

POLISH JOURNAL OF ECOLOGY (Pol. J. Ecol.)	49	2	123-135	2001
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A COMPARATIVE STUDY OF THE LIFE STRATEGIES OF
TWO BACTERIAL-FEEDING NEMATODES UNDER
LABORATORY CONDITIONS. II.
INFLUENCE OF THE INITIAL FOOD LEVEL ON THE
POPULATION DYNAMICS OF *ACROBELOIDES NANUS*
(DE MAN 1880) ANDERSON 1968 AND *DOLICHORHABDITIS*
DOLICHURA (SCHNEIDER 1866) ANDRÁSSY 1983

ABSTRACT: Population dynamics of two bacterial-feeding nematodes *Acrobeloides nanus* and *Dolichorhabditis dolichura* in relation to the initial food level was studied under laboratory conditions. Population density, age structure and selected productivity parameters of the two nematodes were compared in single and mixed species cultures.

Initial food (bacteria *Sporosarcina* sp.) level significantly affected population dynamics of *A. nanus* and *D. dolichura* in the laboratory cultures. While *A. nanus* grew well at the three food levels, *D. dolichura* developed only at the highest initial density of food.

There were significant differences in population dynamics of both studied species at the highest initial density of the bacterial food. In single species cultures population peak of *D. dolichura* occurred earlier than that of *A. nanus* and maximal density of *D. dolichura* was significantly higher than maximal density of *A. nanus*. In mixed cultures population maximum was observed at the same time in both species and their peak densities were similar.

Population maximum of *A. nanus* in mixed cultures was observed earlier than in its single cultures but the peak density of that species in single cultures was significantly higher than in mixed ones. Population peak of *D. dolichura* at the highest food level occurred at the same time irrespective of the type of culture, while peak abundance of that

species in mixed cultures was almost 50% lower than in single cultures.

The differences observed in population dynamics of the two nematode species were discussed with respect to the differences in the food supply of their natural habitats and the role they play in the processes of decomposition and mineralisation in soil.

KEY WORDS: life strategy, bacterial feeding nematodes, initial food level, population dynamics, age structure, population productivity

1. INTRODUCTION

Life-history traits of the two bacterial-feeding nematodes *A. nanus* and *D. dolichura* studied by Ilieva-Makulec (1997, 2001) are obviously only a part of their life-history strategy. Knowledge of their feeding biology would allow to compare the competitive abilities of these species and to understand their role in decomposition processes in soil. So far, feeding requirements of bacterial-feeding nematodes are poorly understood. Some information about the population growth rates of bacterial-feeding nematodes

as a function of food supply can be found in the works of Schiemer (1982a, b, 1983) and Venette and Ferris (1998).

Nematodes from the family Rhabditidae (represented in the current study by *D. dolichura*) occur in short-lived habitats with temporarily high food abundance (Sohlenius 1969b, 1973c, Wasilewska 1974, Yeates 1981, Kozłowska 1986, Dmowska and Kozłowska 1988, Weiss and Larink 1991, Ettema and Bongers 1993). They are called "eusaprobionts" (Paramonov 1962) or "enrichment opportunists" i.e. colonizers in organically rich soils (Ettema and Bongers 1993). In such habitats, with extremely high bacterial activity and high rate of decomposition and mineralization, these nematodes may account for 90% of the whole community (Sohlenius 1973c, Yeates 1981, Kozłowska 1986). In arable soils percent share of these nematodes ranges from 5–10% (Szczygieł 1966) to 22% (Sohlenius 1973c) while in forest mineral soils only 1–1.5% of nematode fauna belong to the genus *Rhabditis* (Yeates 1972, Sohlenius 1973c, Bååth *et al.* 1978).

Species from the family Cephalobidae (represented in these experiments by *A. nanus*) occur in habitats with various food supply (Bååth *et al.* 1978, Sohlenius 1993). Very often they are dominants in nematode communities (Wasilewska 1976, Sohlenius 1996). In grassland soils about 10% of all nematodes belong to the genus *Acrobeloides* (Sohlenius 1973b), in forest soils its percent share was higher – 36% (Sohlenius and Wasilewska 1984), whereas in arable soil even 44% (Sohlenius and Sandor 1987). Cephalobid nematodes are called "general opportunists" and they are rarely replaced by other genera during the secondary succession (Ettema and Bongers 1993). Paramonov (1962) called them "devisaprobionts" because unlike to Rhabditidae they are not so strongly bound to the saprobic habitat but can also be found even in healthy plant parts. Some other works also showed the connections of Cephalobidae with the plants (Roguska-Wasilewska 1961, Ingham *et al.* 1985, Brussaard *et al.* 1990, Grifiths *et al.* 1991, 1992).

Thus, there are distinct differences in food supply of the natural habitats in which dense populations of *A. nanus* and *D. dolichura* occur. These differences suggest that it might be of interest to see the effect of food

supply on the population dynamics of these two species under laboratory conditions.

The aim of this work was to study and to compare population dynamics of *A. nanus* and *D. dolichura* in relation to the initial level of the bacterial food.

