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THE PLANARIAN *ARTIOPOSTHIA TRIANGULATA* (DENDY) FEEDING ON EARTHWORMS IN SOIL COLUMNS

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Summary—Predation on three species of earthworms by the terrestrial planarian, *Artioposthia triangulata*, was compared in columns of artificial soil (10 cm dia, 1 m depth) at four different temperatures (5, 10, 12 and 16°C). The planarian significantly reduced the number of earthworms and affected the vertical distribution of all species by reducing prey numbers in the top 20 cm. Greater earthworm mortality occurred at higher temperatures but there was no difference in the numbers of each species that were killed. © 1997 Elsevier Science Ltd.

INTRODUCTION

The terrestrial planarian, *Artioposthia triangulata* (Dendy), is an introduced predator of earthworms from New Zealand that has successfully established itself in the British Isles and other islands in north-west Europe (Blackshaw and Stewart, 1992).

This planarian can have substantial effects on natural earthworm populations and may cause localised prey extinction (Mather and Christensen, 1993; Blackshaw, 1995). There is also evidence that there may be differential effects on earthworm species with some, e.g. *Lumbricus terrestris* (L.), more susceptible to predation in the field (Blackshaw, 1990).

Previous reports have quantified predation rates in dishes at constant temperature (e.g. Blackshaw, 1991). Variable temperature will be a feature of the planarian–earthworm interaction in the field. This paper reports an investigation into the feeding effect of *A. triangulata* on the survival of three earthworm species in artificial soils at four different temperatures that lie within the normal range for Northern Ireland.

MATERIALS AND METHODS

Medium loam soil was mixed with horse manure at a ratio of 9:1 by mass and sterilised for 48 h at 80°C. Water was added to bring the soil up to a friable consistency (moisture range 21–25% of wet soil mass).

One metre lengths of plastic piping (10 cm dia) were cut into 10 cm sections and reassembled with the joints covered by adhesive plastic tape. The soil mixture was added to these pipes and gentle vibration used to facilitate settlement of the soil. Wood boards were then externally clamped to the top and bottom.

Adults of *L. terrestris*, *L. rubellus* (Hoffmeister) and *Allolobophora chlorotica* (Savigny) were collected from the field using formalin sampling, washed and then stored at 5°C for 2 weeks to ensure that only healthy specimens were used. Individuals were picked at random and put in single species batches of eight prior to introduction to the tubes.

A sequence of four experiments was carried out at 5, 10, 12 and 16°C. The earthworms were added to the pipes and allowed to acclimatise for 7 days at the experimental temperature. Each experiment consisted of three blocks with six pipes each of the three species. A single specimen of *A. triangulata* was added to half the pipes at the end of the acclimatisation period.

The pipes were maintained at the experimental temperatures for 3 weeks and then opened and searched using hand-sorting. The numbers of earthworms and the depth section within the pipe where they were found were recorded.

Data were first analysed for the effect of *A. triangulata* on the total number of each earthworm species surviving in the tubes by analysis of variance. The analysis was then extended to include the depth at which earthworms were found and all possible interactions.

RESULTS

All *A. triangulata* survived the experiment. The presence of the planarians had a significant effect

