Functional Ecology 1990, **4**, 357-368

Modelling the diffusion component of dispersal during recovery of a population of linyphiid spiders from exposure to an insecticide

Terrestrial

C. F. G. THOMAS*, E. H. A. HOL† and J. W. EVERTS
Department of Toxicology, Agricultural University, Bomenweg 2, 6703 HD Wageningen, The Netherlands

Abstract. This study was designed to describe the spatial and temporal dynamics of an assemblage of linyphiid spiders during recovery from local depletion by an insecticide. A field of winter wheat was partly sprayed with 10g a.i. ha^{-1} of deltamethrin. Of the linyphiid spiders, *Erigone atra* (Blackwall) was reduced by 89% and *Oedothorax apicatus* (Blackwall) females by 82%. Recovery of the populations is described in space and time by comparisons of relative densities of spiders at different distances from an adjacent unsprayed area using multiple-range tests, regression models and a diffusion model. Median estimated recovery times (ERT_{50}) are calculated for species at different distances from the unsprayed area. For *O. apicatus* females ERT_{50} ranged from 1·1 to 15·3 weeks and for *E. atra* from 3·7 to 6·5 weeks at 15 and 75 m from the unsprayed area. Differences in recovery patterns for three spider categories are explained in terms of susceptibility to the pesticide and modes of dispersal. The consequences are discussed with reference to interplot interference in field ecotoxicity trials and commercial practice.

Key-words: Deltamethrin, diffusion, dispersal, interplot interference, linyphiid spiders, modelling, spatial dynamics

Introduction

In ecotoxicological studies, the side-effects of pesticides on the beneficial fauna are typically assessed using fields divided into plots, each receiving different treatments (e.g. Everts *et al.*, 1990). The duration of effect is defined as the time taken for significant differences to disappear between the numbers of non-target animals trapped in treated and untreated plots. This effect is influenced by the movement of arthropods between plots and is therefore dependent on plot size and species ability and propensity to disperse. These and other factors affecting field experimental designs have been discussed by Jepson (1989).

This paper attempts to answer the following questions:

1 What happens to a linyphiid spider population following exposure to the insecticide deltamethrin?

2 How rapidly does the population recover by immigration from an adjacent reservoir population?

3 What are the differences between species?

4 How important are the different dispersal mechanisms in the recovery process?

Linyphiid spiders (Araneae: Linyphiidae) were studied for four main reasons. They are important predators of aphids in cereals (Sunderland, Fraser & Dixon, 1986; Sopp & Chiverton, 1987); they have been shown to be good indicators of insecticide side-effects (Everts *et al.*, 1989); they suffer high mortality when exposed to deltamethrin (Rzehak & Basedow, 1982; Basedow, Rzehak & Voss, 1985), and they are also common and abundant in a variety of arable crops.

Three linyphiid categories were examined in this study. Adults of female *Oedothorax apicatus* (Blackwall); male *Erigone atra* (Blackwall); male and female *Bathyphantes gracilis* (Blackwall). In dispersal studies, data are easier to interpret when there are no increases in numbers of animals due to reproduction. Previous studies on the population dynamics of two closely related species *Oedothorax fuscus* (Blackwall) (De Keer & Maelfait, 1987) and *Erigone arctica* (White) (van Wingerden, 1977) have indicated the adult summer population to be composed of the progeny of an overwintering generation. The summer adults produce offspring that do not reach maturity until the autumn. The adult population trapped

* Present address: C.F.G. Thomas, Department of Biology, University of Southampton, Medical and Biological Sciences Building, Bassett Crescent East, Southampton, SO9 3TU, UK.
† Present address: E.H.A. Hol, Institute of Wildlife Toxicology, Western Washington University, Bellingham, Washington, 98225, USA.