2. MATERIALS AND METHODS

The experiments were conducted in Petri dishes with a diameter of 10 cm. 25 ml of 0.6% sterile bactoagar (without any nutrients to create a situation in which the two nematode species would be limited by the abundance of available food with time) with a known density of a bacteria *Sporosarcina* sp. was poured into sterile Petri plates. Three different initial food densities were prepared: 8×10^8 colony-forming-units (cfu) ml⁻¹ (high); 8×10^7 cfu ml⁻¹ (medium) and 8×10^6 cfu ml⁻¹ (low). Each plate was inoculated with 25 young females of each nematode species. At each initial level of the bacterial food the experiment was carried out in three variants (Table 1). Feeding requirements of *A. nanus* and *D. dolichura* were studied by culturing nematodes separately (single species cultures) and together (mixed species cultures). The animals used to start the cultures were selected randomly from monoxenic cultures of the two nematode species with the density of a food organism – *Sporosarcina* sp. – 8×10^8 cfu ml⁻¹. The experiments were conducted in the darkness at $20 \pm 1^\circ\text{C}$. All experimental animals were inoculated at the central part of the plates.

Table 1. Experimental design

Initial density of the bacteria	Variant	Initial nematode density (ind. plate ⁻¹)	
		<i>A. nanus</i>	<i>D. dolichura</i>
<i>Sporosarcina</i> sp. High (8×10^8 cfu ml ⁻¹)	1	25	–
	2	–	25
	3	25	25
Medium (8×10^7 cfu ml ⁻¹)	1	25	–
	2	–	25
	3	25	25
Low (8×10^6 cfu ml ⁻¹)	1	25	–
	2	–	25
	3	25	25

cfu – colony forming units

Twice per week all experimental plates were uncovered for 30 minutes to be aerated. The experiment lasted 49 days. Every seven days population numbers of each species were determined in 6 replicate plates. As the methods used were destructive, enough cultures (in total 126 plates) were started to provide material for successive samplings.

To estimate population production values of the studied species at each sampling date about 15–30 juveniles and adults from each variant were taken and their length and width were measured under the microscope. In *D. dolichura* cultures with medium and low bacterial concentrations, because of the very low nematode densities, all found individuals were measured. The equation of Andrassy (1956) was used to calculate the nematode weight.

Mean body weight of juveniles and adults as well as mean abundance of those two development stages in the experimental cultures were used to calculate the population biomass.

Data concerning the length and rate of reproduction, survival rates of different development stages (see details in Ilieva-Makulec 2001) as well as data on the density and biomass of juveniles and adults from that experiment were used to estimate population production of both studied species at the highest food level. The equation of Petrusiewicz (1967) was used in calculations:

$$P = \Delta B + E,$$

where:

P – total population production,

ΔB – population production derived from the body growth and reproduction i.e. change in standing crop of population during time t ,

E – elimination i.e. loss of energy enclosed in population biomass as a result of deaths.

Total production of *A. nanus* and *D. dolichura* populations in the experiment was calculated as a sum of production values from all successive samplings.

Production values were converted to energy units assuming dry weight to be 20% of fresh weight (Yeates 1979) and 1 mg dry weight to represent 23 J (Nicholas and Stewart 1978).

The significance of differences between means of all studied population parameters was estimated with non-parametric Mann-Whitney test (Siegel 1956).

An analysis of variance (ANOVA) was applied to the density of the two nematode species on the effects of food concentration (three initial food levels), type of culture (single and mixed species cultures) and time of the study (7 sampling dates during the study period). Analyses of variance were performed on all experimental results using the Statgraf statistical package. The significantly different means ($P < 0.05$) were separated using Tukey's Honestly Significant Difference.

The η^2 (so called ratio of correlation) was used to describe what proportion of the variance in the experimental results can be explained by each particular studied factor and/or their interactions (Brzeziński and Stachowski 1984).

3. RESULTS

3.1. POPULATION DYNAMICS OF *A. NANUS*

There were significant differences in the population dynamics of *A. nanus* at different initial densities of bacteria *Sporosarcina* sp. The initial food inoculum explained 22% of the variance in *A. nanus* density (Table 2).

In both, single and mixed cultures, populations of *A. nanus* were the most abundant at the highest initial bacterial level (Figs 1A, 2A). The abundance of *A. nanus* populations in single cultures decreased significantly with decreasing of the initial density of *Sporosarcina* sp. (Tukey test, $P 0.05$). However, in mixed cultures such a correlation was not found. For example, at the lowest initial density of *Sporosarcina* sp., *A. nanus* populations were more abundant than at a medium bacterial density (Tukey test, $P 0.05$).

At the highest initial level of *Sporosarcina* sp. *A. nanus* population peak was observed 35 days after the beginning of the experiment in single cultures and on 28th day in mixed cultures. At medium bacterial density, maximal density of *A. nanus* was noticed 7 days later – on 42nd and 35th day, respectively in single and mixed cultures. After the peak, the abundance of *A. nanus* decreased irrespective of bacterial level and type of cultures (Figs 1A, 2A).