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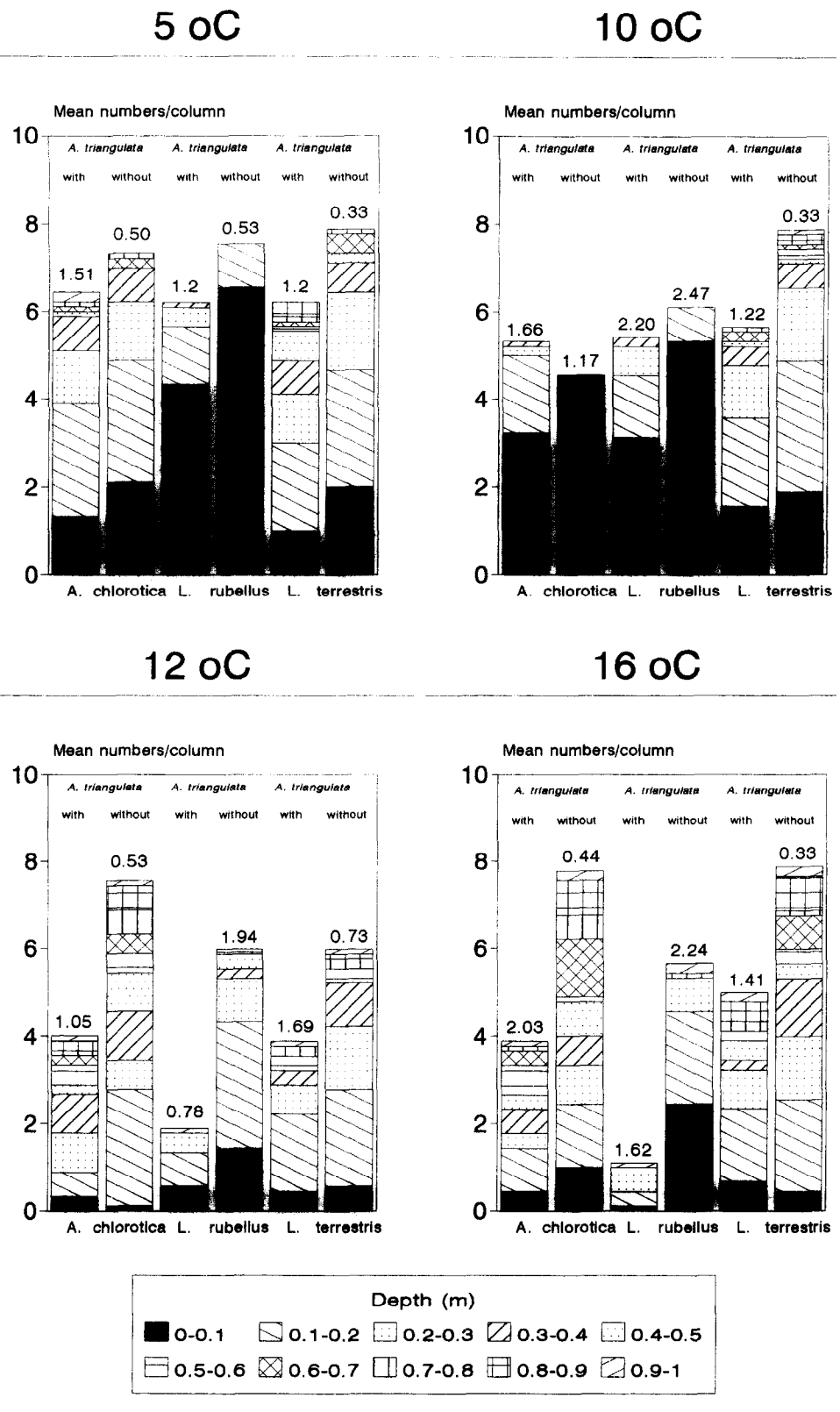

Fig. 1. Recovery of earthworms from soil columns with or without the predatory planarian *A. triangulata* after 3 weeks. Numbers are the standard deviations of earthworm counts (n = 9).

