-1}$)	Calorific equivalent of oxygen consumption (cal·m^{-2}·$month^{-1}$)	Ave. soil temp. (°C) 0-30 cm depth
Jan	168,000	9	46	3.7
Feb	214,800	19	93	7.4
Mar	305,400	57	275	13.6
Apr	173,400	45	217	17.0
May	157,800	71	343	23.4
Jun	187,800	120	576	27.7
Jul	193,200	148	712	30.0
Aug	66,000	45	215	28.4
Sep	216,000	128	613	26.7
Oct	109,200	44	211	21.1
Nov	244,800	43	206	13.0
Dec	233,400	25	119	8.6

Table 3. Mean numbers, oxygen consumption and calorific equivalents of omnivore-predaceous nematodes for each of 12 months, and average soil temperatures at Rock Valley, Nevada

	Mean·m^{-2}·$month^{-1}$ (0-30 cm)	Oxygen consumption (ml O_2 consumed·m^{-2}·$month^{-1}$)	Calorific equivalent of oxygen consumption (cal·m^{-2}·$month^{-1}$)	Ave. soil temp. (°C) 0-30 cm depth
Jan	115,200	7	36	3.7
Feb	131,400	14	66	7.4
Mar	145,200	32	151	13.6
Apr	108,600	33	157	17.0
May	108,000	57	272	23.4
Jun	101,400	75	360	27.7
Jul	88,800	79	377	30.0
Aug	41,400	32	155	28.4
Sep	169,800	116	557	26.7
Oct	67,200	31	150	21.1
Nov	162,000	33	158	13.0
Dec	160,200	20	94	8.6

Table 4. Mean numbers, oxygen consumption and calorific equivalents of plant-parasitic nematodes for each of 12 months, and average soil temperatures at Rock Valley, Nevada

	Mean·m^{-2}·$month^{-1}$ (0-30 cm)	Oxygen consumption (ml O_2 consumed·m^{-2}·$month^{-1}$)	Calorific equivalent of oxygen consumption (cal·m^{-2}·$month^{-1}$)	Ave. soil temp. (°C) 0-30 cm depth
Jan	84,000	4	19	3.7
Feb	106,800	8	38	7.4
Mar	77,400	12	57	13.6
Apr	75,600	16	78	17.0
May	49,200	18	88	23.4
Jun	44,400	23	112	27.7
Jul	54,600	35	166	30.0
Aug	32,400	18	86	28.4
Sep	49,200	24	115	26.7
Oct	21,000	7	33	21.1
Nov	100,800	15	70	13.0
Dec	77,400	7	32	8.6

Table 5. Annual numbers, oxygen consumption and calorific equivalents for four nematode trophic groups in desert soils at Rock Valley, Nevada

Nematode trophic groups	Mean no. identified·yr^{-1}	Metabolism (ml O_2·m^{-2}·yr^{-1})	Calorific equivalent (cal·m^{-2}·yr^{-1})
Fungal feeders	52,300	123	594
Microbial feeders	189,200	754	3625
Omnivore predators	116,600	527	2534
Plant parasites	64,400	185	894
Nematode community	422,590·m^{-2}	1590 ml O_2·m^{-2}·yr^{-1}	7632 cal·m^{-2}·yr^{-1}

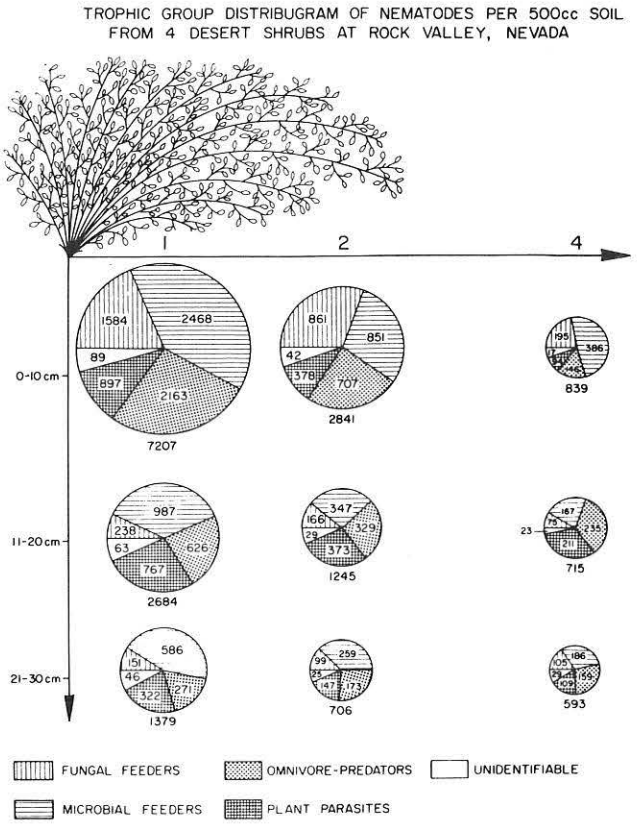

Figure 1. Trophic group distribugram of nematodes per 500 cc soil from four desert shrubs at Rock Valley, Nevada.

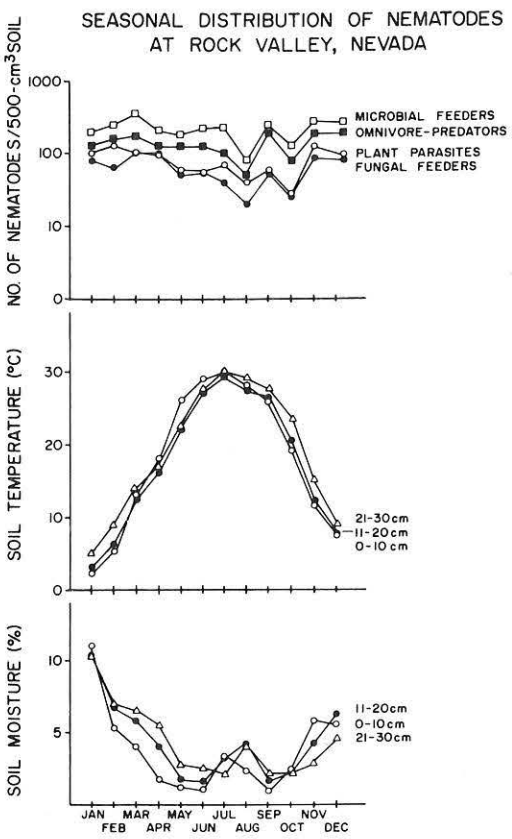

Figure 2. Seasonal distribution of nematodes at Rock Valley, Nevada.

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