The population growth pattern of *A. nanus* significantly differed between its single and mixed cultures at the same initial

Table 2. Results from three-way ANOVA for *A. nanus* population density at three initial food levels, two types of cultures and 7 sampling dates during the study period

Source of variation:	SS	d.f.	MS	F*	η^2 (%)
Initial food level (IFL)	6015132	2	3007565.9	153.45	22
Culture type (C)	853422	1	853421.5	43.54	3
Time (T)	7722433	6	1287072.1	65.67	28
Interactions:					
IFL \times C	549986	2	274993.0	14.03	2
IFL \times T	4609781	12	384148.4	19.60	17
C \times T	3199062	6	533177.1	27.20	12
IFL \times C \times T	3726803	12	310566.0	15.85	14
Error	624321	210	2972.9		2

* – all results were significant at $P < 0.001$

η^2 – ratio of correlation – describes what proportion of the variance in the experimental results could be explained by studied factors

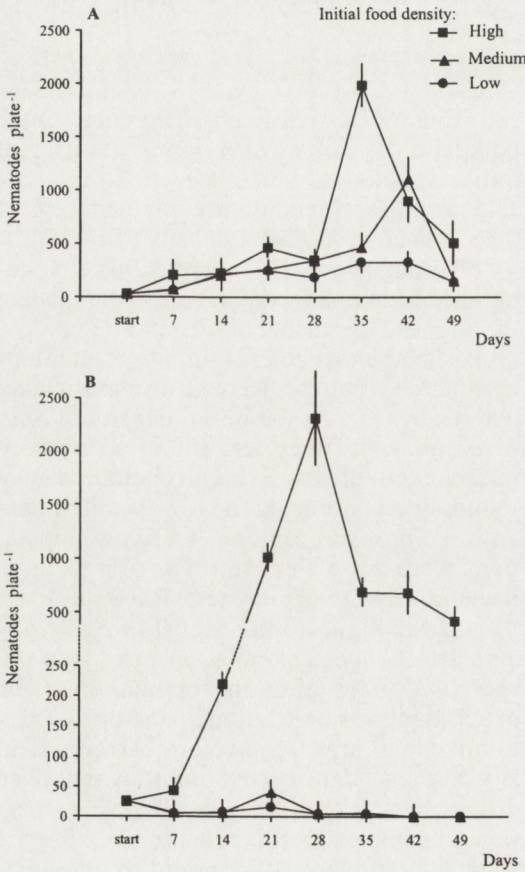


Fig. 1. Population dynamics of *A. nanus* (A) and *D. dolichura* (B) at three initial food levels in single species cultures (mean densities \pm S.D.),

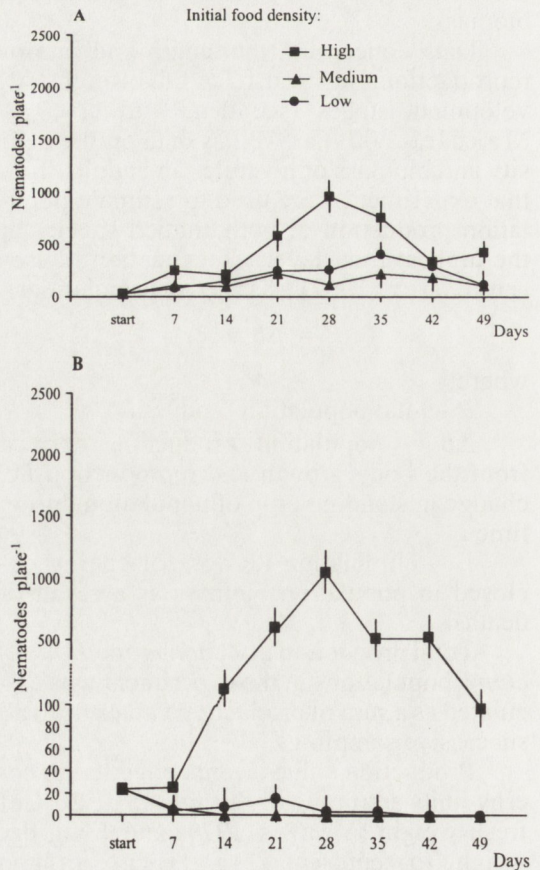


Fig. 2. Population dynamics of *A. nanus* (A) and *D. dolichura* (B) at three initial food levels in mixed species cultures (mean densities \pm S.D.).

level of bacterial food (Table 2, $P < 0.05$). Furthermore, *A. nanus* populations at high and medium bacterial level were more abundant in single than in mixed cultures (Tukey test, $P < 0.05$). The abundance of *A. nanus* was similar in single and mixed cultures only at the lowest bacterial density.

The presence of the second nematode species (*D. dolichura*) in cultures influenced the time when the maximum of *A. nanus* population was reached. At both initial levels of bacterial food – high and medium, the population maximum of *A. nanus* in mixed cultures was observed 7 days earlier than in its single cultures. However, the peak abundance of *A. nanus* in single cultures was significantly higher than in mixed ones (Mann-Whitney test, $P < 0.05$) (Figs 1A, 2A).