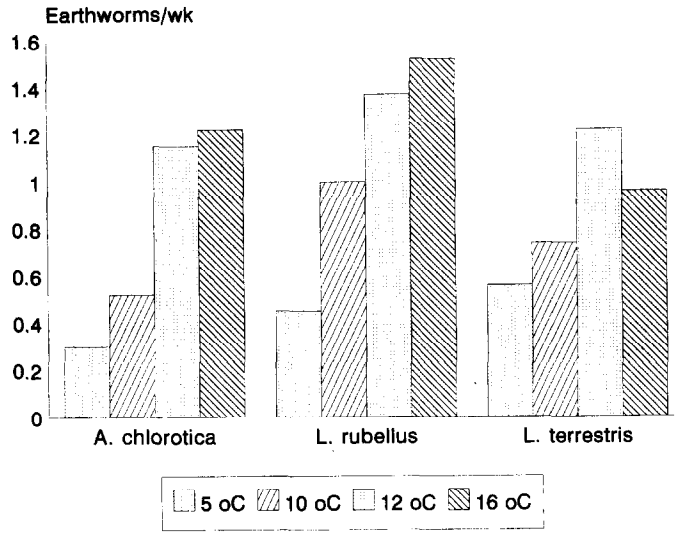

Fig. 2. Estimated predation rates for three earthworm species at four temperatures.

(5°C—$P < 0.001$, SEM = 0.272; 10°C—$P < 0.001$, SEM = 0.549; 12°C—$P < 0.001$, SEM = 0.336; 16°C—$P < 0.001$, SEM = 0.417) on the survival of earthworms at all temperatures (Fig. 1). There were significant differences in survival of the three earthworm species at all but 5°C (10°C—$P < 0.001$, SEM = 0.448; 12°C—$P < 0.001$, SEM = 0.412; 16°C—$P < 0.001$, SEM = 0.511) but there were no significant planarian–earthworm species interactions ($P > 0.05$).

Estimations of predation rates wk^{-1} were made by subtracting mean numbers surviving in planarian-treated tubes from control means and dividing by 3. Predation rates were related to temperature and increased from 5 to 12°C (Fig. 2).

Artioposthia triangulata significantly influenced the depth profile of each earthworm species (5°C—$P < 0.001$, SEM = 0.214; 10°C—$P < 0.001$, SEM = 0.208; 12°C—$P < 0.001$, SEM = 0.276; 16°C—$P < 0.01$, SEM = 0.237). These effects occurred largely in the top 20 cm of the soil columns where the planarian reduced numbers of earthworms (Fig. 1).

DISCUSSION

Individual *A. triangulata* were recovered from the pipes over the full range of depths. There was also evidence from earthworm remains that feeding had occurred throughout the column profile. The significant interaction between the planarians and the depths at which earthworms were found confirms that predation is not confined to the soil surface but can also occur deeper in the soil profile. The data do, however, indicate that most predation in soil is close to the surface.

The earthworm species used in this study represent the ecological groupings Epigées (*L. rubellus*), Aneciques (*L. terrestris*) and Endogées (*A. chlorotica*) proposed by Bouche (1977). There was, however, no significant difference in planarian feeding effects on each of the three earthworm species. This suggests that, under the experimental conditions, differential availability of, or selection for, prey did not occur. While this contrasts with previous observations (Blackshaw, 1990) it should be noted that the populations of earthworms in the pipes equated to over 1000 m^{-2} and were therefore more readily available than at field densities. Equal susceptibility of the three earthworm species implies that frequency of *A. triangulata* feeding is dependent upon numbers of worms rather than their size so that prey population density rather than biomass will be critical for the rate of growth of the planarians.

The results clearly showed the importance of temperature in determining the rate of attack on earthworms (Fig. 2). The range of estimated predation rates (0.52–1.00 earthworms wk^{-1}) at 10°C (Fig. 2) is lower than that of 1.4 reported by Blackshaw (1991) for *Eisenia fetida* (Savigny) in Petri dishes which is unsurprising because the prey would have been harder to find in the current study. There was no increase in planarian feeding activity at 16°C compared with 12°C. It remains to be seen whether this is relevant to the field but, given that the upper lethal temperature of *A. triangulata* is around 20°C (Blackshaw and Stewart, 1992), such a result would not conflict with existing knowledge. *Artioposthia triangulata* activity may therefore be maximal at soil temperatures typical of Northern Ireland and this could be one factor to explain the success of

this planarian as an invader in north-west Europe (Blackshaw and Stewart, 1992).

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