3.2. POPULATION DYNAMICS OF *D. DOLICHURA*

It was found that initial density of bacterial food influenced significantly the population growth of *D. dolichura*. The results of ANOVA presented in Table 3 indicate that food inoculum explained almost 40% of the total variance in *D. dolichura* density.

Unlike *A. nanus*, population growth of *D. dolichura* at medium and low initial food levels was negligible (Figs 1B, 2B). In both, single and mixed cultures, *D. dolichura* abundance was significantly higher at the highest in comparison to the other two levels of the bacterial food (Tukey test, $P < 0.05$).

Population development pattern of *D. dolichura* differed significantly between its single and mixed with *A. nanus* cultures at the same initial bacterial level ($P < 0.05$).

The abundance of *D. dolichura* at the highest bacterial density was significantly higher in single than in mixed cultures (Tukey test, $P < 0.05$). In the two species cultures *D. dolichura* populations peaked the same day (after 28 days) that did *D. dolichura* cultured alone, but peak population abundance of that species in mixed cultures was almost 50% lower than that in the single cultures (Mann-Whitney test, $P < 0.05$). After the peak the abundance of *D. dolichura* continuously decreased till the end of the experiment

It was difficult to assess the effect of medium and low bacterial level on *D. dolichura* population growth because of the very low abundance of that species in these cultures (Figs 1B, 2B).

3.3. A COMPARISON OF THE POPULATION DYNAMICS, AGE STRUCTURE, BODY LENGTH AND PRODUCTIVITY OF *A. NANUS* AND *D. DOLICHURA*

There were significant differences in population dynamics of both studied species at the same initial density of bacterial food (Figs 1, 2). It was found that only at the highest bacterial level and only the single populations of *D. dolichura* were more abundant than the single populations of *A. nanus*

Table 3. Results from three-way ANOVA for *D. dolichura* population density at three initial food levels, two types of cultures and 7 sampling dates during the study period

Source of variation:	SS	d.f.	MS	F*	η^2 (%)
Initial food level (IFL)	19684043	2	9842021.0	831.53	41
Culture type (C)	805464	1	805464.3	68.05	2
Time (T)	7556215	6	1259369.1	106.40	16
Interactions:					
IFL \times C	1502891	2	751445.4	63.49	3
IFL \times T	15079438	12	1256619.8	106.17	31
C \times T	1008531	6	168088.6	14.20	2
IFL \times C \times T	1974178	12	164514.8	13.91	4
Error	653434	210	311.6		1

* – all results were significant at $P < 0.001$

η^2 – ratio of correlation – describes what proportion of the variance in the experimental results could be explained by studied factors

(Tukey test $P < 0.05$). In all other variants, *A. nanus* populations were significantly more abundant than the populations of *D. dolichura* (Tukey test, $P < 0.05$).

At the highest bacterial density in single species cultures, population peak of *A. nanus* was noticed later (on 35th day) than in *D. dolichura* (on 28th day). Maximal density of *D. dolichura* was significantly higher than maximal density of *A. nanus* (Mann-Whitney test, $P < 0.05$). After the peak, population density of *D. dolichura* decreased more rapidly than the density of *A. nanus* and the nematode density at the end of the experiment in comparison to the peak density was 82 and 72% lower for *D. dolichura* and *A. nanus*, respectively (Figs 1A, 2A).

In mixed cultures with high initial level of *Sporosarcina* sp. population maximum was observed at the same time in both studied species (after 28 days). By contrast to the single cultures peak densities of *A. nanus* and *D. dolichura* in mixed cultures were similar ($P < 0.05$). The decline phase which occurred

after the peak was again much more pronounced in *D. dolichura* than in *A. nanus*. At the end of the experiment the abundance depression was 49% for *A. nanus* and up to 91% for *D. dolichura* populations (Figs 1B, 2B).

It was found that in both types of cultures juvenile forms dominated in *A. nanus* populations. Their percent share varied between 68 and 93% of the total density and no significant differences in different trials were found (Figs 3A, B, C and 4A, B, C).

Juvenile forms dominated also in populations of *D. dolichura* at the highest initial bacterial level. Their percent share was very high during the whole experiment but especially when population peak was observed – 96 and 94% of the total density in single and mixed cultures respectively (Figs 3D and 4D). At medium and low food levels the situation was not so clear, in some observations significantly higher percent of adult forms was found while in the others juveniles were the only age group noticed in the *D. dolichura* populations (Figs 3E, F and 4E, F).

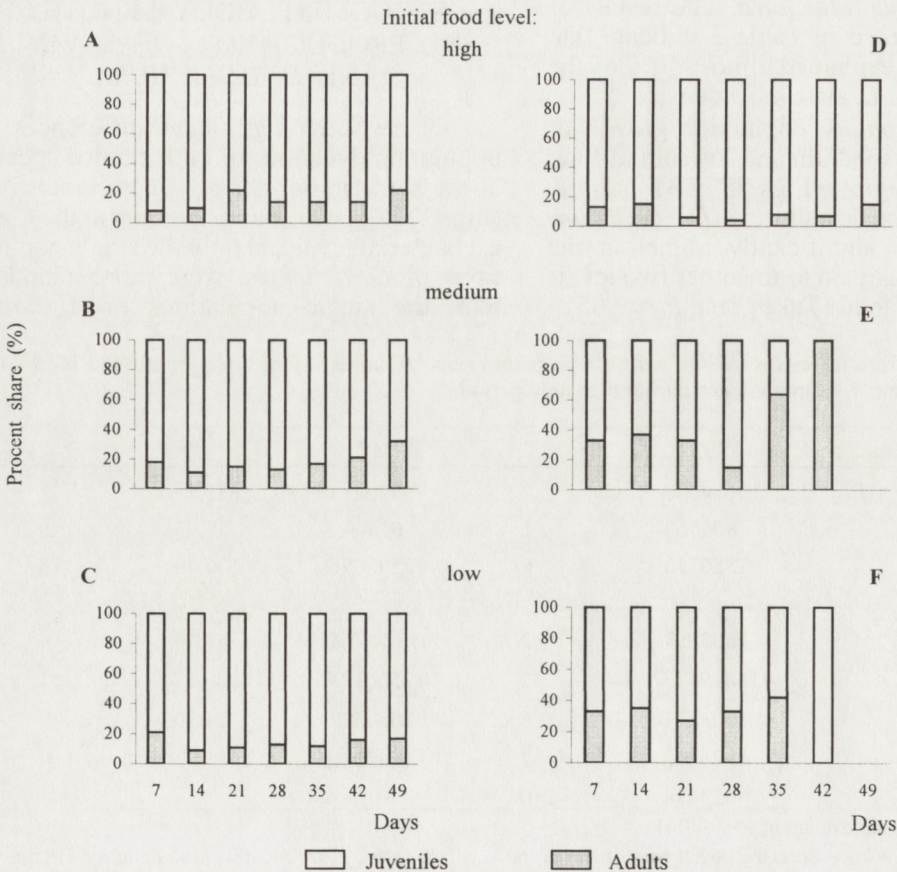


Fig. 3. Age structure of *A. nanus* (A, B, C) and *D. dolichura* (D, E, F) populations in single species cultures at three initial food levels.

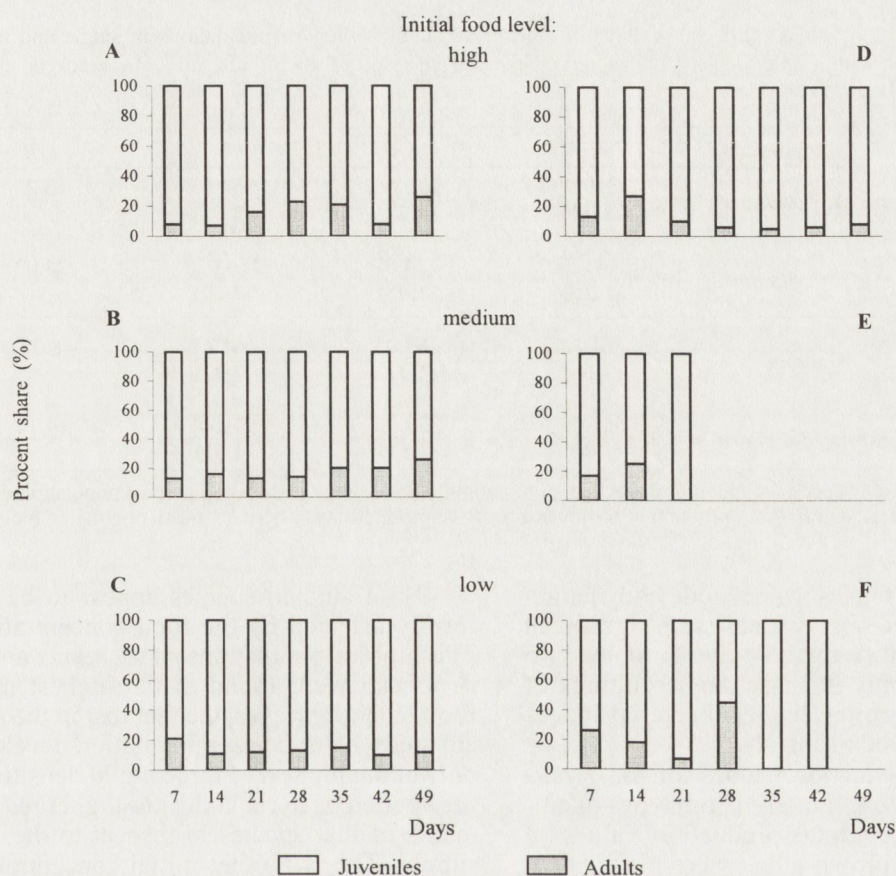


Fig. 4. Age structure of *A. nanus* (A, B, C) and *D. dolichura* (D, E, F) populations in mixed species cultures at three initial food levels.

The age structure of *D. dolichura* and *A. nanus* populations did not depend on the presence of the second species in the cultures.

During the first 14 days of the experiment in both, single and mixed cultures more juveniles were found in *A. nanus* as compared to *D. dolichura* populations. In contrary,

more juveniles were found in *D. dolichura* than in *A. nanus* populations in later observations (Figs 3A, D and 4A, D).

It was found that females of the two studied species 14 days after the beginning of the experiment were longer than the females found after 49 days of culturing (Table 4).

Table 4. Body length (in μm) of *A. nanus* and *D. dolichura* females (mean \pm SD) in single (A) and mixed (B) species cultures at three different initial food levels

Days of culturing	<i>A. nanus</i>			<i>D. dolichura</i>		
	Initial food level			Initial food level		
	High	Medium	Low	High	Medium	Low
(A)						
14 days	457.5 \pm 24.8	440.6 \pm 9.4	440.0 \pm 0.7	834.5 \pm 140.2	775.0 \pm 33.2	780.0 \pm 15.4
49 days	398.5 \pm 9.6	425.6 \pm 13.2	420.0 \pm 14.6	777.5 \pm 100.7	–	–
(B)						
14 days	476.3 \pm 17.7	491.9 \pm 62.9	476.6 \pm 30.1	870.0 \pm 50.2	715.0 \pm 10.4	798.0 \pm 13.4
49 days	402.8 \pm 23.4	401.6 \pm 35.6	412.5 \pm 26.1	780.0 \pm 32.1	–	–

–no females were found

Table 5. Production values* (μg wet weight) of *A. nanus* and *D. dolichura* populations in single and mixed species cultures with initial density of bacteria *Sporosarcina* sp. of 8×10^8 cfu ml⁻¹. In brackets energy equivalents (in J) are given.

Culture	Population	<i>E</i>	ΔB	<i>P</i>	P/\bar{B}
Single	<i>A. nanus</i>	379.09 (1.74)	275.56 (1.27)	654.65 (3.01)	13.25
	<i>D. dolichura</i>	1141.21 (5.25)	424.07 (1.95)	1565.28 (7.20)	24.02
Mixed	<i>A. nanus</i>	361.74 (1.66)	283.93 (1.31)	645.67 (2.97)	8.08
	<i>D. dolichura</i>	651.09 (3.00)	328.35 (1.51)	979.44 (4.51)	19.14

* – sum from seven successive measurements, *E* – elimination, ΔB – change in standing crop of population during time *t*, *P* – total production, P/\bar{B} – production turnover or relative productivity, where \bar{B} – mean population biomass.

The differences in nematode body length from these two observations were significant ($P < 0.05$) in all mixed cultures of the two species and only in those single cultures of *A. nanus* where the highest bacterial inoculum was applied (Table 4).

Total production values of *A. nanus* populations were similar in both types of cultures. However, total production values of *D. dolichura* grown alone were higher than when it was grown together with *A. nanus* (Table 5).

Absolute production values of *D. dolichura* were higher than values of *A. nanus* independent on the type of cultures (Table 5).

The ratio P/\bar{B} of the both studied species was higher in their single cultures than in mixed cultures. It was found that the production turnover was faster in *D. dolichura* than in *A. nanus* independent on the type of culture (Table 5)

4. DISCUSSION

4.1. NEMATODE POPULATION DYNAMICS AS AFFECTED BY FOOD ABUNDANCE

The results of this study confirm Schiemer's findings (1982a, b, 1983) about food dependence of bacterial-feeding nematodes. According to Schiemer there is a critical threshold of food supply below which no individual and population growth is observed.

Both studied species appear to be uniformly affected by the food concentrations. The highest populations of *A. nanus* and *D. dolichura* were found at the highest initial food level. However, the fact that in the present study *D. dolichura* population developed only at the highest of three initial densities of the applied bacteria, indicates higher requirements of that species in respect to the food supply. The two other initial concentrations of *Sporosarcina* sp. – 10^6 and 10^7 cfu ml⁻¹ (medium and low) are undoubtedly close to the critical threshold characteristic for that species. It seems that such food densities are sufficient for covering metabolic costs, but not the growth and reproduction of *D. dolichura*.

The lowest food concentration at which growth and reproduction of bacterial-feeding nematodes are observed is different for different species. For example for *Caenorhabditis briggsae* it lies above 10^8 cfu ml⁻¹ (Nicholas *et al.* 1973, Schiemer 1982a, b) while for the *Plectes palustris* it is below 10^8 ml⁻¹ (Schiemer *et al.* 1980). Feeding requirements of *D. dolichura* were similar to those of some other species of Rhabditidae: *Pelodera* sp. (Marchant and Nicholas 1974), *Caenorhabditis elegans* (Croll 1975) and *Rhabditis curvicauda* (Woombs and Laybourn-Parry 1984). *A. nanus* in the present experiments showed a lower food dependence than *D. dolichura*. The fact that populations of *A. nanus* developed at the three applied food concentrations shows its ability for adaptations to such a food supply which is insufficient for *D. dolichura*.

My finding that females of both studied species at the end of the experiment were shorter than the females at the beginning is in agreement with the results of other authors – Chuang (1962), Sohlenius (1969b, 1973b) and Popovici (1973). These changes in the body length are probably connected with the decrease of food supply during the experiment. As food concentrations are reduced, growth rates of individuals decrease and maturation time increases; animals tend to mature at a smaller body size. Similar results were obtained when life cycles of those two species were studied in xenic and monoxenic agar cultures (Ilieva-Makulec 2001).

According to Sohlenius (1969a, b) some common features in population growth of bacterial-feeding nematodes can be found. Usually the period of slow increase in numbers at the beginning is followed first by the period of an exponential growth and then the period of decrease of population density. Population dynamics of the two species in the present study showed great similarities with that pattern.

Population dynamics of *D. dolichura* was similar to that of *Rhabditis oxycerca* observed by Marinari Palmisano and Turchetti (1975) in monoxenic cultures with other Gram-positive bacteria – *Bacillus subtilis*. The population maximum of those two nematode species was observed at about the same time – after 25 days for *R. oxycerca* and after 28 days for *D. dolichura*. Unlike *D. dolichura*, the density of *R. oxycerca* did not decrease so fast after the peak and it remained at a high level up to 60th day of the experiment.

In comparison to *D. dolichura* some other species from the families Rhabditidae and Diplogasteridae reached their population maximum earlier – *Pelodera teres* in 8–10 days, *Mesodiplogaster biformis* and *Diplogaster nudicapitatus* in 10–12 days and *Rhabditis terricola* in 12–15 days (Sohlenius 1969b).

Population peak of *A. nanus* in monoxenic cultures with *Sporosarcina* sp. (in the present study) and in cultures with *E. coli* (Popovici 1973) occurred approximately at the same time, after 35 and 40 days, respectively. In the cultures with *E. coli*, Sohlenius (1973a) observed the highest growth rate of *A. nanus* population in 35 and 40 days, while the population maximum occurred till after 53 days. Thomas (1965) observed several peaks in the population dynamics of *Ac-*

robeles complexus and the last of them occurred on 80th day of the experiment.

The distinct differences in population dynamics of both species are probably due not only to their different feeding requirements but also to their different pattern of colonising the Petri plates. Direct observations indicated that *A. nanus* has stronger tendencies to aggregate on the agar surface, while *D. dolichura* moved and dispersed faster over the surface. The ability of *Acrobeloides* sp. to form reproductive spots was observed by Jairajpuri and Azmi (1977). Hence, it seems that in my experiment just exactly that ability to make aggregates permitted the individuals of *A. nanus* to overcome the initial environmental resistance due to the dense bacterial growth. It was possible because, as Hanschke *et al.* (1969) (cited after Sohlenius 1988) found, individuals in a group of nematodes can excrete some exoenzymes, which suppress bacterial growth. In such a way, group effects were probably of greater importance for the establishment of the *A. nanus* populations because, as it is known, the nematodes from the genus *Acrobeloides* do not tolerate high density of bacterial food (Sohlenius 1973b, 1993, Bååth *et al.* 1978). The fact that in mixed cultures *A. nanus* peaked earlier than in its single cultures suggests that the presence of *D. dolichura* (using the same source of food) also had an additional beneficial effect on *A. nanus* at the beginning of the experiment.

Population dynamics of both studied species differed much more between their single than in mixed cultures and it was opposite to the situation observed by Sohlenius (1988) where two species of the genus *Panagrolaimus* were studied.

Populations of *A. nanus* and *D. dolichura* were more abundant in single than in mixed cultures. These findings are in line with the results of Sohlenius (1988). Probably the presence of two nematode species using the same food source leads to a faster decrease of food supply in mixed cultures than in single cultures.

4.2. POPULATION AGE STRUCTURE AND FOOD AVAILABILITY

The competitive abilities and coexistence of nematode species in a food limited habitats depend not only on differences in their survival rates but also on the age structure of nematode populations.

The results concerning the age structure of *D. dolichura* populations at the highest bacterial concentration and of *A. nanus* at all three applied bacterial densities were similar with the microcosm observations of Anderson *et al.* (1981) and with the field studies of Kozłowska (1967) and Wasilewska (1967). According to Wasilewska (1967) characteristic for eusaprobionts (mainly nematodes from Rhabditidae and Diplogasteridae to whom *D. dolichura* belongs) is very high percent share of juveniles (90–96.8%) in their populations. The same author found a lower percent share of juveniles in the populations of the devisaprobionts (mainly Cephalobidae and Panagrolaimidae) – from 66 to 72.4%. In the studies of Kozłowska (1967) juvenile and adult forms from Rhabditidae and Diplogasteridae constituted 97.5 and 2.5%, respectively while the same age groups belonged to Cephalobidae accounted for 78 and 22%, respectively. In a microcosm study percent share of adults in *A. nanus* populations ranged between 24 and 30% (Anderson *et al.* 1981).

The age structure of *D. dolichura* populations at medium and lowest bacterial concentrations differed significantly from the pattern described above. The observed pronounced fluctuations of the ratio between adults and juveniles could be explained by very low growth and reproduction rates of *D. dolichura* in such, probably unfavourable, food conditions.

4.3. NEMATODE POPULATION PRODUCTIVITY AND FOOD SUPPLY

The ratio P/\bar{B} (i.e. turnover or relative productivity) for *D. dolichura* populations (24 and 19.1, respectively in single and mixed cultures) and for *A. nanus* (13.3 in single cultures) was higher than the P/\bar{B} value obtained in natural conditions by Sohlenius (1979) for the whole nematode community (7.8) and also for the group of bacterial-feeding nematodes (9.3). Only the production turnover of *A. nanus* in mixed cultures (8.1) was similar to the results of Sohlenius (1979).

5. CONCLUSIONS

The obtained results show pronounced differences between the two studied bacte-

rial-feeding nematodes *A. nanus* and *D. dolichura* when their population growth parameters in relation to initial food level was studied. According to Schiemer (1983) differences in the species reaction to food supply could explain their occurrence and/or a probable species succession in a changeable environment. The results from many studies showed that species from the two families Rhabditidae and Cephalobidae were the first nematode colonizers of the sites where decomposition processes occurred. However, some authors (Bååth *et al.* 1978, Wasilewska *et al.* 1981, Sohlenius and Wasilewska 1984, Wasilewska and Bienkowski 1985, Griffiths and Caul 1993, Griffiths *et al.* 1994) found that in some cases the decomposition was connected with the domination of rhabditid, while in others cases (Wasilewska 1979, Santos *et al.* 1981, Sohlenius and Boström 1984, Pradham *et al.* 1988, Griffiths *et al.* 1993) with cephalobid nematodes. According to Southey (1982), the pronounced dominance of Rhabditidae among bacterial-feeding nematodes is an evidence for decomposition of fresh organic material in wet habitats. Bouman *et al.* (1993) found that the dense populations of Rhabditidae were connected with short-term but intensive mineralization, while the occurrence of Cephalobidae with more stable rates of mineralization processes. Present results following Ettema and Bongers (1993) allow for including *D. dolichura* to the group of "enrichment opportunists" i.e. species of organically rich habitats and *A. nanus* to the group of "general opportunists".

In spite of the obvious limitations to laboratory experiments such as that described it is possible to state that, under conditions of the experiment, initial food level does exert strong influence on population dynamics of the two studied nematode species.

6. SUMMARY

Life-history traits of the two bacterial-feeding nematodes *Acrobeloides nanus* and *Dolichorhabditis dolichura* studied by Ilieva-Makulec (1997, 2001) are obviously only a part of their life-history strategy. Knowledge of their feeding biology would allow to compare the competitive abilities of these species and to understand their role in decomposition processes in soil.

Population dynamics of two bacterial-feeding nematodes *A. nanus* and *D. dolichura* in relation to the initial food level was studied under laboratory conditions (Table 1). Population density, age structure and selected productivity parameters of the two nematodes were compared in single and mixed species cultures.

Both studied nematode species appear to be significantly and uniformly affected by the food concentrations (Tables 2 and 3, Figs 1 and 2). The highest populations of *A. nanus* and *D. dolichura* were found at the highest initial food level. But, while *A. nanus* grew well at the three food levels, *D. dolichura* developed only at the highest initial density of food. That fact, indicates higher requirements of *D. dolichura* in respect to the food supply.

There were significant differences in population dynamics of both studied species at the highest initial density of the bacterial food (Figs 1 and 2). In single species cultures population peak of *D. dolichura* occurred earlier than that of *A. nanus* and maximal density of *D. dolichura* was significantly higher than maximal density of *A. nanus*. In mixed cultures population maximum was observed at the same time in both species and their peak densities were similar.

Population maximum of *A. nanus* in mixed cultures was observed earlier than in its single cultures but the peak density of that species in single cultures was significantly higher than in mixed cultures. Population peak of *D. dolichura* at the highest food level occurred at the same time irrespective of the type of culture, while peak abundance of that species in mixed cultures was almost 50% lower than in single cultures (Figs 1 and 2).

The distinct differences in population dynamics of both species are probably due not only to their different feeding requirements but also to their different pattern of colonising the Petri plates. Direct observations indicated that *A. nanus* has stronger tendencies to aggregate on the agar surface, while *D. dolichura* moved and dispersed faster over the surface. It seems that in my experiment just exactly that ability to make aggregates permitted the individuals of *A. nanus* to overcome the initial environmental resistance due to the dense bacterial growth. The fact that in mixed cultures *A. nanus* peaked earlier than in its single cultures suggests that the presence of *D. dolichura* (using the same source of food) also had an additional beneficial effect on *A. nanus* at the beginning of the experiment.

The differences observed in population dynamics (Figs 1 and 2), body length of females (Table 4), age structure (Figs 3 and 4) and productivity (Table 5) of the two nematode species could be explained by the differences in the food supply of their natural habitats and the role they play in the processes of decomposition and mineralisation in soil.

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